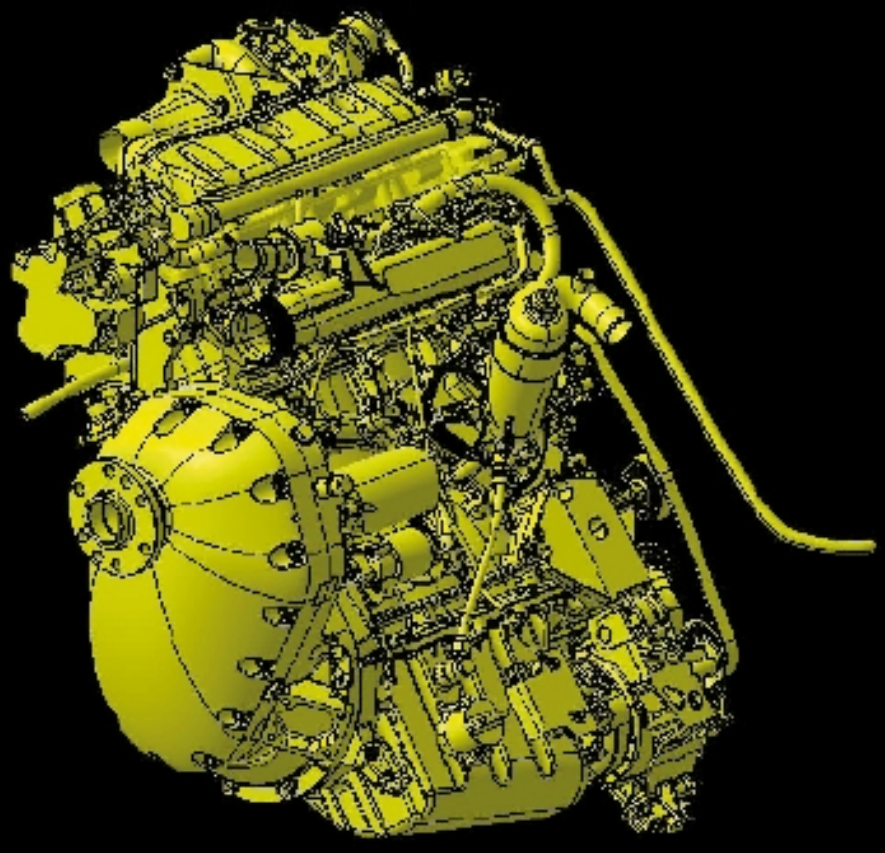
Austro Engine

Operation Manual AE 300

Doc. No.: E4.01.01



This page is intentionally left blank

Date: Wiener Neustadt, 2012-03-08

Author: Austro Engine GmbH
Rudolf – Diesel – Straße – 11
A-2700 Wiener Neustadt

Document number: E4.01.01
Revision: 11

		Date:	Signaturen:
Prepared:	A. Greiner / Documentation	08.03.2012	
Checked:	S. Kunstmüller / CVE Testing	12.03.2012	
Checked:	Chr. Grassl / CVE Design	12.03.2012	
Checked:	G. Fritz / CVE Electronic	12.3.2012	
Approved:	B. Jäger / Chief Engineer	12.3.2012	

1. Index

2. Identification

2.1 Type Designation

Brand Name: AE 300

TC-Designation: E4 for the engine followed by a letter, which indicates installation specific configuration changes.
E4-A Basic Design

For detailed information to the available installation specific configurations refer to MSB E4-002

If not otherwise stated this manual is applicable to all available installation specific configurations.

2.2 Engine Identification

The serial number is placed beneath the manifold. For further questions **Austro Engine GmbH** can be contacted

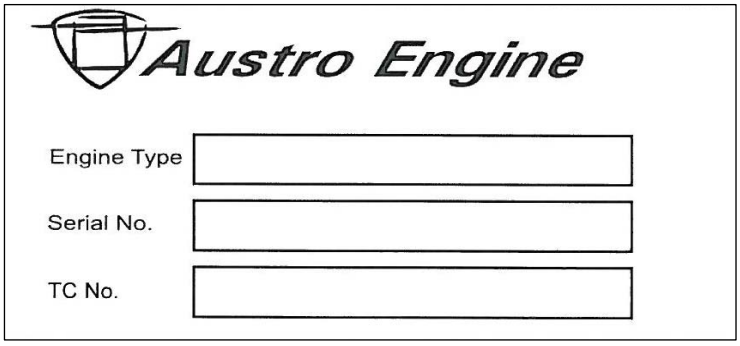


Fig. 2.1: Engine Identification

2.3 Record of Revision

All revisions of this manual, with exception of Temporary Revisions must be recorded in the following table.

The new or amended text is indicated by a vertical black line at the left hand side of the revised page, with the revision number and date appearing at the bottom of the page.

Temporary revisions, if applicable, are inserted behind the cover page of this manual. Temporary revisions are used to provide information on systems or equipment until the next 'permanent' revision of the Engine Manual. If a 'permanent' revision covers a Mandatory or Optional Design Change Advisory (MDC or ODC), the corresponding temporary revision is superseded.

