Propeller Synchrophaser System Technical Description

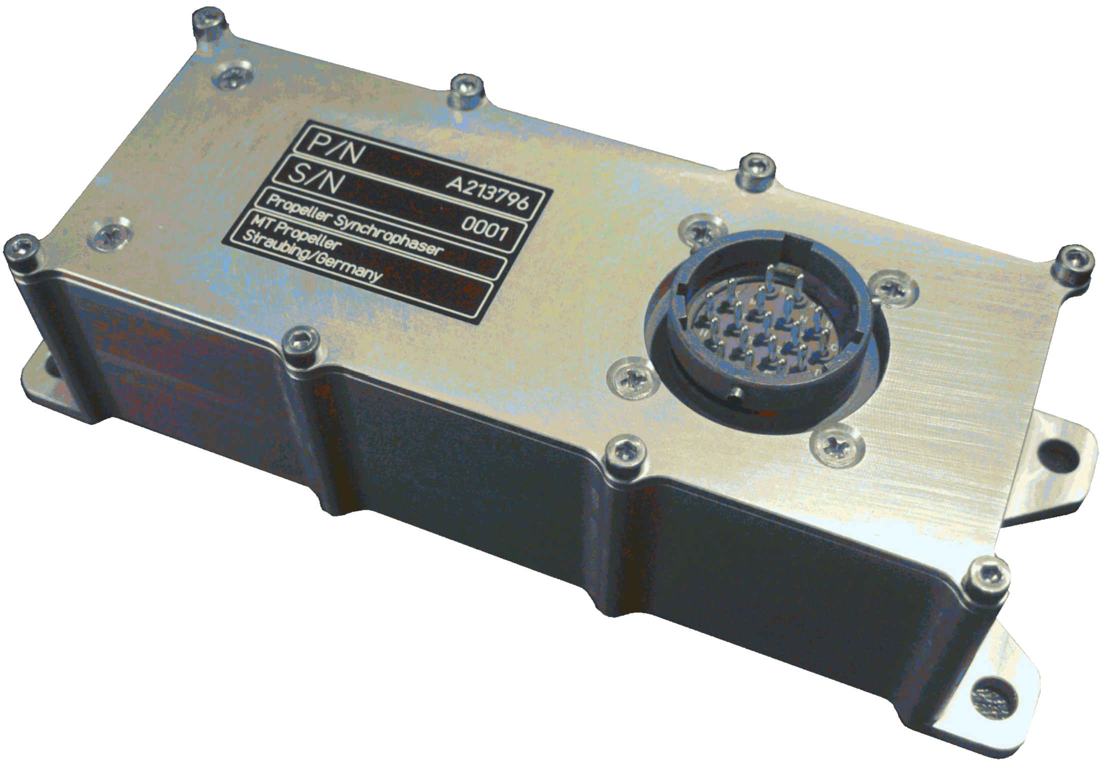

Table of Contents

1 Introduction....2
2 Theory of Operation....2
3 Mechanical and Electrical Specification....3
4 Synchrophaser System Interfaces....4
4.1 Activation Switch and Status LED Interface....6
4.2 CANaerospace Network Interface....6
4.3 System Normal Operation Data....6
4.4 Normal Operation Data Format....7

1 Introduction

the MT Propeller Synchrophaser System controls the propeller speed and phase relationship on twin-engine aircraft to eliminate engine beats and minimize sound and vibration in the aircraft. The system receives speed signals from the left and right engine, compares their frequency and phase relationship, and produces correction signals that are imposed on the left and/or right propeller governor. The correction signals allow the slower propeller to increase and the faster propeller to decrease in speed, until both propellers are rotating at the same speed.

The Synchrophaser System also controls the phase relationship of the two propellers by electronically delaying the speed signal from the right or left propeller. The amount of delay is evaluated during flight test to minimize sound and vibration in the cockpit. A CANaerospace network interface allows the Synchrophaser System to communicate with other aircraft systems for data exchange, maintenance operation and system configuration.

2 Theory of Operation

The Synchrophaser System electronics is based on a high performance 32-bit microcomputer system with floating-point computation capabilities that interfaces to Variable Reluctance Speed (VRS) magnetic pickup transducers from the left and right engine and to magnetic coil actuators within the left and right propeller governors.

Power is applied to the Synchrophaser System by means of a circuit breaker, while activation of the system is accomplished by means of a switch marked OFF/PHASE mounted on the aircraft instrument panel. Activation of the system is confirmed by an indicator LED, also mounted on the aircraft instrument panel. All signal and power connections between the aircraft and the Synchrophaser are accomplished through a single multi-pin MS27499 connector.

