mt-propeller

ATA 61-25-65

(E-2565)

Operation and Installation Manual

ELECTRONIC SYNCHROPHASER Control Box

Part No.: **P-8SP-( )**
Type: **( )-213796**

Revision 8: February 15th, 2022

The technical content of this document is approved under authority of DOA No. EASA.21J.020.

EASA DE.21G.0008
EASA.21J.020

Warning

People who fly should recognize that various types of risks are involved; and they should take all precautions to minimize them, since they cannot be eliminated entirely.

Before a MT Synchrophaser System is certified as being safe to operate on an airplane, an adequate margin of safety must be demonstrated. Even though every precaution is taken in the design and manufacture of a part, history has revealed rare instances of failures.

It is essential that the MT Synchrophaser System be properly maintained according to the recommended service procedures and a close watch be exercised to detect impending problems before they become serious. Unusual operation characteristics should be investigated and repaired as it could be a warning that something seriously is wrong.

As a fellow pilot, I urge you to read this Manual thoroughly. It contains a wealth of information about your new MT Electronic Synchrophaser Control System.

Thank you for choosing a MT-Propeller Synchrophaser System.
Properly maintained it will give you many years of reliable service.

Gerd R. Mühlbauer
President
MT-Propeller Entwicklung GmbH

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1	2014-10-02	2, 3, 8, 13, 14, 16;	Editorial Changes
2	2014-12-02	2, 3, 7, 13, 13-1, 19;	Editorial Changes
3	2015-11-19	2, 3, 18, 18-1, 19;	Editorial Changes
4	2018-09-18	2, 3, 9, 9-1, 10, 13, 13-1, 14,19;	Exchange of existing Synchrophaser Wiring Diagram Update of continuity and Resistance Values
5	2019-02-04	2, 3, 13;	New Synchrophasing Wiring Diagram
6	2020-05-29	2, 3, 18-1;	Synchrophasers without switch
7	2021-03-29	2, 3, 4, 14, 16, 18-1;	Synchrophasers without switch Update
8	2022-02-15	2, 3, 9;	Synchrophaser LED interface added

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1. GENERAL

The **MT-Propeller Synchrophaser System** controls the propeller speed 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 relationship, and produces correction signals that are imposed on the left and 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. A **CANaerospace network interface** allows the Synchrophaser System to communicate with a test box for data exchange, maintenance operation and system configuration.

2. DESCRIPTION

The **MT-Propeller Synchrophaser System** 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 from the aircraft engines is applied to the Synchrophaser System via 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 (optional), 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 which is wrapped around a coil of wire. A ferrous rotating element with a single projection or tooth is mounted on the deice slip ring or spinner bulkhead. As this 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 propellers. The output amplitude of the signal varies with rotation speed and is around 2.4 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 of the two propellers with high accuracy.

The rpm control of the two propellers 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 rpm. The maximum rpm correction range is 25 rpm. An ISO 11989 compatible Controller Area Network (CAN) interface provides communication with a test box. This interface can also be used during flight test to modify internal parameters and store information permanently into the internal memory of the Synchrophaser. Figure 3.1 shows the block diagram of the Synchrophaser System.

3. SPECIFICATION DATA

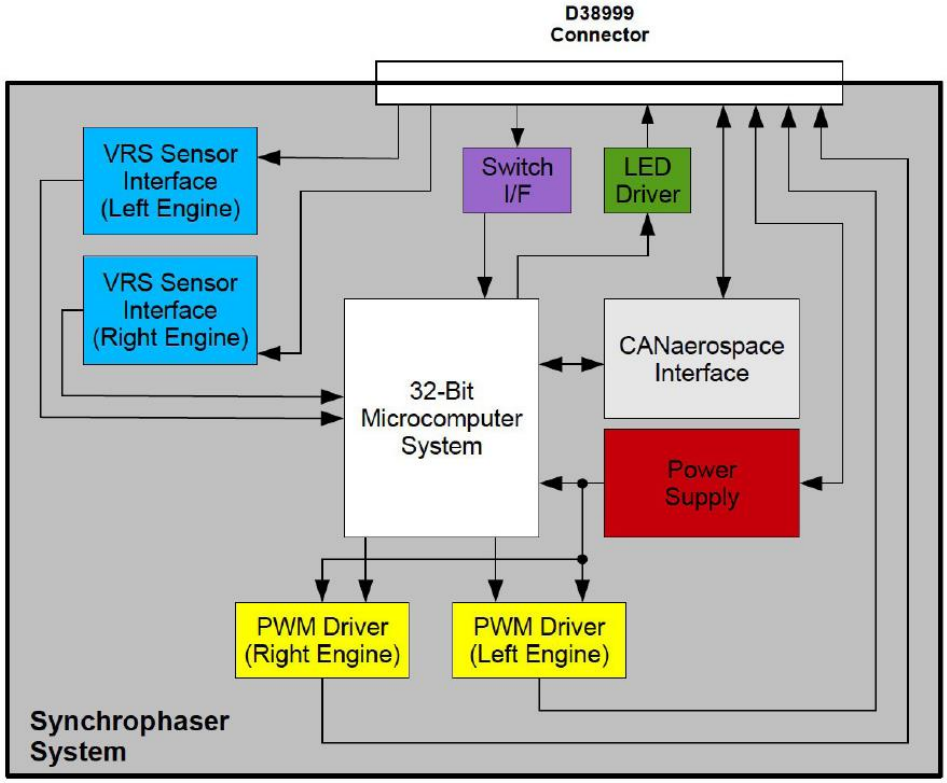


Figure 3.1: Synchrophaser System Block Diagram

Item	Specification Data
Mechanical Dimensions	115mm (4,53``) x 49mm (1.93``) x 31,5mm (1.24``) without flanges
Mass	0,23 kg (.51 lbs)
Electrical Power Supply	9 - 36 VDC
Power consumption	Coil dependant, up to 2A at 28 VDC supply
CANaerospace Interface	Isolated, according to ISO 11898
Operating Temperature Range	-40° deg. C to +85° deg. C
Operating Altitude	Up to 15000m
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

Figure 3.2: Synchrophaser System Specification Data

4. DIMENSIONS

The view with dimensions of the Synchrophaser Control box is shown in Figure 4.1. The housing is machined from aerospace grade aluminum and protected by Alodine 1200 or similar surface treatment. The internal electronics is protected by conformal coating.