It is the responsibility of the installer to ensure that this manual is maintained to a current status.

If the address or the ownership of the engine/aircraft changes, an address card has to be sent to Austro Engines GmbH.

2.3.1 List of Revision

Re. No.	Reason	Chapter	Page(s)	Date of Revision	Approval	Date of Approval	Date Inserted	Signature
0	First Release	all	all					
1	Authority remarks updated	all	all					
2	Authority remarks updated	1 2 3 6 7	Cover page2 1,.2 1,3,4,6,7 2,4,6,8,9,11 13 1,2 2,3,5,6,7,9, 12,14,15,161 7	2009.03.19				
3	Type plate updated, details to negative g and low oil pressure added, Add. Info Propeller Self Test added. Worm Up rpm changed. Engine Perform. curve changed.	1 2 3 4 5 7 8	Cover page2 1,2 1,3,4 4,8,9,13 1 2,3 13,14 1	2010.01.28				
4	Oil temperature changed form 125° to 130 °.	2 3	Cover Page2 3,4 8,9	2010-02-03				
5	Design holder updated. Text at propeller and Engine off corrected.	2 3 5	Cover Page2 3,4,5 2 3	2010-05-05				

Re. No.	Reason	Chapter	Page(s)	Date of Revision	Approval	Date of Approval	Date Inserted	Signature
6	TS-1 Qualification and Gearbox oil temp. added.	2 3 5	Cover Page 2 4,5 8,9 2,3					
7	MDC-E4-126	2 3	Intro. 2 4,5 7,8,9	2010-09-07				
8	MDC-E4-196	1 2 3	Intro. 2 1,2 4,5 9,10	2011-01-25				
9	MDC-E4-239	2 3	Intro. 2 4,5 8,9	2011-07-19				
10	MDC-E4-249	2 3	Intro. 2 4,5 8-14	2011-10-24				
11	MDC-E4-172	1 2 3 7	Intro. 2 1-2 4,5 9-15 3-19	2012-03-08				

2.3.2 List of Valid Pages

Chapter	Page	Revision	Date
	Coversheet	1	2009-02-10
	Intro 1	1	2009-02-10
	Intro 2	11	2012-03-08
	Intro 3	1	2009-02-10
1	1	11	2012-03-08
	2	11	2012-03-08
2	1	3	2010-01-28
	2	1	2009-02-10
	3	5	2010-05-05
	4	11	2012-03-08
	5	11	2012-03-08
	6	5	2010-05-05
	7	2	2009-03-19
	8	2	2009-03-19
3	1	1	2009-02-10
	2	5	2010-05-05
	3	1	2009-02-10
	4	3	2010-01-28
	5	1	2009-02-10
	6	2	2009-03-19
	7	7	2010-09-07
	8	10	2010-10-24
	9	11	2012-03-08
	10	11	2012-03-08
	11	11	2012-03-08
	12	11	2012-03-08
	13	11	2012-03-08
	14	11	2012-03-08
	15	11	2012-03-08
4	1	3	2010-01-28
	2	1	2009-02-10
5	1	1	2009-02-10
	2	6	2010-06-24
	3	6	2010-06-24
	4	1	2009-02-10
6	1	2	2009-03-19
	2	2	2009-03-19
7	1	1	2009-02-10
	2	2	2009-03-19
	3	11	2012-03-08
	4	11	2012-03-08
	5	11	2012-03-08
	6	11	2012-03-08
	7	11	2012-03-08
	8	11	2012-03-08
	9	11	2012-03-08
	10	11	2012-03-08
	11	11	2012-03-08
	12	11	2012-03-08
	13	11	2012-03-08
	14	11	2012-03-08
	15	11	2012-03-08
	16	11	2012-03-08
	17	11	2012-03-08
	18	11	2012-03-08
	19	11	2012-03-08
8	1	3	2010-01-28

2.4 Manufacturer

Austro Engine GmbH
Rudolf – Diesel – Straße 11
A-2700 Wiener Neustadt
POA NR. AT.21G.0010

2.5 Design Holder

Austro Engine GmbH
Rudolf – Diesel – Straße 11
A-2700 Wiener Neustadt
DOA Nr. EASO.21J.399

2.6 List of Figures

2.7 List of Abbreviations

AE	Austro Engine
BATT	Battery
CAD	Computer Aided Design
CAN	Controller Area Network
CCW	Counter-Clockwise
CPC	Connector Type
CS	Certification Specification
DOHC	Double Overhead Camshaft
EECS	Electric Engine Control System
EECU	Electric Engine Control Unit
ECU	Electric Control Unit
EMI	Electromagnetic Interference
EPC	Electric Pneumatic Converter
ESD	Electrostatic Sensitive Device
FAR	Federal Aviation Regulations
GND	Ground
GPC	Glow Plug Control Unit
HIRF	High Intensity Radiated Field
HPP	High Pressure Pump
MBN	Mercedes Benz Norm
MDC	Mandatory Design Change
ODC	Optional Design Change
RPM	Revolutions Per Minute
SW	Soft Ware
TDD	Type Design Definition
TC	Turbo Charger
Ubatt	Battery Voltage

3. General Information

In the present Operation Manual the proper operation of the aircraft engine **AE 300** is documented.
With the publication of the Operation Manual **Austro Engine GmbH** ensures the correctness of the instructions. In case of changes **Austro Engine GmbH** will inform with Service Bulletins, Service Letters or manual amendments, if it is necessary.
If there are any problems with the operation or any further questions about the engine, **Austro Engine GmbH** can be contacted.