The speed pickup transducers, used for rpm and phase measurement contain a permanent magnet around which is wrapped around a coil of wire. A ferrous rotating element with a single projection or tooth is mounted on the engine drive shaft. As this shaft rotates, the projection on the rotating element passes through the flux field of the permanent magnet and causes an electrical current to be induced into the wire around the magnet. The repetition rate of this induced signal bears a proportional relationship to the speed of the rotation of the engine. The output amplitude of the signal varies with rotation speed and is around 2.0 volts AC peak at 1800 rpm.

The output signal from each speed pickup transducer is applied to a low pass filter network to reduce or eliminate interference from onboard radio transmitting equipment and transient signals that may be induced into the pickup leads. Each of the filtered signals is fed to a signal conditioning circuit that converts these signals into noise-free, constant amplitude pulse trains, the repetition rate of which is proportional to the rotation rate of the individual propellers.

The speed signals are applied to a microcomputer system which measures rpm and phase between the two propellers with high accuracy. The rpm and phase control between the two propeller is computed in software, and the resulting corrections are transformed into pulse width modulated output signals for the left and right propeller governor. Each governor allows for a propeller blade angle correction that results in a rpm variation of 25 revolutions per minute. With both governors being controlled through the Synchrophaser, the maximum rpm correction range is therefore 50 revolutions per minute. If only one governor is controlled through the Synchrophaser, the maximum rpm correction range is 25 revolutions per minute, respectively.

A ISO 11989 compatible Controller area Network (CAN) interface provides communication with other aircraft systems. This interface can also be used during flight test to modify internal parameters (like the phase delay) and store information permanently into the internal memory of the Synchrophaser. Figure 2.1 shows the block diagram of the Synchrophaser System.

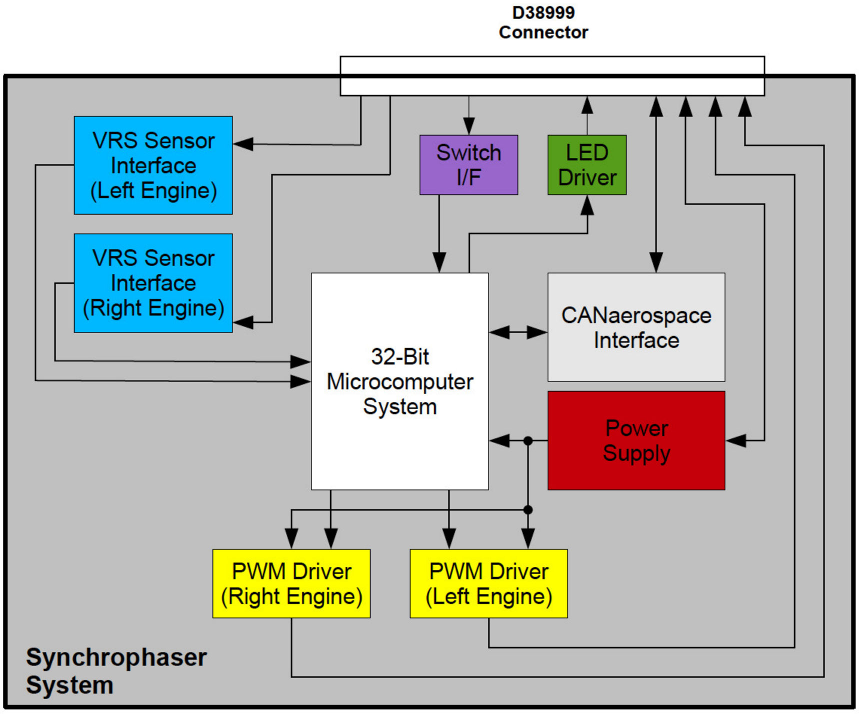

Figure 2.1: Synchrophaser System Block Diagram

3 Mechanical and Electrical Specification

The mechanical and electrical specification data of the Synchrophaser System are shown in Table 3.1.

Item	Specification Data
Mechanical Dimensions	115 mm x 49 mm x 31,5 mm (L x W x H) without flanges
Mass	0.23 kg
Electrical Power Supply	9 – 36 VDC
Power consumption	Coil dependant, up to 3A at 14 VDC supply
CANaerospace Interface	Isolated, according to ISO 11898
Operating Temperature Range	- 40° deg. C to + 85° deg. C
Operating Altitude	Up to 15000 m
Humidity	Less than 95%, non-condensing
Operational RPM Range	1500/min - 3500/min
Phase Measurement Range	360 degrees
Output Signals	0 – 100% Pulse width Modulated Voltage
User Interface	1 Activation Switch, 1 Status LED

Table 3.1: Synchrophaser System Specification Data

The three dimensional view with dimensions of the Synchrophaser System is shown in Figure 3.1. The enclosure is machined from aerospace grade aluminum and protected by Alodine 1200 surface treatment. The internal electronics is protected by conformal coating.

