INSTALLATION MANUAL

FQIS Series 300

Document Nr.: AS94-FQISIM-03

Revision History:

Revision	*Date*	*Changes*
0	20.09.2005	initial document
1	14.10.2005	additionally added recommendations for ACP Sensors installation, location and installation instructions
2	06.03.2006	corrections of reverence numbers to intrinsic safe installation
3	07.02.2008	correction of note 1 under 3.2.1: at least three ground lines have to be connected to airframe ground with a short line

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1. General Description

1.1 Introduction

The **F**uel **Q**uantity **I**ndication **S**ystem is a fuel quantity and low fuel level sensing and indicating system. The system components are:

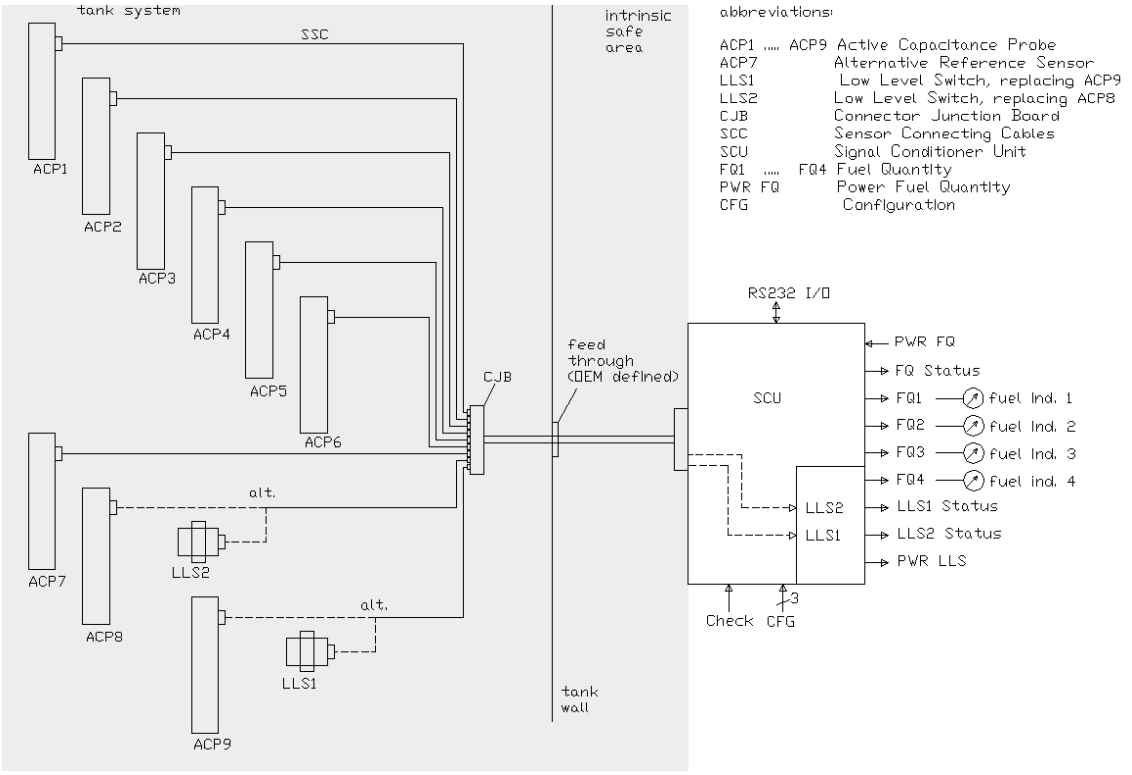
- **A**ctive **C**apacitance **P**robe (**ACP**) with mount
- **L**ow **L**evel **S**witch (**LLS**)
- **S**ignal **C**onditioner **U**nit (**SCU)** Conditioner including Firmware (**SCF**)

The **FQIS** Series 300 is a multi-probe active capacitance device used to determine the fuel quantity and an optronical device to detect a low level fuel state in aircraft tanks.

Digital capacitive probe values and the low level signal(s) are monitored by a fuselage mounted electronic signal conditioner. Conditioned electrical signal values representing the fuel quantity and low level fuel state(s) are available for cockpit indicator display.

1.2 FQIS Series 300 System Overview

1.2.1 Block Diagram



1.3 Configuration

The FQIS Series 300 can be configured to match almost any given aircraft installation need. Up to nine Active Capacitance Probes (ACP) or a maximum of seven ACP and two Low Level Switch (LLS) can be combined to sense fuel levels in one tank or up to 4 tanks.

The Signal Conditioner Unit (SCU) can be configured to drive one to four ea. Fuel indicators with a dedicated Signal format: Voltage, Current, Frequency, Resistance Simulation and ARINC 429.