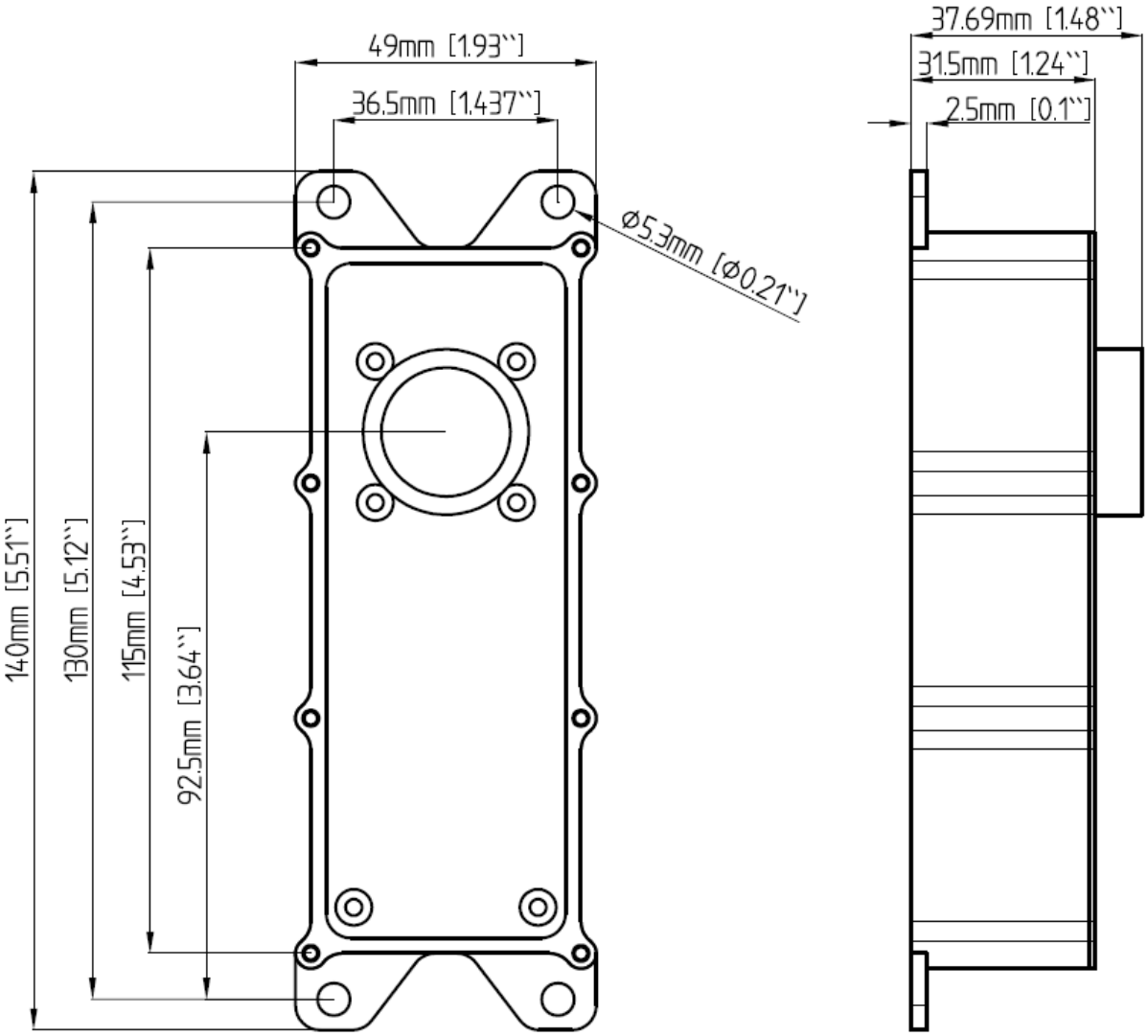


Figure 4.1: Control Box Dimensions

5. MODEL DESIGNATION

P	-	8SP	-	( )	/	( )-
1		**2**		**3**		**4**

Legend:

1: = Propeller Control
2: = Synchrophaser / Synchronizer
3: = Factory Phase Position
4: = Control Box Type

Figure 5.1: Control Box

6. CONNECTOR PIN DESCRIPTION

MS27499 Pin	Signal	Signal Direction (seen from Synchrophaser)
A	Aircraft Ground	Input
B	Aircraft Power (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 connection 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

The synchrophaser system has a single MS27499( )14B18( ) interface connector combining all inputs and outputs.

Figure 6.1: MS27499E14B18P Receptacle View

The system connector specifications are:

- Box Mount receptacle: **MS27499E14B18P**
- Mating Straight plug: **MS27473T14B18S**

7. ACTIVATION SWITCH NETWORK INTERFACE

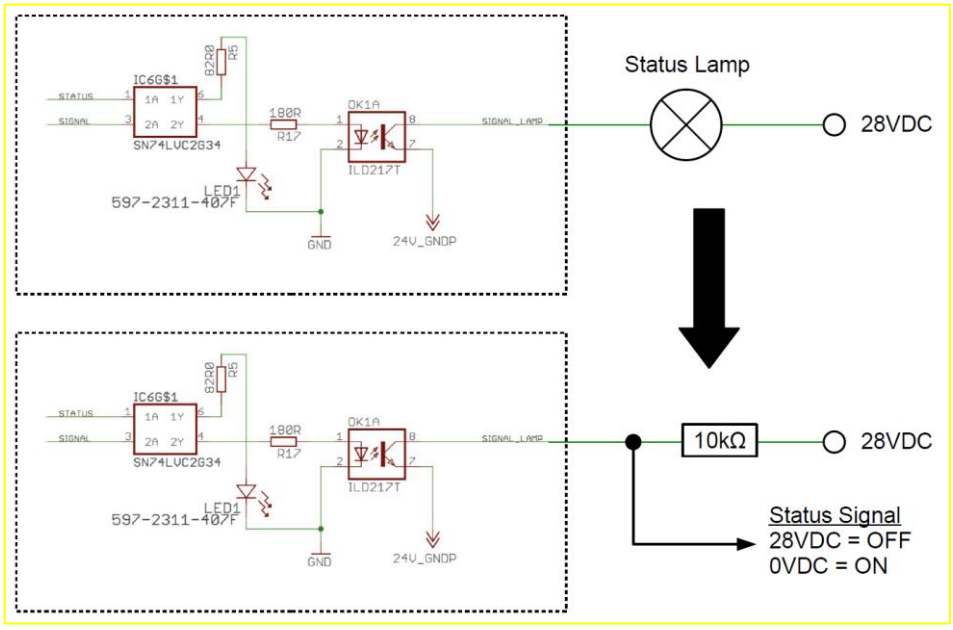
7.1 ACTIVATION SWITCH AND STATUS LED INTERFACE (OPTIONAL)