The following symbols and warning signs are used in the manual to point out important instructions. They must be heeded strictly to prevent personal injury and material damage, to insure operational safety of the aircraft and to avoid any damage to the aircraft as a result of incorrect handling.

Warning: Disregarding these safety rules can cause personal injury or even death.

Caution: Disregarding these special instructions and safety measures can damage the engine or other components.

Note: Additional not or instruction for better understanding of an instruction.

3.1 Description and Using

The AE 300 is a liquid-cooled, in-line four-stroke four cylinder engine with a double overhead camshaft (DOHC) with four valves per cylinder. The valves are actuated by the cam follower

The direct fuel injection is realized by means of a common rail technique and the engine is charged by a turbo charger in combination with an intercooler.

The propeller is activated by a directly integrated gearbox with an integral torsional vibration damper. All engine components are controlled by an EECU system.

- This engine is only designed for pull propeller installations.
- The engine should not be operated without propeller.
- Only useable in aircraft.
- It is not capable for aerobatics use
- It is not allowed to run the engine without the specified quality and quantity of fluids.
- Only the use of recommended equipment and fluids grants a save run of the engine.

3.2 Safety

The required provisions of the employer's liability insurance organization and the other relevant safety rules, like for example the trade supervision authority have to be kept in mind.
The described work steps, contained in this Operation Manual have to be performed only by trained, qualified persons and / or specialized companies, with a current and valid license from the aviation authority to do such work

For further information the local flight agency has to be contacted.

3.3 Safety Information

- To prevent personal injury and damage secure all tools before starting the engine.
- The pertinent accident prevention regulations as well as other commonly accepted safety, occupational health and air traffic legal requirements must be observed. Operators must also observe any additional regulations and requirements which are applicable in their territory.
- The engine has to be protected against contamination and potentially hazardous manipulation.
- Rotation of the propeller by hand is not recommended.

3.4 Dimension and Volume

For further information about measurements refer to the Installation Manual of the **AE 300** engine (Doc. No.: E4-02-01).