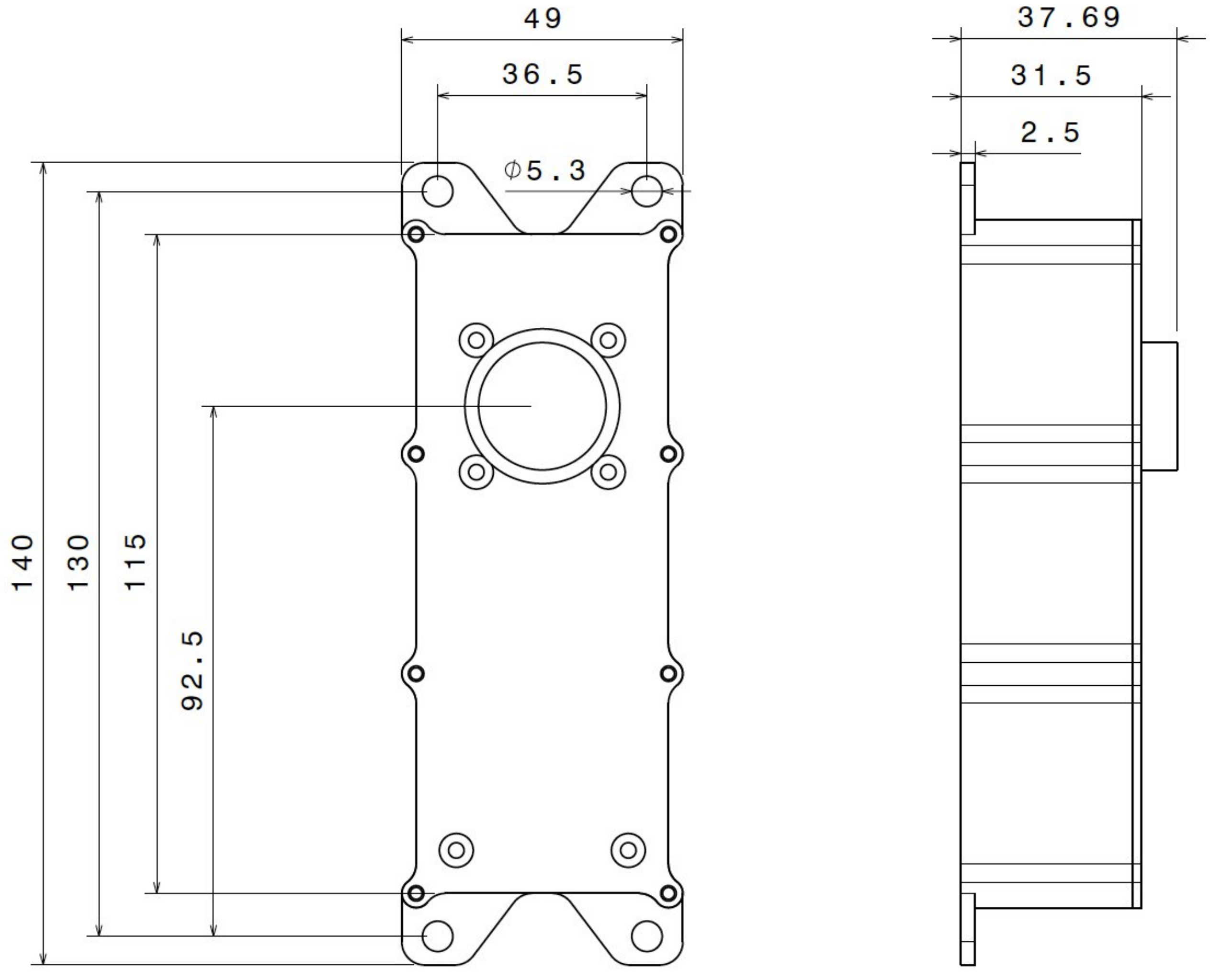

Figure 3.1: Synchrophaser System Dimensions

4 Synchrophaser System Interfaces

The Synchrophaser System has a single MS27499 interface connector combining all inputs and outputs. The system connector specifications are:

- Box Mount Receptacle: **MS27499E14B18P**
- Mating Straight Plug: **MS27473E14B18S**

The mating straight plug for the aircraft wire harness (MS27473E14B18S) can be purchased directly from Filcon Electronic GmbH, Rotwandweg 5, 82024 Taufkirchen, Germany (www.filcon.de) with order number 567021.