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.

Whenever the Synchrophaser is turned on through the Activation Switch, the Status LED indicates if the RPM difference of both propellers is small enough to allow synchrophasing:

- **LED steady green:** (optional)
  The RPM setting of both propellers is within the Synchrophaser's control range
- **LED flickering green:** (optional)
  The RPM setting of both propellers is on the edge of the Synchrophaser's control range (optional)
- **LED off:** (optional)
  The RPM setting of both propellers is out of the Synchrophaser's control range;
  The RPM setting has to be adjusted manually until the LED becomes green again.

In case the indication should be displayed in the glass cockpit the following interface is applicable:



7.2 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 7.1.
The CAN data rate is 1 Mbit/s. The CAN transceiver provides dominant timeout protection.

7.2.1 System Normal Operation Data

The Synchrophaser System continuously transmits Normal Operation Data CAN aerospace messages as described in Figure 7.1.
This data is compatible with CAN aerospace revision 2.0.

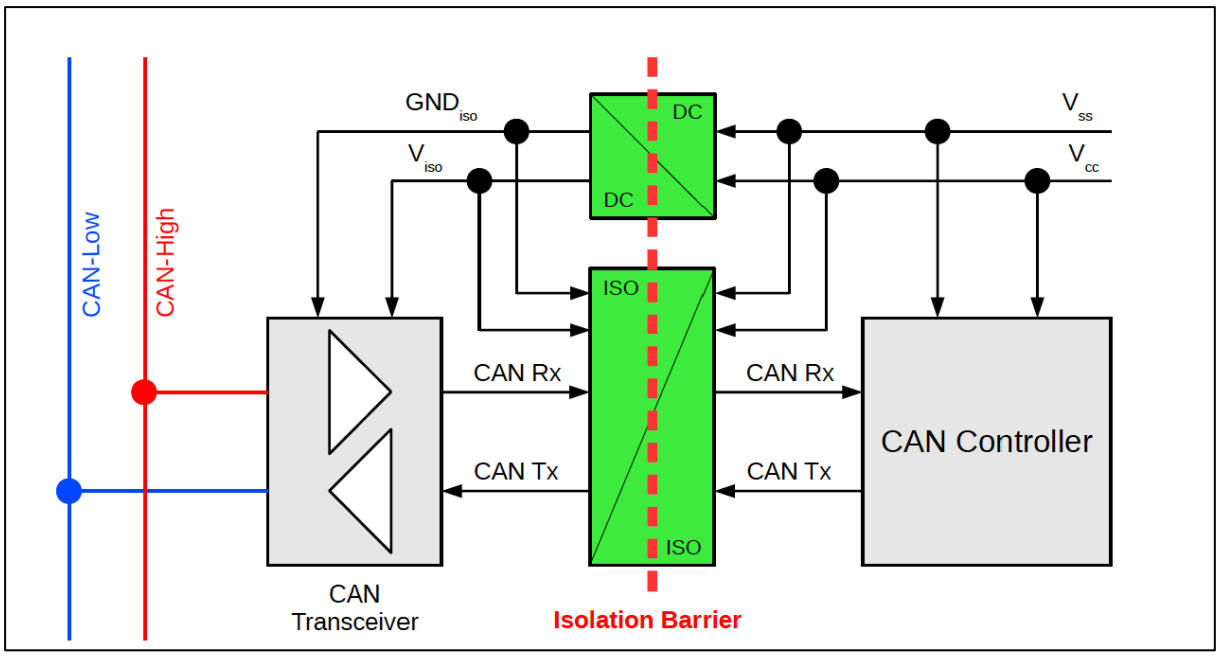


Figure 7.1: MS27499E14B18P Connector View

Parameter Name	Parameter Range	Node-ID	CAN aerospace Identifier	Data Type	Service Code
Left Propeller Speed	1500/min-3500/min	3	500	FLOAT	see Fig. 7.3
Right Propeller Speed	1500/min-3500/min	3	501	FLOAT	see Fig. 7.3
Phase Delay	0ms-500ms	3	556	FLOAT	see Fig. 7.3

Figure 7.2: CAN-Identifier

7.3 NORMAL OPERATION DATA FORMAT

Figure 7.3 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.