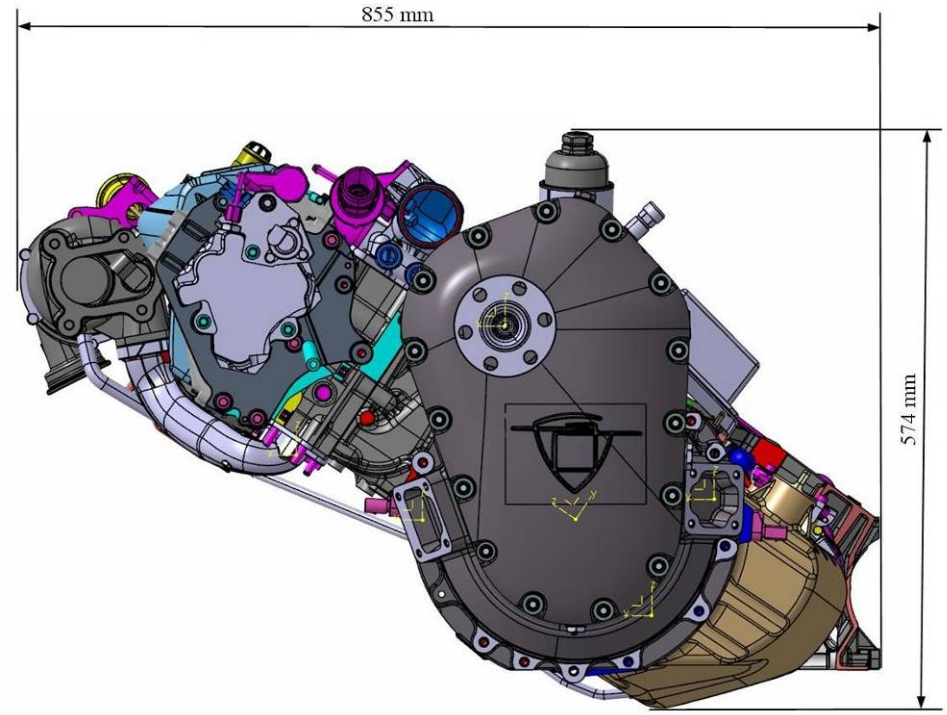


Fig. 3.1: Engine View

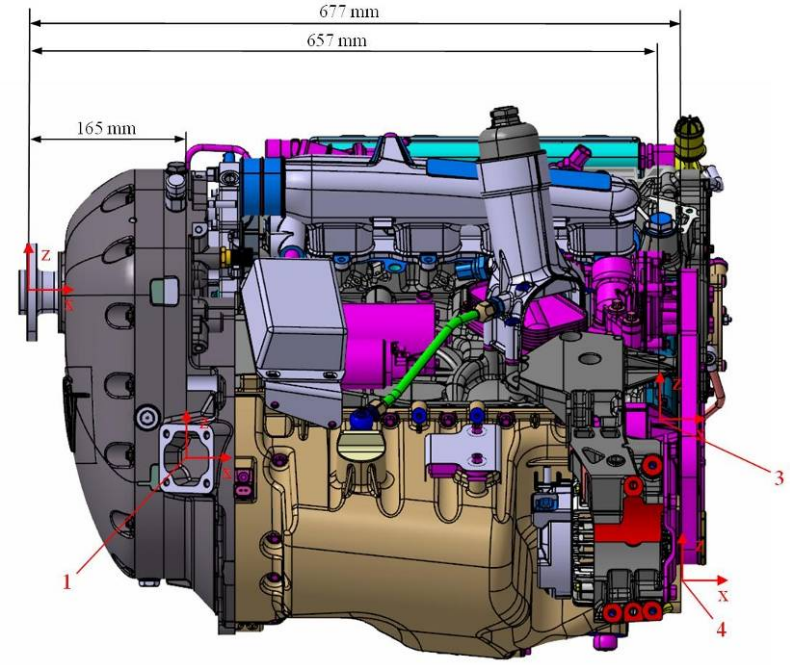


Fig.3.2: Engine View

3.5 Technical Data Sheet

All speed information's refer to the revolution speed of the propeller. The revolution speed of the engine is declared separately.

For detailed manifold data and dimensions refer to the "Installation Manual" of the **AE 300** engine (Doc. No.: E4-02-01).

3.5.1 Engine Performance

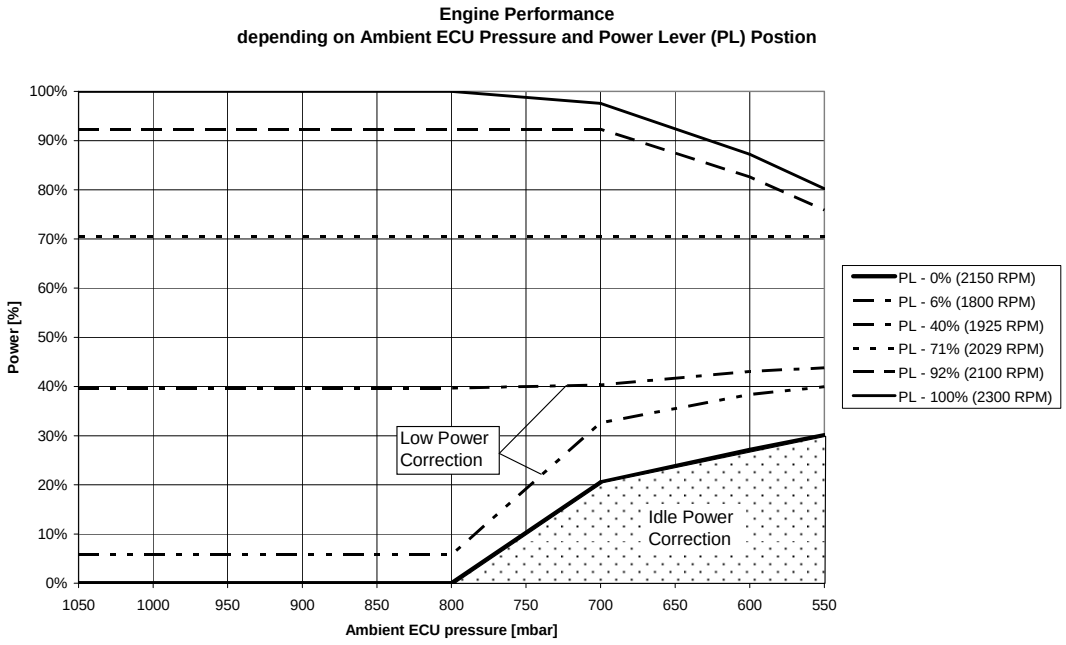


Fig. 3.3: Engine Performance

Low and Idle Power Correction

Below 800 mbar ambient ECU pressure the low and idle power output is increased regarding to the desired power (power lever position) to prevent the engine from combustion extinction.