The pinout of the connector is described in Table 4.1, the connector layout is shown in Figure 4.1.

MS27499 Pin	Signal	Signal Direction (seen from Synchrophaser)
A	Aircraft Ground	Input
B	Aircraft Power (14VDC or 28VDC)	Input
C	Right SVR Speed Pickup Return	Input
D	Left SVR Speed Pickup Return	Input
E	Left SVR Speed Pickup	Input
F	Shield	-
G	Right SVR Speed Pickup	Input
H	RS-232 GND (do not make connections to this pin)	-
J	Left Coil Return	Output
K	Right Coil Return	Output
L	Left Coil	Output
M	Status LED	Output
N	RS-232 TxD (do not make connections to this pin)	Output
P	RS-232 RxD (do not make connections to this pin)	Input
R	Right Coil	Output
S	Activation Switch	Input
T	CAN-High	Bidirectional
U	CAN-Low	Bidirectional

Table 4.1: MS27499 Connector Pinout Description

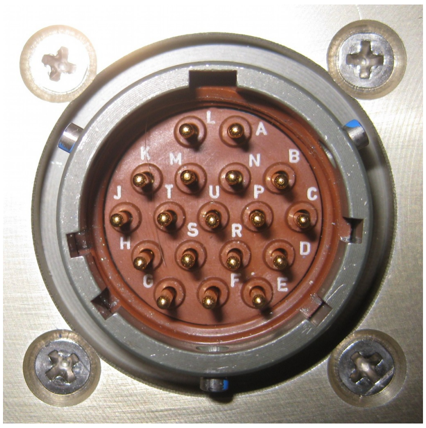

Figure 4.1: MS27499 Connector View

4.1 Activation Switch and Status LED Interface

The synchrophaser activation switch is electrically isolated. To activate the synchrophaser system, the switch has to connect pin "S" of the synchrophaser interface connector to aircraft ground.

The status LED is electrically isolated. This LED is illuminated by the synchrophaser software to display the current system status. The status informs the pilot about the operational state and potential error conditions of the synchrophaser system. The LED anode has to be connected to aircraft power using a current limiting resistor with the appropriate value. For an aircraft supply voltage of 14VDC and a rated LED current of 20mA, the current limiting resistor should have a value of 500Ω (This value has to be doubled for a 28VDC aircraft system). The LED cathode has to be connected to pin "M" of the synchrophaser interface connector.

4.2 CANaerospace Network Interface

The Synchrophaser System CAN interface conforms to ISO-11898-1 and ISO-11898-2. It is electrically isolated and uses the CAN-High and CAN-Low signals for communication on the network as shown in Figure 4.2. The CAN data rate is 1 Mbit/s. The CAN transceiver provides dominant timeout protection.