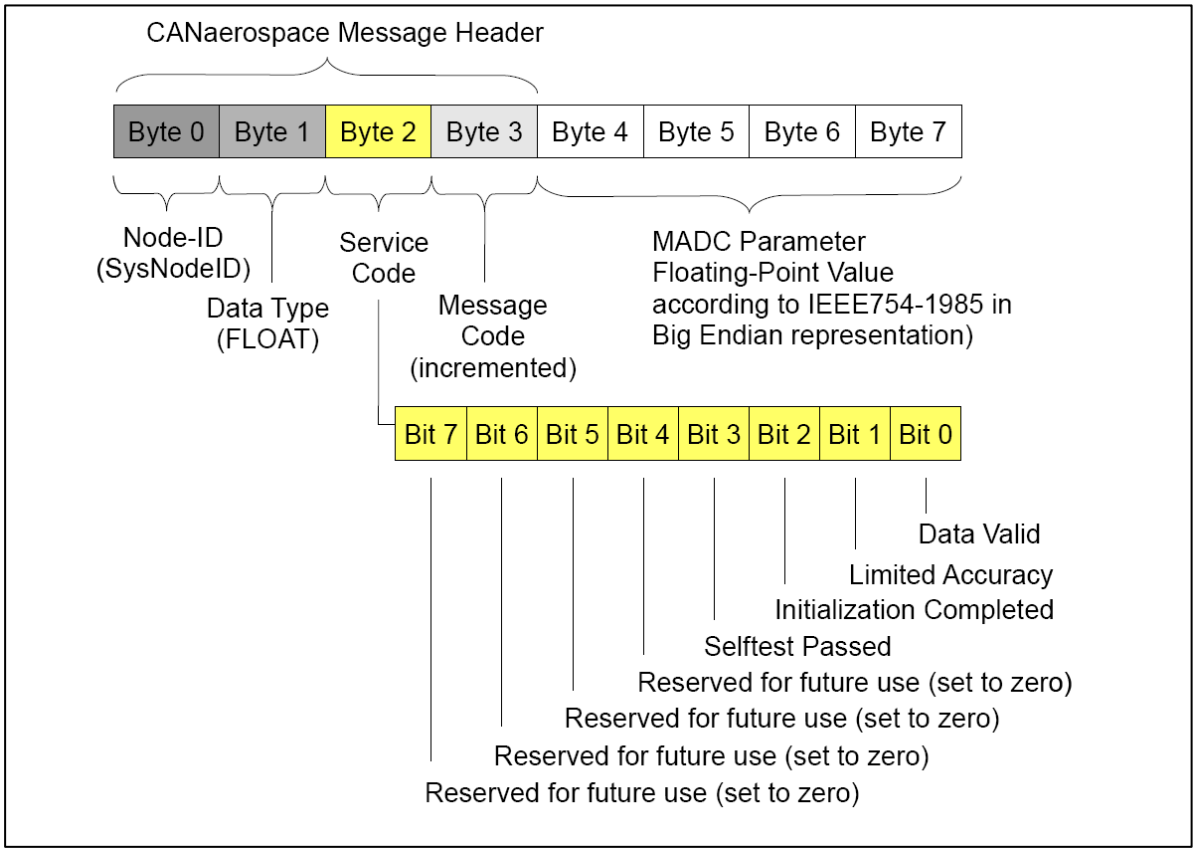


Figure 7.3: CANaerospace Data Format

8. INSTALLATION

8.1 LOCATION OF THE CONTROL BOX

The location of the Electronic Synchrophaser Control Box for installation may vary with each type of aircraft. However it is recommended to be in the cockpit. Figure 4.1 shows the dimensional data for installation. The instrument panel may also vary with each type of aircraft; however, the switch and indicator should be installed in an area convenient to the pilot.

Before connecting the Control Box to the aircraft wiring, verify, that each plug receptacle is connected to the appropriate system component according to the wiring diagram Fig.8.3. In particular, ensure that pins E and D, and pins G and C of the aircraft connector plug are connected to the individual magnetic pickups and that pins L and J, and pins R and K are connected to the proper governor control coils. Ensure that all wires are properly supported.

8.2 LOCATION OF THE TARGET

The target screws (or target brackets) should be installed behind blade no.1 on both sides.

8.3 SPEED PICKUP, TARGET SCREW AND MOUNTING BRACKET

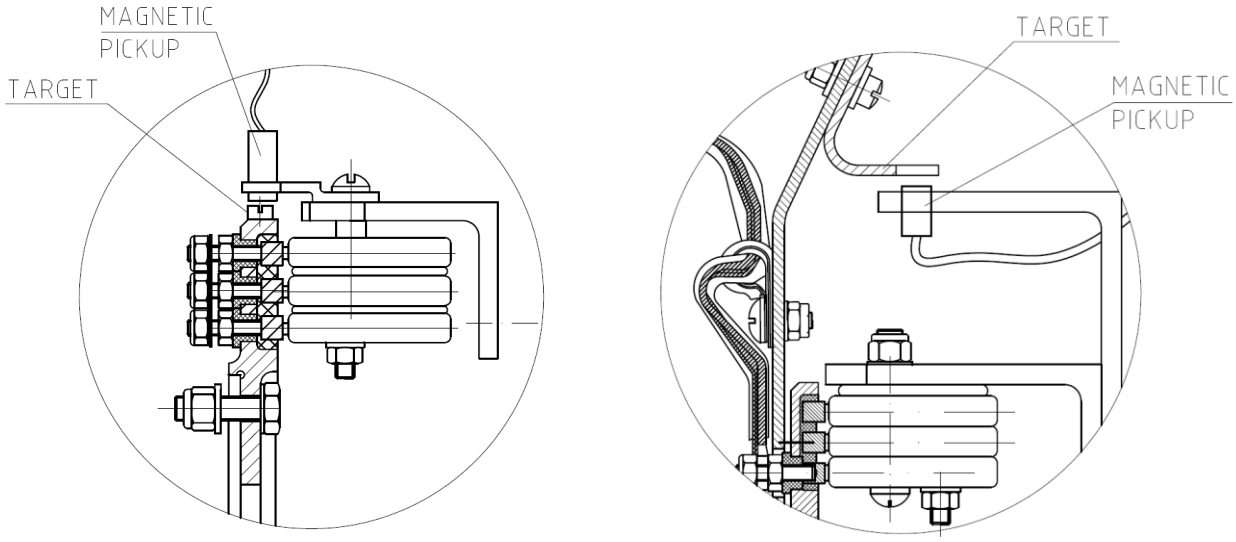


Figure 8.1: Typical Target/ Pickup Installation

8.4 CONNECTION

The electronic assembly is connected to the synchrophaser system as shown in Figure 8.3. Also refer to the wiring procedure specified for the governor's manual and the aircraft manufacturer´s wiring specifications. Recommended wire size is AWG-22 in pairs, shielded, 4 times 2 wires, one each to the magnetic pickup, one each to the governor coil.