3.5.2 High power performance

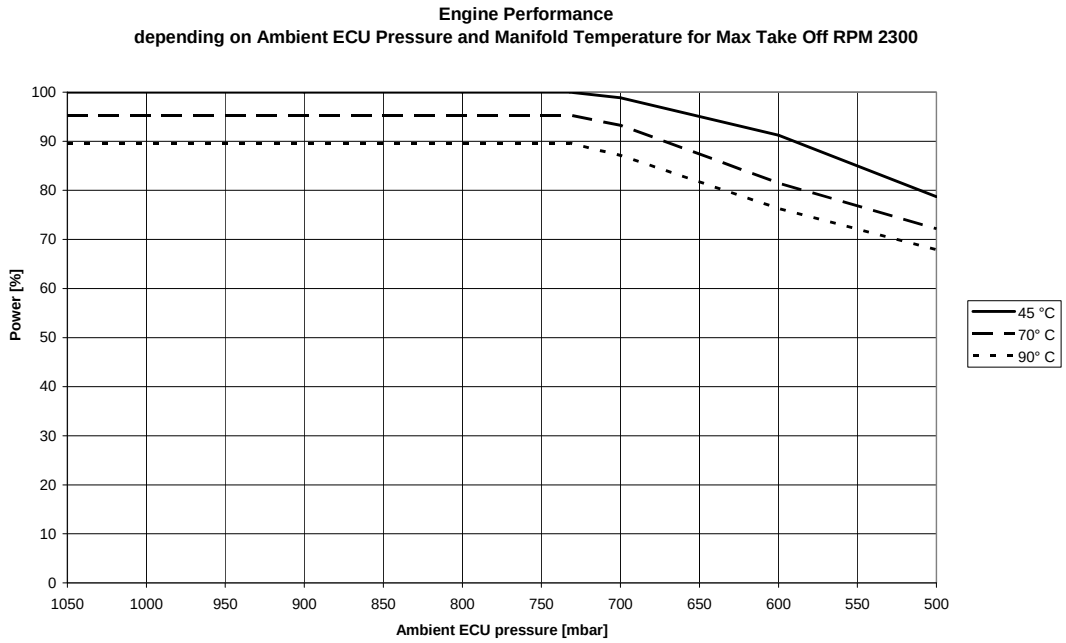


Fig. 3.4: Power Curve RPM 2300

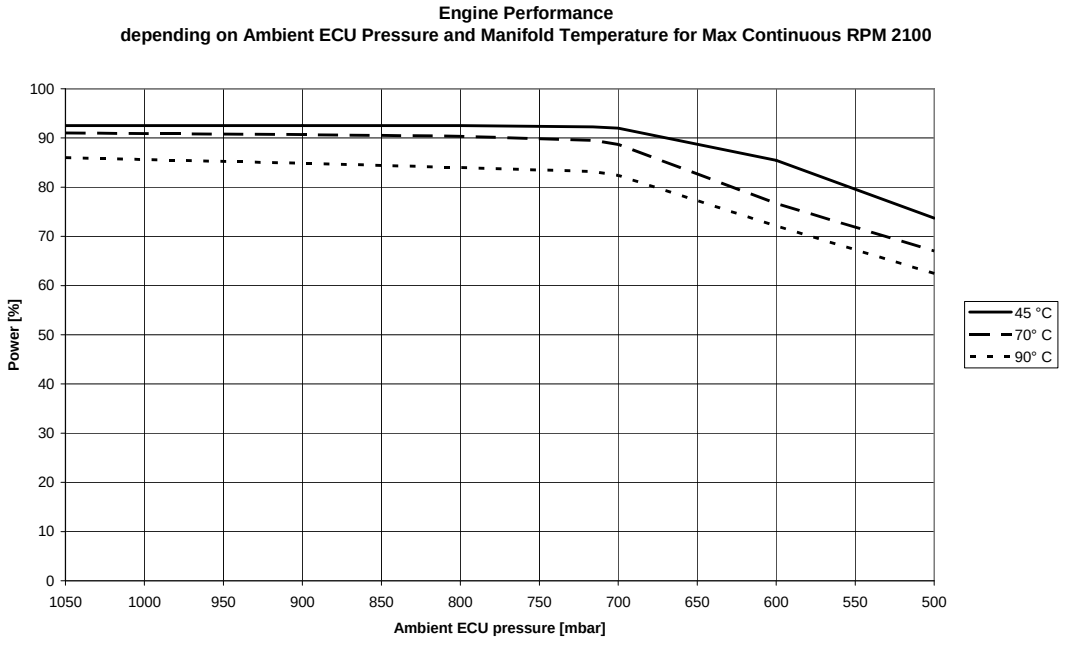


Fig. 3.5: Power Curve RPM 2100

Rated Power (100%): 123,5 kW
(165,6 hp)