The specific system configuration depends upon the aircraft type.

The specific configuration is dedicated by following System Partnumber (P/N):

AS 0 1 - F Q A ❑ ❑ ❑ - 0 0 - 0 1 0 0
F G H

Indices FGH determining the type of Output				
F	**G**	**H**	**FQIS SERIES 300 SYSTEM**	
0	X	X	Configuration SCU to Voltage Level Outputs	U.out
1	X	X	Configuration SCU to Current Level Outputs	I.out
2	X	X	Configuration SCU to Frequency Outputs (PWM)	F.out
3	X	X	Configuration SCU to Resistance Emulation Output	R.out
4	X	X	Configuration SCU to ARINC429 Outputs	A429.out

Indices **X** and **X** for **G** and **H** indicates the Aircraft type application and the FQIS SERIES 300 system configuration for the specific A/C.

If installed by the Aircraft OEM the certification is part of the TC; if retrofit installed, an STC is needed for certification.

1.4 Technical Specifications

nominal operating voltage:	28 V
Supply voltage range:	15 – 32 V
current consumption:	< 0,5A
component accuracy:	± 1% of full scale.
update rate:	1 sec.
display delay:	pin strapable in the range of 10sec – 60 sec for 90% indicator response
FQ status output:	Open collector, Valid fuel quantity signals => 50mA max to ground
Low Level output:	Open collector, LLS immersed => 50mA max to ground. Signal may be customized delayed up to 30 seconds.
output value delay:	10sec to 60 sec for 90% indication selectable by pin strapping within output connector.
standard output:	DC voltage up to four outputs: 0V under range (fault condition), 0,5 to 4,5 VDC empty to full 5VDC over range

Optional outputs:

Current:	DC current up to four outputs: 2 mA under range (fault condition) 4 to 20 mA empty to full 22 mA over range
Resistive sensor emulation:	up to two outputs: 3 to 200 Ω
Frequency variable signal:	up to two outputs: range of 100 Hz to 5000Hz
RS 232:	9600 baud, 8 Bit, even parity;
ARINC 429:	high and low speed

1.5 ETSO Limitations

The System is certified and limited to ETSO-C55 standard.

1.6 Certification of Hardware

The System has been certified to SAE AS405C and to RTCA DO-160E for environmental qualification:

Section	Description	Category		Remarks
		SCU	ACP and LLS	
4	Temperature and altitude	(F2)	(F2)	1)
5	Temperature Variation	B	B	
6	Humidity	B	B	1)
7	Operational Shocks and Crash Safety	D	D	
8	Vibration	[(SRH)(TPE1)]	[(SRH)(TPE1)]	
9	Explosion Proof	E	A	2)
10	Waterproofness	W	X	
11	Fluids Susceptibility	X	F	3)
12	Sand and Dust	X	X	
13	Fungus	X	X	
14	Salt Spray	S	S	
15	Magnetic Effect	Z	Z	
16	Power Input	B	B	4)
17	Voltage Spike	A	A	4)
18	Audio Frequency Cond. Susceptibility	B	X	4)
19	Induced Signal Susceptibility	Z	Z	4)
20	RF Susceptibility	T	T	
21	Emission of RF Energy	B	B	4)
22	Lightning transient Susceptibility	[A3XXX]	[A3XXX]	
23	Lightning direct effects	X	X	
24	Icing	X	X	
25	Electrostatic discharge	A	A	

Remark 1) Higher test level standards demanded in SAE AS405C were additionally tested: Section 4: tested to –65°C, Section 6: tested to 100% relative humidity

Remark 2) Proof of intrinsic safety Ex-i following UL913 and EN50020 / VDE0170/0171

Remark 3) For sensor: immersed tested with Avgas 100LL, Mogas, Aviation Jet A or Jet A-1 fuel and diesel

Remark 4) explicit test for ACP, LLS and indicator not required. Test on SCU is performed with ACP, LLS and indicator connected.

SCU
DO-160E Env. Cat. (F2)BBD[(SHR)(TPE1)]EWXXXSZBABZTB[A3XXX]XXA

ACP, LLS and CJB
DO-160E Env. Cat. (F2)BBD[(SHR)(TPE1)]AXFXXSZBAXZTB[A3XXX]XXA

Performed tests are in most cases higher standards as specified at SAE AS405C. In cases where SAE AS405C claimed demands are higher test level standards, tests were performed at the claimed test levels of SAE AS405C.

1.7 Certification of Software

The FQIS SERIES 300 Signal Conditioner Unit (SCU) contains built in software. The built in Firmware is certified according EUROCAE ED-12B and RTCA DO-178B Software Level C.

This software is determined as built in Firmware and is not field serviceable.