8.5 GOVERNOR MAGNETIC COIL RESISTANCE

For aircraft using P&WC PT6 engines with Woodward governor, the coil resistance should read 115-145 ohms plus resistor values from 0-60 ohms.
All readings could be 20% higher if taken during heat soak following engine shut down.
Other governors may have different coils and perhaps different resistant value. See governor spec for details.

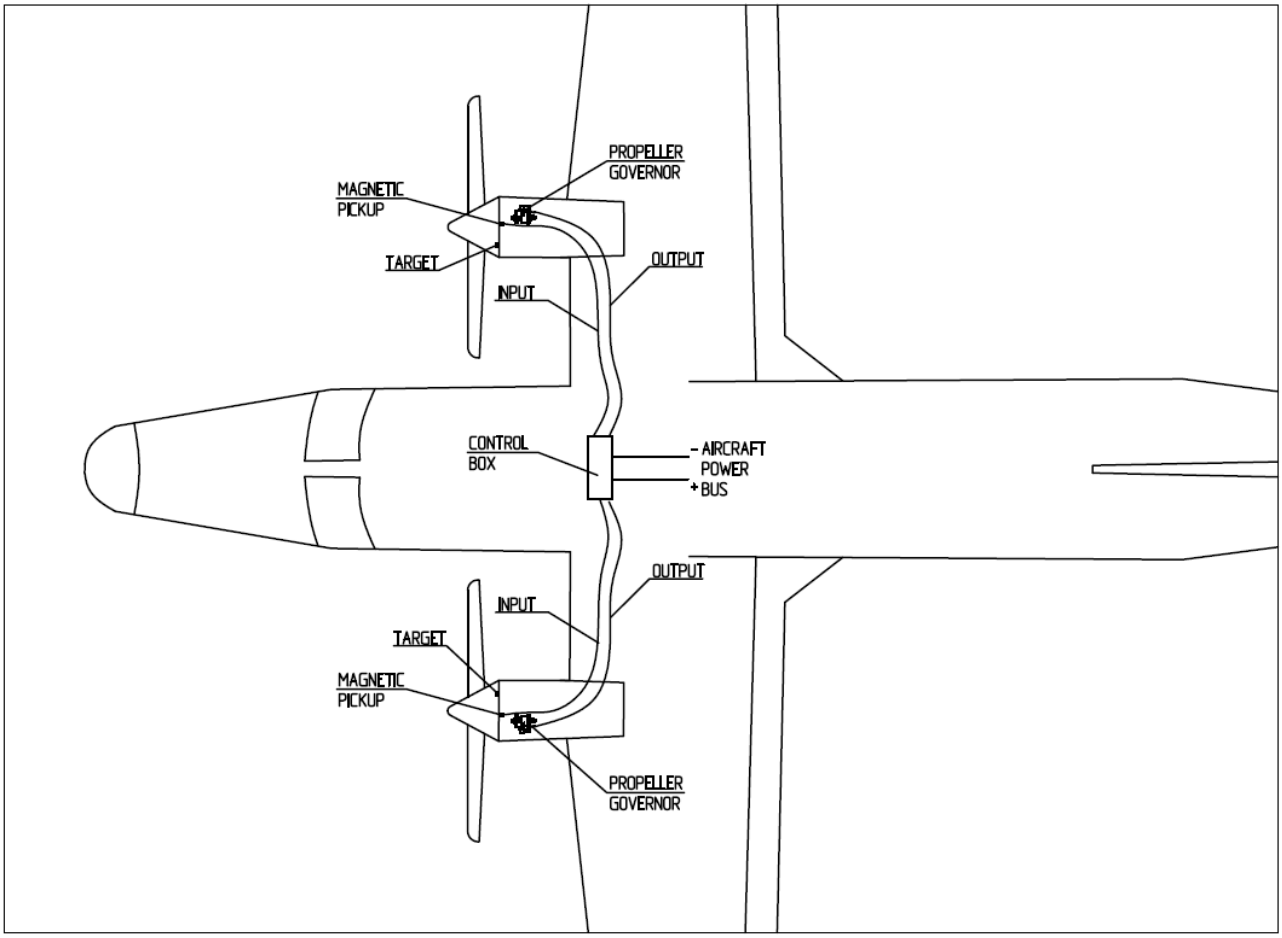


Figure 8.2: Synchrophaser System Operation

Synchrophasing Wiring Diagram:
P-8SP-( ): Type A-213796

WARNING:
THERE MUST BE ABSOLUTELY NO SWITCHES OR RELAYS IN THE WIRE GOING FROM THE SYNCHROPHASER TO THE COILS.