3.5.3 Fuel consumption

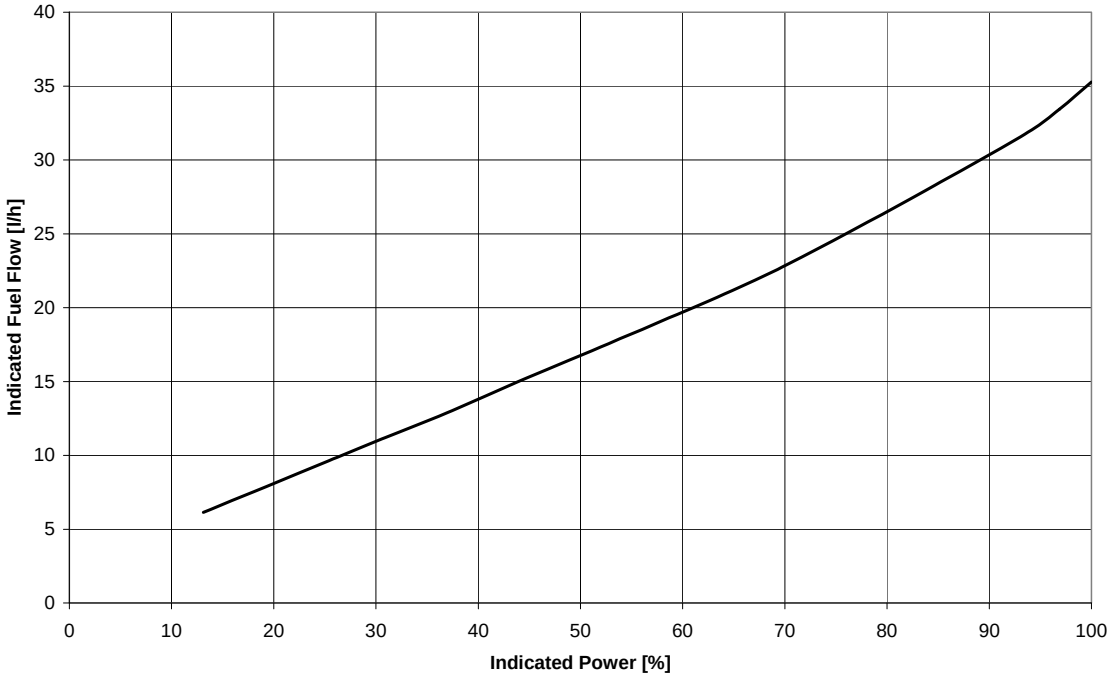


Fig.3.6: Fuel consumption

3.5.4 Propeller Setpoint Curve

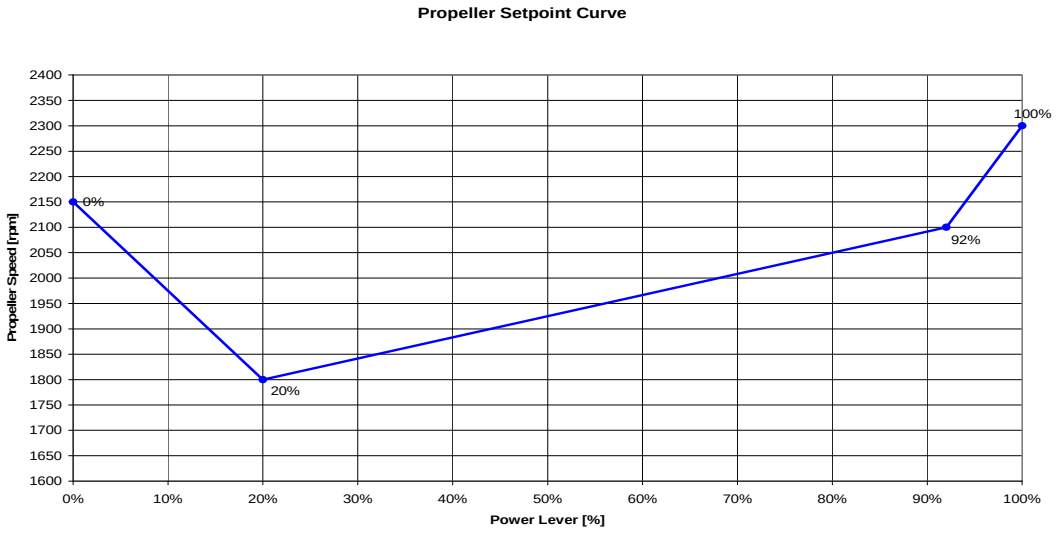


Fig. 3.7: Propeller Setpoint Curve

The propeller setpoint is set on the governor by the EECS on the basis of power lever position this rpm is held at any airspeed as long as the propeller is within the range of Stops (refer also to chapter 6.2).

3.5.5 Engine and Gearbox Data Sheet

Max. take off power (max. 5 min.):	123,5 kW
Max. continuous power:	123,5 kW
Max. recommended cruising power:	114 kW
Max. prop. Over speed:	2500 rpm
Max. take off speed:	2300 rpm
Max. continuous speed:	2300 rpm
Max. recommended cruising speed:	2100 rpm
Idling prop speed:	710 rpm
Gearbox ratio:	I = 1.69

3.5.6 Limitation Section

All temperature and pressure limits must not be exceeded. The limits have to be shown to the pilot in a red range.

3.5.6.1 Oil

Oil temperature (start):		min.	-30 ºC
			(-22 ºF)
Oil temperature (normal operation)		min.	50 °C
			(122 °F)
		max.	135 °C
			(275°F)
Oil temperature		max.	140 ºC
			(284 ºF)
Oil pressure:	at idle	min.	0,9 bar
			(21.75 psi)
	(at max. cont. conditions)	min.	2.5 bar
			(36.26 psi)
		max.	6.5 bar
			(94.25 psi)

Approved engine oil types:

Brand name	SAE Grade
Shell Helix Ultra	5W-30
ADDINOL SUPER POWER MV 0537	5W-30
BP Visco 5000 5W-30	5W-30
REPSOL ELITE Common Rail 5W30	5W-30
Gulf Formula GMX	5W-30
G-Energy F Synth 5W-30	5W-30
QUARTZ 9000 ENERGY 5W-30	5W-30
Gulf Formula GX	5W-30
Shell Helix Ultra	5W-40
LIQUI MOLY 5W-40 LEICHTLAUF HIGH TECH	5W-40
megol Motorenoel High Condition	5W-40
SYNTIUM 3000	5W-40
LUKOIL LUXE synthetic	5W-40
Castrol SLX Professional Longtec 0W-40	0W-40

It is not recommended to mix different SAE grades.