1.8 Remarks for intrinsic safe installation:

Cables from Sensors to Tank break through and to the SCU are subject to electrically intrinsic safe installation. Regulation for intrinsic safe installation have to be followed. See Document AS94-FQISUL-00 and corresponding Document AS94-FQISAC-00 respective FAA Advisory Circular AC25.981-1C.

1.9 Limited Warranty

The FQIS Series 300 System and its complete subunits are warranted to be free from defects in materials or workmanship for two years from date of purchase. This warrants does not cover failures due to abuse, misuse, accident or unauthorized alterations or repairs.

IN NO EVENT AVIONIK STRAUBING WILL BE LIABLE FOR ANY INCIDENTAL, SPECIAL INDIRECT OR CONSEQUENTIAL DAMAGES, WHETHER RESULTING FROM USE, MISUSE OR INABILITY TO USE THIS PRODUCT OR DEFECTS IN THE PRODUCT.

Avionik Straubing retains exclusive right to repair or replace the unit or software or offer a full refund of the purchase price at its sole discretion. This shall be a sole and exclusive remedy for any breach of warranty.

To obtain warranty service contact Avionik Straubing GmbH or the aircraft Manufacturer (OEM).

AVIONIK STRAUBING GmbH
Flugplatzstr. 5
D-94348 Atting
Germany

2. Installation

2.1 Introduction

To achieve the desired reliability and performance of the product careful planning of the installation with all advices are to be considered. Any deviation of the installation instructions prescribed in this document shall be in accordance with the requirements set forth in FAA AC25.981-1C and 14 CFR Part 43.

The installation of the FQIS Series 300 System is always based on a TC or STC.

2.2 Installation Considerations

2.2.1 Active Capacitance Probe (ACP) location

The ACP location has to be defined together with the aircraft manufacturer to minimize the influence of pitch, roll and centrifugal forces to the actual level indication.

For complex tank geometry and a multiple ACP configuration computer based optimization programs apply.

2.2.2 Low Level Switch (LLS) location

The LLS location depends upon the minimum required fuel level. The LLS can be horizontally or vertically mounted as feasible depending upon specific tank geometry.

2.2.3 Signal Conditioner Unit (SCU) location

The SCU should be located in the close vicinity of the tank break trough connector. The content of intrinsic safe installation as outlined in 1.8 applies.
The SCU can be mounted in any mechanical position.

2.2.4 Wiring and Cables

Intrinsic safe installation procedure according 1.8 generally apply.

For internal tank wiring use the prefabricated RG-316/U coaxial cable assemblies. Use AWG 22 Tyco-Raychem 44- or 55 series or equivalent wires for the connection of the SCU to the aircraft.

Intrinsic safe installation of the critical wiring Tank break through connector to the SCU can be archived by a short as possible cable harness which is separated from any other aircraft cabling. Shielded cables are used to protect these intrinsic safe lines.

The tank break through connector must be approved by Avionik Straubing GmbH for technical characteristics as described in ANSI/UL913. This connectors must comply to regulations determined in ANSI/UL913, Table 9.1.

for Voltages ≤ 10,0 Volts:	
clearance distance between Pins:	≥ 1,5 mm
creepage distance between Pins:	≥ 1,5 mm

One shielding around the whole cable harness is acceptable.
The wires inside the shielding have not to be shielded (coaxial).

Shielding is connected to airframe ground on each side using a separate cable. This uncommon installation is necessary due to protection from lightning induced transients. Problems with induced noise are not encountered since digital signal transmission. The intrinsic safe lines have to be separated from other cable harnesses (see AC25.981-1C or later).

If long intrinsically safe wires from SCU to the break through tank connector are necessary, additional means of transient suppression devices near the tank should be considered to be installed.

2.3 Installation Procedure

Intrinsic safe installation procedure according 1.8 generally apply.
For the electrical and mechanical installation aircraft specific installation praxis applies according AC43-13-2A.

2.3.1 ACP installation

The mechanical and electrical installation of ACP-Sensors are highly depending on the specific aircraft tank configuration. So only a few general descriptions apply:

1. Install ACP-Sensors according to installation instructions of the Aircraft manufacturer for the specific aircraft. Use non corrosive, self locking screw material.
2. The minimum clearance between the tank walls and the Sensors must be:
   - for metallic tank material:
     - 10 to 20mm lower Sensor side
     - 10 mm minimum upper Sensor side
   - for isolating tank material:
     - 5 to 8mm on lower Sensor side
     - 3 to 5 mm on upper Sensor side
   - for carbon fibre tank material, see below

   Guidelines for exact application dimensions for clearances had to be approved by Avionik Straubing and airframe manufacturer.
3. Insert SMB Coaxial Connector of SCC into SMB Jack of ACP Case
4. After connecting the SMB Coaxial Connector to the ACP-Sensor fix SCC Cable Assembly with an adequate nylon Ty-Rap (min. 3 mm width) to the outer ACP-Tube or the lower mounting bracket at a maximum distance of 5 cm to the SCC Connector depending on the length of the actual Sensor.