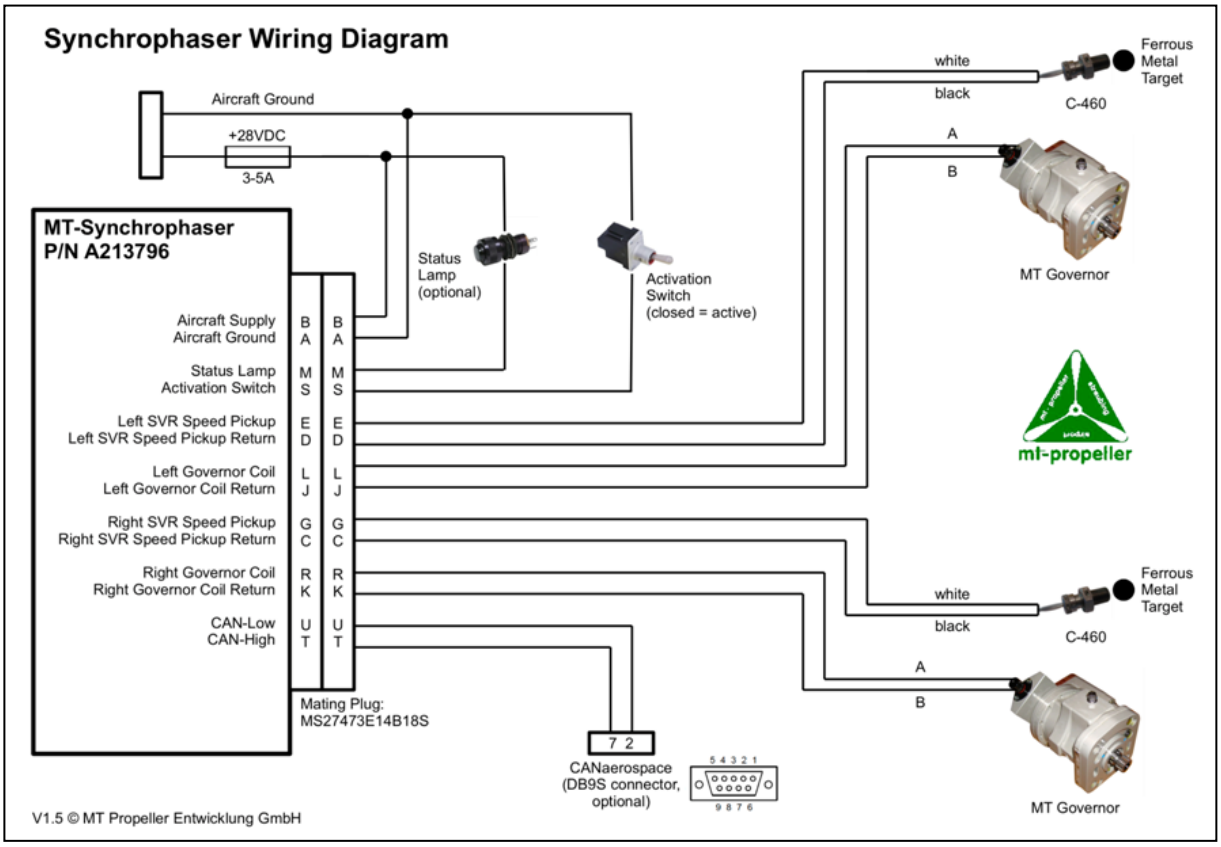


Figure 8

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9. TESTING AND TROUBLESHOOTING

9.1 WIRING TEST

When checking wiring resistances and continuity, the synchrophaser circuit breaker should be open (OFF) and the aircraft master switch turned OFF.
Resistance and continuity checks are made at the aircraft wiring connector that attaches to the control box.

Unplug the control box and probe the aircraft wiring connector to verify resistances given in Fig. 9.1.
If any discrepancies are found in the following checks, they must be corrected before continuing. Figure 8.3 shows a typical aircraft wiring schematic.

NOTE:
IF COILS ARE CHECKED IMMEDIATELY AFTER ENGINE SHUTDOWN, THEY MAY READ AS MUCH AS 20% HIGHER DUE TO HEAT SOAK.

Component or Function	Resistance		
Left Pickup	59.5 Ohms		
Right Pickup	59.4 Ohms		
Right Coil	Open		
Left Coil	Open		
Coil Common	Open		
Coil Common	Open		
(Airframe)	0.8 Ohms		
28 VDC	Open		
Jumper	0.5 Ohms		
	Application:		
	PT-6	**Other**	**AVIA**
Left Coil	115-206	112-138	29.7- 31.4
Right Coil	115-206	112-138	29.7- 31.4

Figure 9.1 Continuity and Resistance Values

9.2 SIGNAL AMPLITUDE TEST

The peak-to-peak amplitude of the input signal is recommended to be 2.4 volts peak-to-peak minimum at minimum cruise rpm. The clearance between the rotating target and the magnetic pickup (0.5-0.8mm or 0.02``-0.03`` initially) is the primary factor affecting output amplitude. Before performing aircraft maintenance affecting target gap, it is advisable to first measure the existing clearance and tag the pickup before disturbing the clearance. If propellers are exchanged or brush blocks moved, always return the clearance setting to the original measurement. The only time a new setting is required is when a magnetic pickup is replaced.

When magnetic pickup replacement is necessary, use the same clearance as a starting point. Measure the amplitude at minimum cruise rpm using an oscilloscope. A voltmeter will not provide a usable output reading as the signal is present for only a very small portion of the signal cycle. The waveform should comply with Figure 9.2. An inverted signal (negative pulse before positive) indicates magnetic pickup leads are reversed (this will normally not affect proper synchrophaser operation). Pay particular attention to waveform abnormalities or electromagnetic interference exceeding +0,5 volts on the input signal baseline. This interference will cause unsatisfactory synchrophaser operation if the control box is triggered more than one time in each propeller rotation. This interference is more likely to occur at high rpm so a waveform check at highest rpm is also recommended.