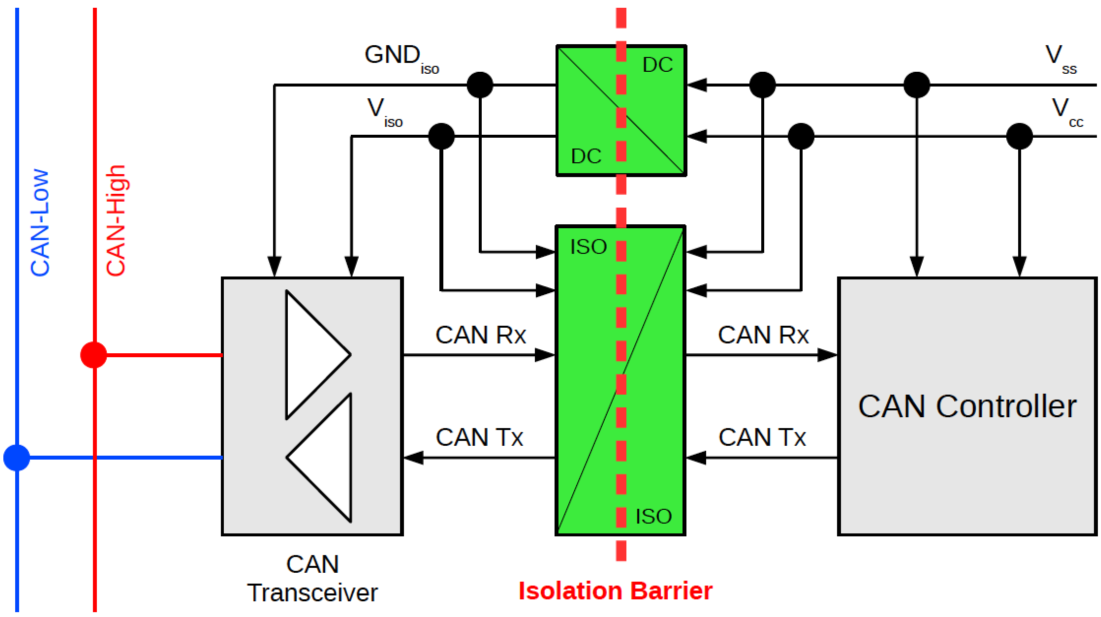

Figure 4.2: CANaerospace Network Interface

4.3 System Normal Operation Data

The Synchrophaser System continuously transmits Normal Operation Data CANaerospace messages as described in Table 4.2. This data is compatible with CANaerospace revision 2.0.

Parameter Name	Parameter Range	Node-ID	CANaerospace Identifier	Data Type	Service Code
Left Propeller Speed	1500/min – 3500/min	3	500	FLOAT	See Fig. 4.3
Right Propeller Speed	1500/min – 3500/min	3	501	FLOAT	See Fig. 4.3
Phase Delay	0ms - 500ms	3	556	FLOAT	See Fig. 4.3

Table 4.2: Synchrophaser Transmitted Normal Operation Data

4.4 Normal Operation Data Format

Figure 4.3 shows the format of Normal Operation Data messages transmitted by the Synchrophaser System. The Service Code of these messages contains sensor and computation status information which may be used by receiving stations to act correspondingly. The message code is incremented for each transmission. Each parameter uses its own message code for this purpose.

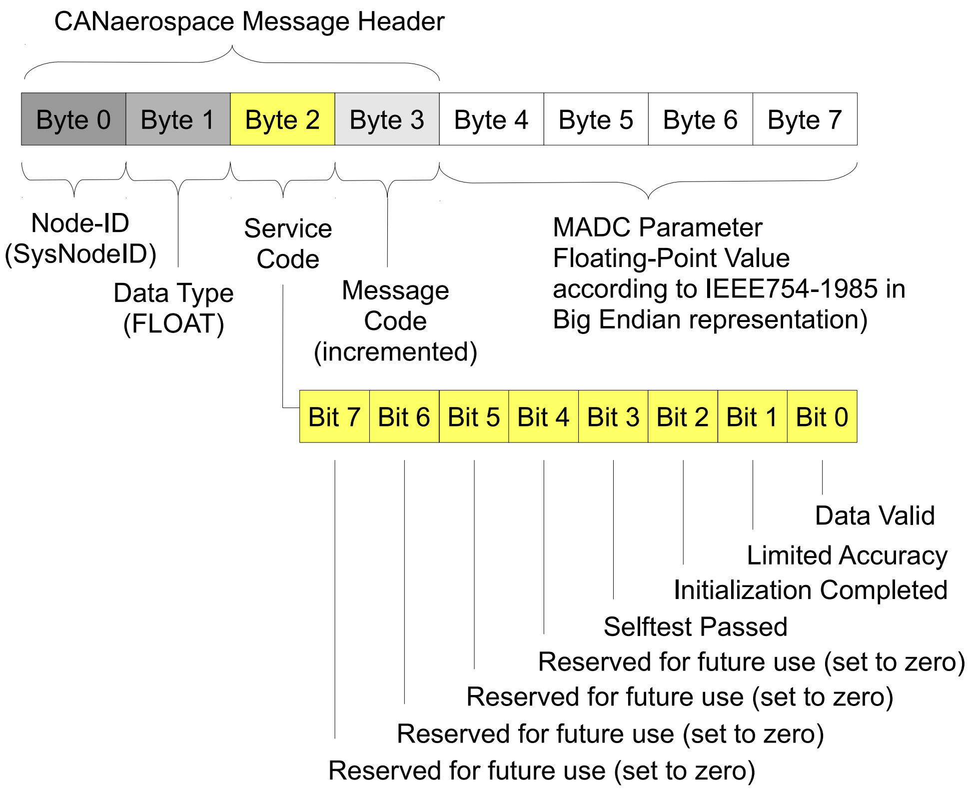

Figure 4.3: Normal Operation Data Format