For mechanical dimension see figure 5-1 and 5-2.

2.3.2 LLS installation

The mechanical and electrical installation of LLS-Sensors are highly depending on the specific aircraft tank configuration. So only a few general descriptions apply:

1. Install LLS-Switch according to installation instructions of the Aircraft manufacturer for the specific aircraft. Use non corrosive, self locking screw material.
2. Insert SMB Coaxial Connector of SCC into SMB Jack of LLS Switch
3. After connecting the SMB Coaxial Connector to the LLS-Sensor fix SCC Cable Assembly with an adequate nylon Ty-Rap (min. 3 mm width) to the LLS-Tube close to the SCC Connector.

For mechanical dimension see figure 5-3.

2.3.3 SCU installation

The SCU mechanical installation to the aircraft fuselage at the predefined position has to be performed using four ea. 10/32 inch screws. According UL913 additional grounding of the SCU housing has to be connected to aircraft chassis via a 6mm² minimum (AWG 10 or 2 x AWG 12).

Connecting points are mechanical mounting lugs.
Use tooth washer and verify clean metal contact surface.

For mechanical dimension see figure 5-4.

2.3.4 Cable installation

Use aircraft installation praxis as outlined in AC43-13-2A. Special care is necessary in the fields of: vibration, induced cable damage, crimping techniques, minimum bending radius and cable identification.

3. System interconnects

3.1 SCU

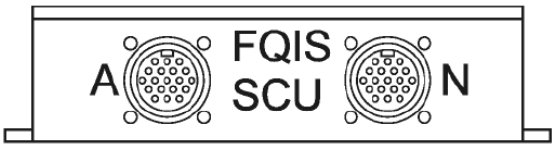


Fig. 3-1: position of SCU connectors

SCU Connector Sockets (male):

- Type A (J1): P/N AS51-20D19A-00
- Type N (J2): P/N AS51-20D19N-00

Corresponding cable connector (female):

- Type A: P/N: AS52-26D19A-00
- Type N: P/N: AS52-26D19N-00

3.1.1 Connector J1 tank / sensor side Type A Connector Socket

Pin	Direction	Signal	Remark	MD25m
A	SIG	ACP 1		1
B	GND	ACP 1 return		2
C	SIG	ACP 2		3
D	GND	ACP 2 return		4
E	SIG	ACP 3		5
F	GND	ACP 3 return		6
G	SIG	ACP 4		7
H	GND	ACP 4 return		8
J	SIG	ACP 5		9
K	GND	ACP 5 return		10
L	SIG	ACP 6		11
M	GND	ACP 6 return		12
N	SIG	ACP 7		13
P	GND	ACP 7 return		14
R	SIG	ACP 8 / LLS 2	depending on modification	15
S	GND	ACP 8 / LLS 2 return		16
T	SIG	ACP 9 / LLS 1	depending on modification	17
U	GND	ACP 9 / LLS 1 return		18
V	reserved			19

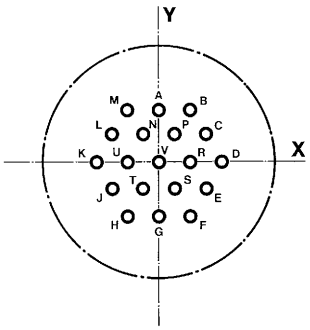


Fig.3-2 Pin Position of Connectors

3.1.2 Connector J2 Input / interface side Type N Connector Socket

Pin	Direct.	Signal	Remark	MD25f
A	IN	VS-FQ	28 VDC for fuel quantity	1
B		GND (1) / return		2
C	OUT	STATUS-FQ	Open collector, Low = valid signals	3
D	OUT	CH 1	Voltage 0-5V / current 4-20mA (2) Tank 1	4
E	OUT	CH 2	Voltage 0-5V / current 4-20mA (2) Tank 2	5
F	OUT	CH 3	Voltage 0-5V / current 4-20mA (2) Tank 3	6
G	OUT	CH 4	Voltage 0-5V / current 4-20mA (2) Tank 4	7
H		GND (1)		8
J	OUT	CHA	ARINC 429 Signal A / PWM / frequ. / res. Emul. (2,3)	9
K	OUT	CHB	ARINC 429 Signal B / PWM / frequ. / res. Emul. (2,3)	10
L		GND (1)		11
M	IN	/CHECK	Connect to GND for service mode	12
N		RxD	Receive RS232 serial data	13
P		TxD	Transmit RS232 serial data	14
R		GND (1)		15
S	OUT	LLSW 2	Open collector, Low = sufficient fuel (2)	16
T	OUT	LLSW 1	Open collector, Low = sufficient fuel (2)	17
U		GND (1)		18
V	IN	VS-LL	28 VDC for low level switch	19