CAUTION

Use only one type of approved E4 engine oil for an oil change.
Oil brands which are not approved must not be used.

Oil volume (initial filling)		7.5 l
Oil volume (continuously)	min.	5 l
	max.	7 l

CAUTION

Only engine oils conforming to MB 229.5 specification are approved by **Austro Engine GmbH** to be used for operation. **Austro Engine GmbH** will not assume any liabilities if other types of oil are used.

Gearbox temperature (start):	min.	-30 ºC
		(-22 ºF)
Gearbox temperature (full load)	min.	35 ºC
		(95 °F)
	max.	120 ºC
		(248 ºF)

Gearbox oil type:	Shell Spirax S6 GXME 75W-80
	(former brand name: Shell Spirax GSX 75W-80)
Oil volume	2,1 l

Initially fill 1,6 l into the gearbox.
After a ground run with more than 1800 rpm fill gearbox up to inspection window.

3.5.6.2 Coolant

Coolant temperature (start):	min.	-30 ºC (-22ºF)
Coolant temperature (full load)	min.	60 ºC (140 ºF)
Coolant temperature	max.	105 ºC (221 ºF)

It has to be ensured that the freezing point of the coolant is at or below -30 ºC before operating the engine.

3.5.6.3 Fuel

Operation with Kerosene:

Fuel temperature at HPP:	during operation	min.	-30 ºC (-22 ºF)
		max.	60 ºC (140 ºF)

If the fuel temperature is below -30 ºC (-22 ºF), the fuel has to be warmed.

Operation with Diesel Fuel:

If the engine is operated with Diesel fuel or a blend of Kerosene and Diesel fuel the following temperature limits have to be observed:

Fuel temperature at HPP:
During operation

min.

-10 °C (14 °F)	Operation with Diesel Fuel Class D, E or F
- 5 °C (23 °F)	Operation with Diesel Fuel Class C
+5 °C (41 °F)	Operation with Diesel Fuel Unknown Class

max.

60 °C (140 °F)	Operation with Diesel Fuel all Classes

For detailed information regarding Diesel Fuel Classes refer to Chapter 7.3

3.5.6.4 Fuel Grade

Kerosene	Jet A, Jet A – 1 (ASTM D 1655)
	TS-1 (Russia; GOST 10227-86)
	TS-1 (Ukraine, GSTU 320.00149943.011-99)
	RT (Russia; GOST 10227-86)
	RT (Ukraine; GSTU 320.00149943.007-97)
	No. 3 Jet Fuel (China; GB 6537-2006)
	JP-8 (F34) (USA, MIL-DTL-83133G-2010)
Diesel Fuel	Diesel (EN 590)

If the present fuel grade in the system is unknown the engine needs to be operated in the Diesel fuel temperature limitations.

CAUTION

For Diesel fuel operation MSB-E4-014 must be accomplished for defined engine S/N therein.

3.5.6.5 Speed

Max. prop. over speed:	2500 rpm
Max. take off speed:	2300 rpm
Max. continuous speed:	2300 rpm

3.5.6.6 Voltage

	min.	20,5 V
	max.	32,2 V

3.5.6.7 Performance

Certified Altitude

Max. altitude	18.000 ft

Intentional negative g operation is not allowed.

3.5.7 Information Section

The pressure and temperature in the information section are the optimum of the AE 300 engine and should be kept in mind. The range between the limits and the optimum can be indicated yellow. For a better overview the optimum can be shown in a green range.

3.5.7.1 Engine Oil

Optimum operating oil temperature:	min.	50 ºC
		(122 ºF)
	max.	125 ºC
		(257 ºF)
Optimum operating oil pressure:	min.	4.0 bar
(n = 1700 – 2300 rpm)		(58 psi)
	max.	4.9 bar
		(71 psi)
Oil consumption:		< 0.1 l/h

3.5.7.2 Coolant

Coolant temperature (optimum)	min.	60 ºC (140 ºF)
	max.	95 ºC (203 ºF)
Coolant:	Water / radiator protection mixed at ratio of 50:50	
Recommended radiator protection type:	Glysantin G 48 Protect Plus	
Water specification:	Only use distilled water for mixing ratio	

3.5.7.3 Fuel

Fuel inlet temperature at HPP (Takeoff power):	optimum:	<50 ºC (<122 ºF)