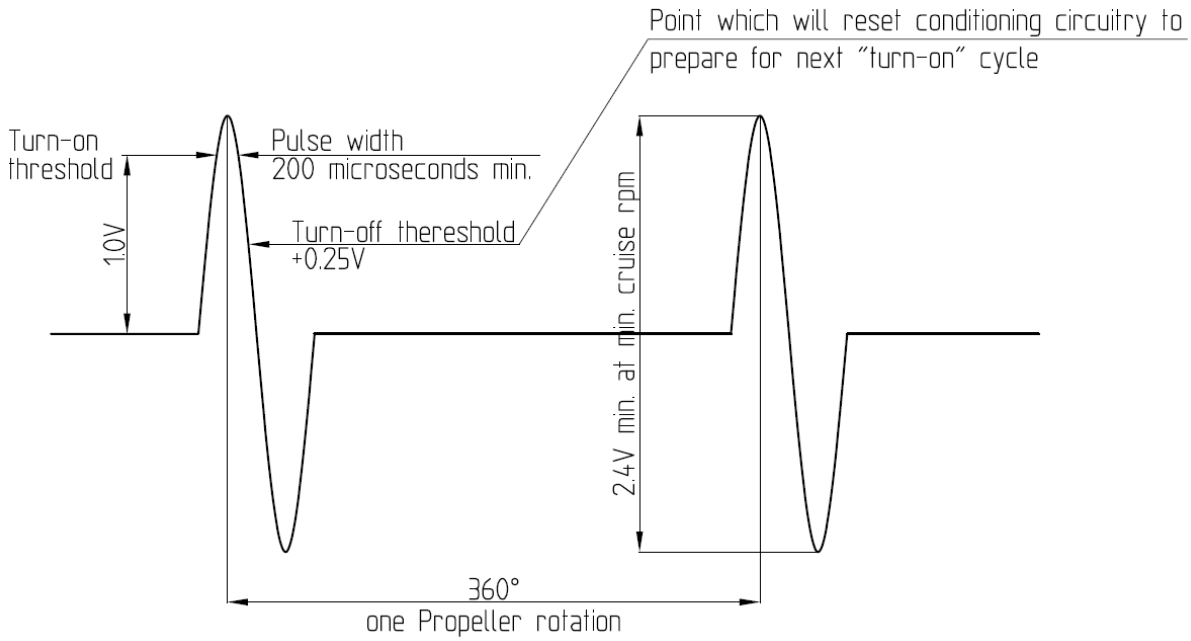

Figure 9.2 Phase Signal Waveform

9.3 SUPPLY VOLTAGE TEST

Upon successful completion of resistance checks, the supply voltage (24…28 VDC) can be checked. With the control box unplugged, close the synchrophaser circuit breaker, turn on the aircraft master switch. With a DC voltmeter check between pin A (positive) and pin B (negative) of the aircraft wiring connector for proper polarity and bus voltage.

9.4 GOVERNOR TRIM COIL TEST

Following a resistance check, it is possible to energize the governor trim coils and test for rpm rise.
Disconnect the aircraft wiring connector at the control box. A jumper between receptacles J, K, and A can be rigged as shown in Figure 9.3. Another jumper will be used alternately between L and B and between R and B or plug in a test box between the control box and aircraft wiring plug.
Ground run engines at normal cruise rpm with propellers under governor control. With the jumper between B and L the left propeller rpm should increase by the trim range or about one percent of propeller rpm when the instrument panel synchrophaser switch is turned on. To check the right trim coil, turn the synchrophaser instrument switch off and move the jumper so it is between B and R. Turn the synchrophaser switch on and note the rise in rpm on the right propeller. If neither side increases make sure that enough engine power is being generated to bring the propellers off of their low pitch stops. Both sides should operate equally. If rise in rpm is abrupt on one side and is sluggish on the other, suspect that the propeller or governor has too much friction. Hunting during synchrophaser operation will be the result of too much friction or hysteresis. If manual speed settings wander more than 10 rpm in quiet air without the synchrophaser operating, either the governors or the propellers could be the cause of poor synchrophaser operation. Rpm rise time is normally between ½ second and 1½ seconds. If input signals are satisfactory and trim coil action is correct, the control box should be checked. If resistance and continuity checks are correct, a new control box should be used.

CAUTION:
Do not insert a jumper larger than 1mm (0.04``) diameter into connector. Sockets or connectors will be damaged