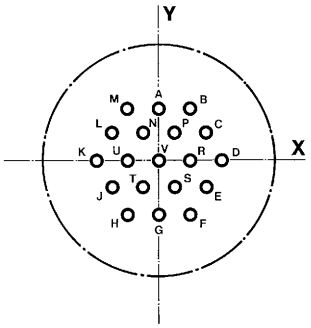


Fig.3-2 Pin Position of Connectors

1. at least three ground lines have to be connected to airframe ground with a short line. Additionally the blank connection of the SCU unit housing has to be connected to airframe ground using a strong connection wire or band (6mm²).
2. depending on hardware modification
3. PWM, frequency and resistor emulation output have only two tank systems (tank1 and tank2). ARINC 429 transmits the levels of up to 4 tanks via one serial data interface using the signals CHA and CHB.

3.2 ACP

Use prefabricated Sensor Connecting Cables (SCC). This SCC are built by Avionik Straubing GmbH and are specific for each aircraft application.

3.3 LLS

Use prefabricated Sensor Connecting Cables (SCC). This SCC are built by Avionik Straubing GmbH and are specific for each aircraft application.

4. Post Installation Checkout

For post installation checkout and troubleshooting a dedicated Service Adapter Data Cable is available and can be ordered at Avionik Straubing GmbH.

1. Thoroughly check mechanical and electrical installation as outlined above
2. Set system to service mode by alternating Switch S1 of Service Adapter Cable to GND position (this switches J2, PIN M to ground)
3. Connect Personal Computer (PC) to RS232 I/O
4. Start Terminal Program on PC (with LF enabled)
5. Power the System Up
6. Check RS232 Protocol on PC for:
    a. correct Tank Values: 0 for empty Tanks
    b. no error messages
    c. Status.out is Valid (Low)
7. Check Analog Outputs for T1 to T4 (depending on configuration):
    a. Voltage Output Versions
       U.out values alternating periodically for 4 seconds
       in the following Steps: 0,25V, 0,5V, 2,5V, 4,5V
    b. Current Output Versions
       I.out values alternating periodically for 4 seconds
       in the following Steps: 4mA, 12mA, 20mA
8. Set system to normal operation mode mode by alternating Switch S1 of Service Adapter Cable to OPEN position (this switches J2, PIN M open)
9. Check Analog Outputs for T1 to T4 (depending on configuration):
    a. U.out values must be 0,5 Volt for empty Tanks
    b. I.out values must be 4 mA for empty Tanks

5. Troubleshooting

For troubleshooting see FQIS SERIES 300 System Maintenance Manual P/N AS94-FQAMTM-00 or for further assistance call Avionik Straubing GmbH.

6. Drawings:

6.1 Schematics for installation principles in aircrafts

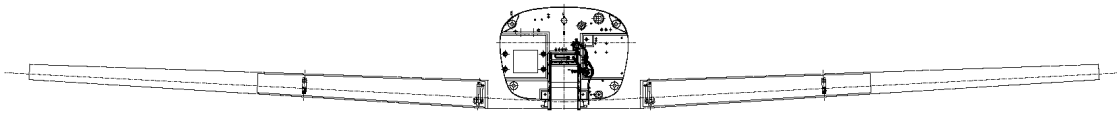


Fig. 6-1: Position of Sensors in Aircraft wings

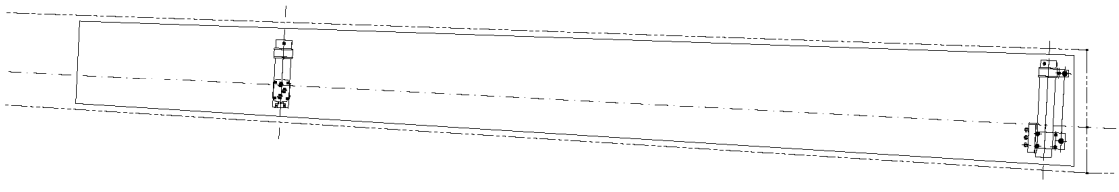


Fig. 6-2: Position of Sensors in Aircraft wing

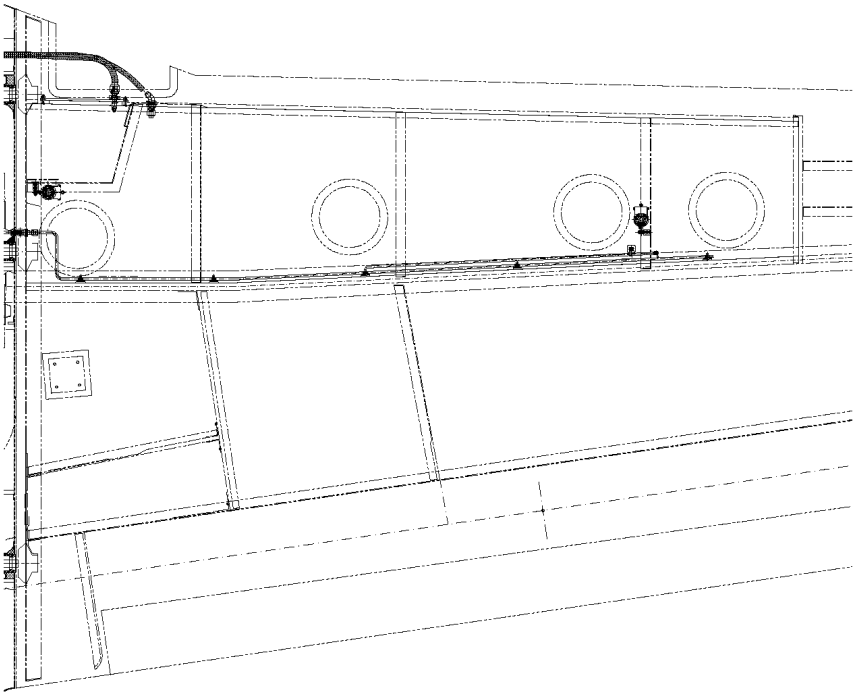


Fig. 6-3: Position of Sensors in Aircraft wing (top view)

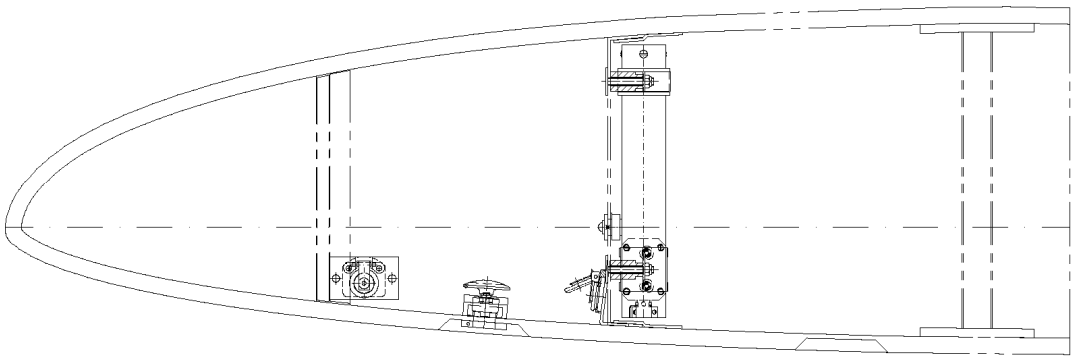


Fig. 6-4: Position of Sensors in Aircraft wing (wing section)