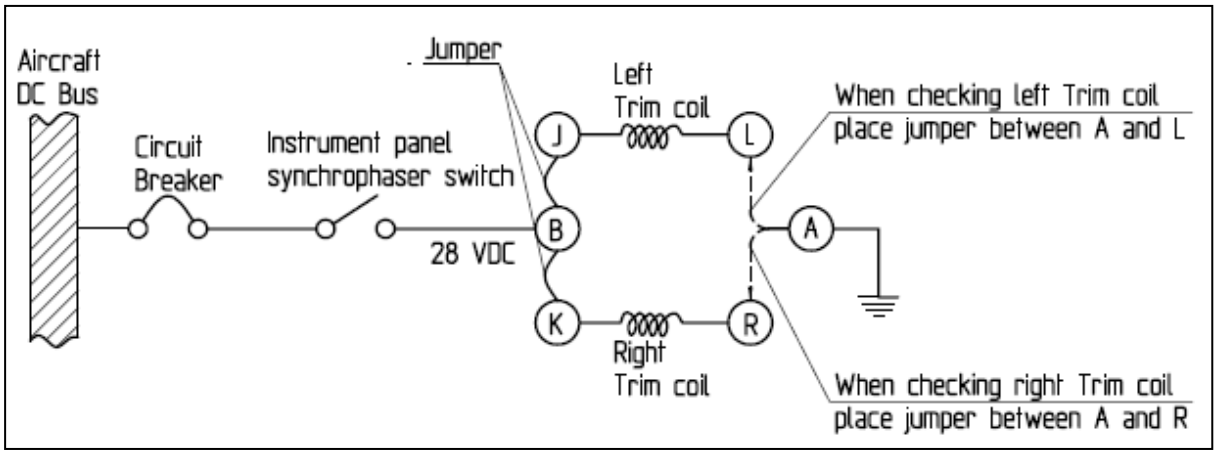

Figure 9.3: Governor Trim Coil Test Schematic

9.5 TROUBLESHOOTING

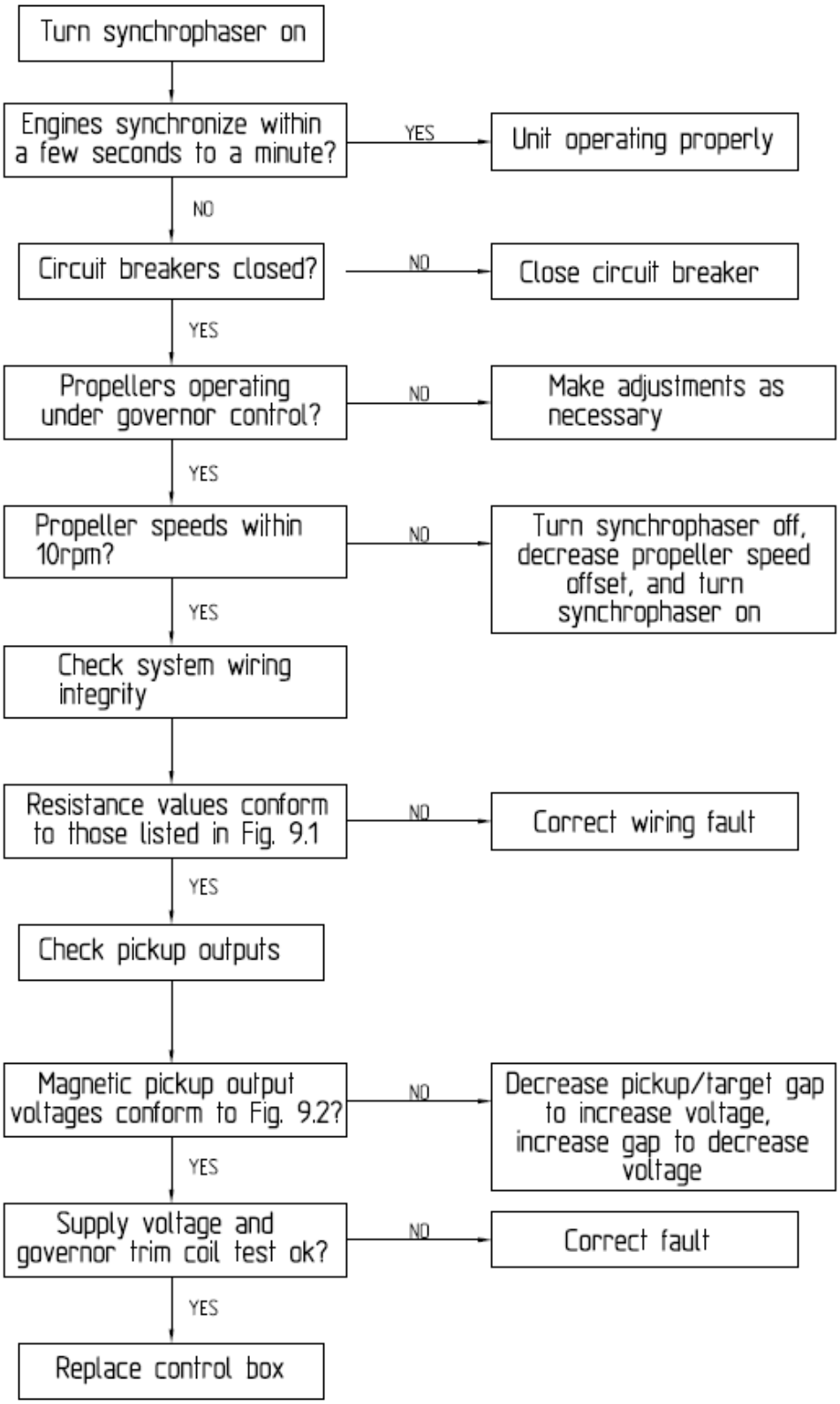

Figure 9.4 Troubleshooting Guide

10. OPERATION

10.1 The synchrophaser control box outputs current to trim coils within the propeller governors creating a magnetic field which alters governor speed settings.
The trim range is limited mechanically and by available bus voltage. Regardless of current polarity, the trim coil always raises rpm above manual speed settings upon initial system engagement.
From that point the control box and the propeller governor make a double correction.
The engine with the lower speed is corrected up and the other engine (higher speed) is corrected down by reducing its current to maintain proper propeller phase relationship.

10.2 Current is supplied to the governor trim coils by pulse-width modulation. Pulse-width is defined as that portion of time current is present as compared to the total time of the modulating cycle.
The aircraft bus voltage is applied to the trim coil during the “on” time of the pulse-width modulation. This “on” time can be all the way from zero to 100% of the modulation cycle, depending on manual speed settings and propeller blade phase error.
The system operates on a push/pull principle.
To accomplish this, the control box outputs alternate “on” time to each of the two governor trim coils during each cycle. Whatever portion of the cycle the left trim coil is energized, the right coil is de-energized. During the remainder of the cycle the opposite is true.

10.3 One input signal from each propeller are the only input signals required for the synchrophaser. The Control box looks at any phase error in the two input signals and continuously outputs pulse-width modulation to the governor trim coils changing rpm in a direction to restore the selected relative phase position. Since the synchrophaser is not a flight-critical system, power is furnished by a nonessential aircraft power bus.

10.4 Input signal amplitude is affected primarily by the clearance between the target and magnetic pickup. A lack of attention to this important clearance dimension is the number one cause of system malfunction. Typical target installation of two systems is shown in Figure 8.4.

10.5 Input signal are produced by a target moving through the magnetic field of a magnetic pickup. A single target is mounted on the propeller bulkhead or de-ice slipring.
The geometry of the target is such that a short duration sine wave is produced once per revolution of the propeller.

10.6 FLIGHT OPERATION

CAUTION:
In case, engine torque indicator variations occur after the synchronizer is switched on, switch off the synchronizer and check if the torque variations disappear. If the variations disappear, keep the synchronizer off and contact MT-propeller.

After take-off and the first reduction in power setting, match propeller rpm to within 10 rpm or less. This must be done by ear or by using a synchroscope. Attempting to match power levers or tachometers is not sufficient.

Turn the synchrophaser switch to ON.

Governor trim range is approximately 25 rpm. If this trim range is exceeded, the synchrophaser will disable its outputs and propeller rpm will return to the existing manual settings.
Before synchrophaser engagement is reestablished, turn off the propeller synchrophaser switch, match propeller rpm to within 10 rpm or less, and turn the system on. If the synchrophaser remains energized during an in-flight shutdown and propeller feathering, the synchrophaser will quickly detect an out-of-range condition and disengage automatically.

It is recommended but not required to switch the system off during take-off and landing.

In case no switch is installed:
In case engine torque indicator variations occur after the synchronizer is active pull the circuit breaker for the synchronizer to switch it off.
At an installation without switch the synchrophaser will automatically engage after the RPM between both propellers is within 10 RPM.

11. PARTS LIST: P-8SP-( ) – TYPE A-213796

Quantity	Description	Part No	Remark
1	Control Box	P-8SP-( ) Type A-213796	
1	Mating Plug	MS27473T14B18S	
1	Status Lamp	MS25041-3 green	Optional
1	Activation Switch	MS35058-22	
2	Magnetic Pickup	C-460	
2	Mating Plug	MS3106A-10SL-3S	
2	Strain Relief	97-3057-1004-1	