6.2 Active Capacitance Probes (ACP) Type B Dimensions for Installation

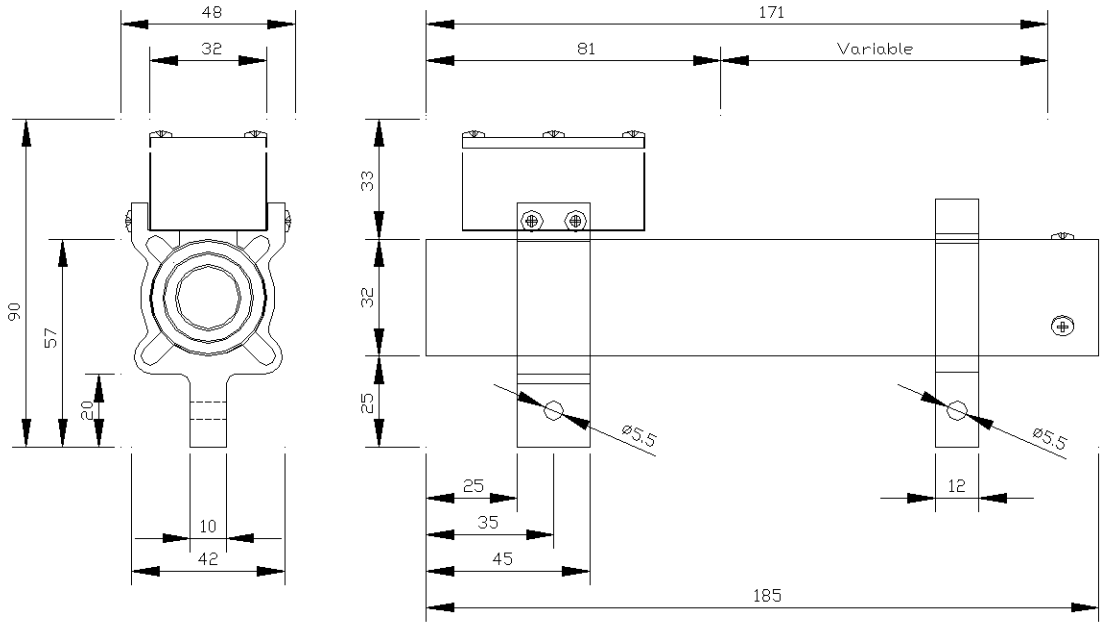


Fig. 6-5: Inboard ACP Sensor

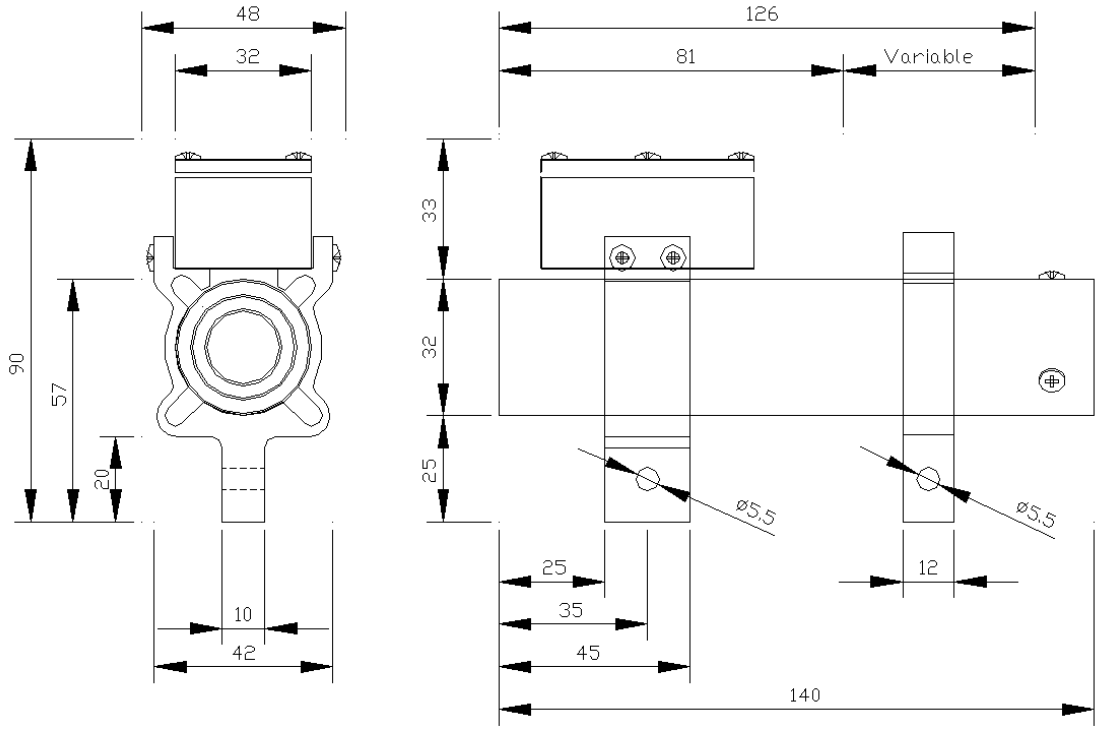


Fig. 6-6: Outboard ACP Sensor

6.3 Low Level Switch (LLS) Dimensions for Installation

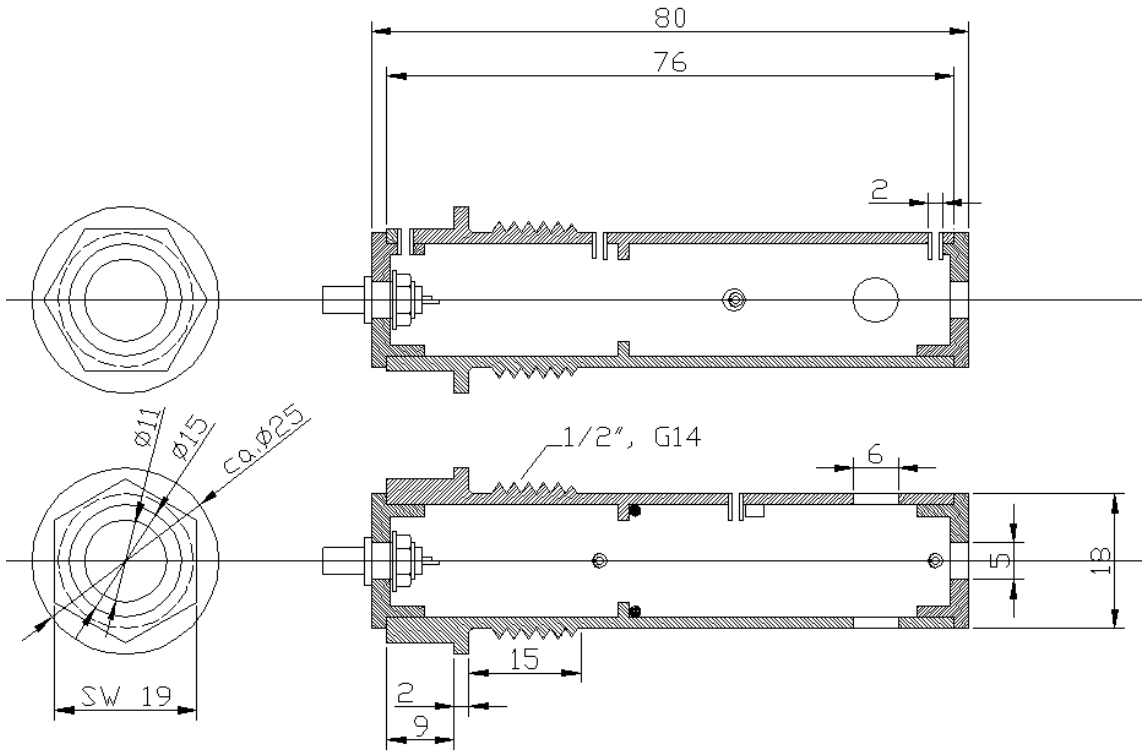


Fig. 6-7: LLS Switch

6.4 Signal Conditioner Unit (SCU) Dimensions for Installation

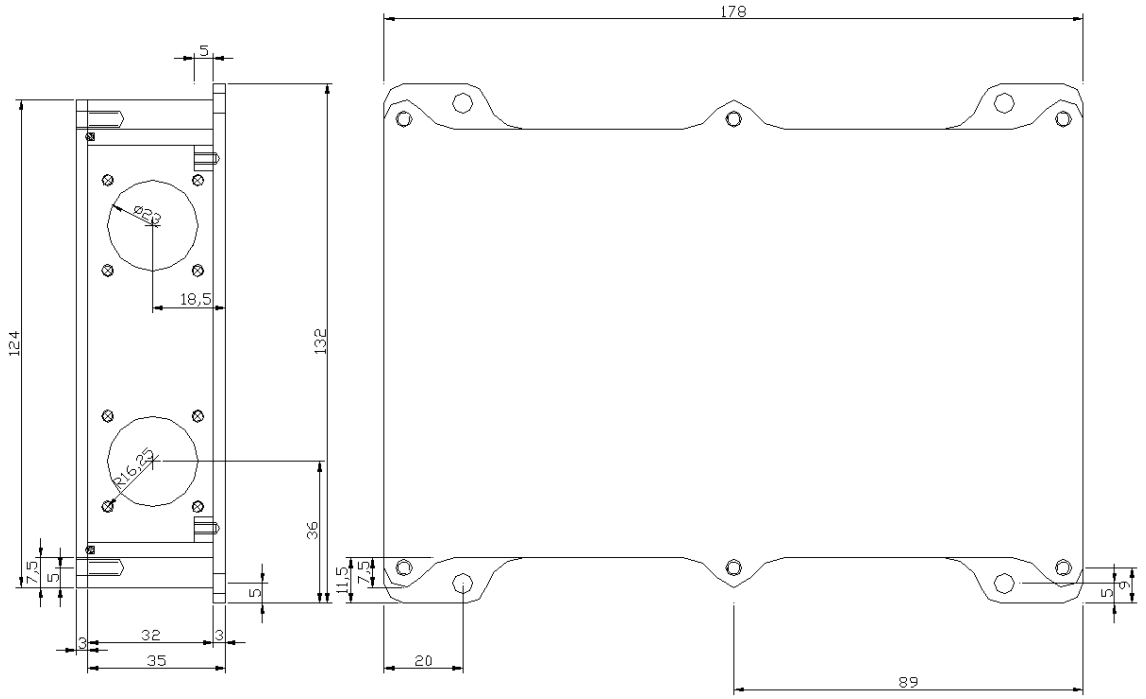


Fig. 6-8: SCU

6.5 Sensor Connecting Cables (SCC) Dimensions for Installation

The dimensions and mechanical characteristics of the SCC's are highly depending on installation in certain Aircrafts. Use only original prefabricated SCC produced by Avionik Staubing GmbH for tank internal sensor connection.