3.5.8 Operating Envelope

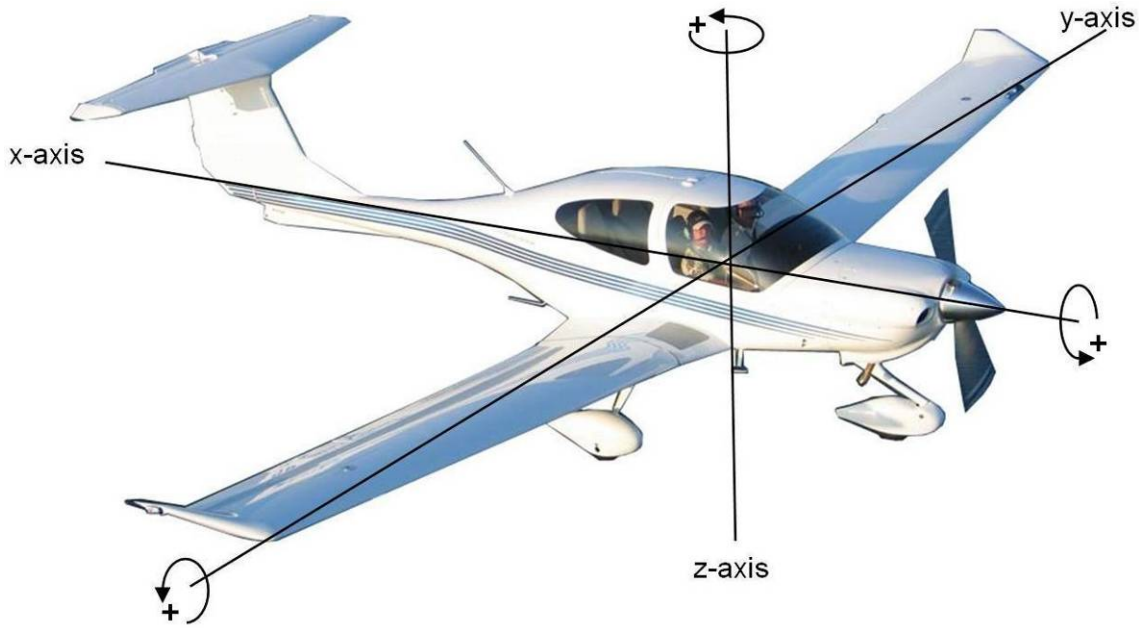


Fig. 3.8: Banking Rotation

Banking rotation deviations from the apparent perpendicular:

Around the x - axis:	max.	±15 º
Around the y - axis	max.	-35 º / + 25 º
Around the z - axis	max.	±20 º

Up to these deviations from the apparent perpendicular, proper lubrication is ensured.

CAUTION

Intentional negative g operation is not permitted.
Intentional negative g operation can lead to low oil pressure and subsequently to turbo charger damage.

4. Delivery, Standstill Period and Storage

4.1 Delivery

The AE 300 engine is delivered from **Austro Engine GmbH** without conservation.
If an initial operation is not possibly within 8 weeks the engine must by conserved according to chapter 4.3.
An appropriate first conservation can be performed by **Austro Engine GmbH** and must be assigned at the ordering.

4.2 Standstill Period

If the engine is not used for four weeks an engine ground run has to be performed.

- Engine Start and Warm Up according to chapter 5.1.2 and chapter 5.1.3.
- 100% load until 100 ºC (212 ºF) oil temperature
- 1 minute 100% load
- 1 minute idle power
- Shut down.

4.3 Storage up to 6 month

- Perform engine oil and filter change.
- Change oil to preservation oil Fuchs Titan EM530 DC or Shell Helix Ultra DC225.10.
- Check coolant level – if necessary correct the coolant level.
- Warm up the engine according chapter 5.1.2 and chapter 5.1.3.
- 100% load until 100 ºC (212 ºF) oil temperature.
- 1 minute 100% load.
- 1 minute idle power.
- Shut down.
- Relieve V-belt tension – refer to the Maintenance Manual E4.08.04
- Close all engine openings airproof.

The engine must not be started after V-belt tension relieve.

4.4 Storage over 6 month

Contact engine manufacturer Austro Engine GmbH.

4.5 Engine depreservation

Open all engine openings.
Install V- belt. – refer to the Maintenance Manual.
Change engine oil to approved engine oil.
Perform an engine ground run according chapter to 4.2.

5. Operating Instructions

These operating instructions are for the using of the **AE 300** engine. For more information about the flight operation the manufacturer of the aircraft has to be contacted.

Only authorised persons who hold a valid license are allowed to execute the following steps.

5.1 Engine Start Procedure

Further information of the A/C start procedure refer to the manual of the aircraft manufacturer.

For safety reasons the engine start must only be performed in a secure and safe area protected for unauthorized persons. The start must only be executed by persons with a valid license of an aviation authority.

The start procedure is only for the straight engine function.

5.1.1 Pre-Start Inspection

Check Fuel Quantity
Check Fuel Temperature
Check Air Inlets / Outlets for blockage
Check Engine Oil Level
Check Gearbox Oil Level
Check Breather Outlet for blockage
Check for Oil leakage
Check for Fuel leakage
Check for Coolant leakage
Drain Water of the fuel system (for drain position refer to the aircraft flight manual)

5.1.2 Engine Start

1. Engine Master – "ON"
   Glow plug lights – "ON"
2. Glow plugs – „OFF"(the glow plug lights extinguish after not more than 15 seconds)
3. Propeller Area – Clear and Save
4. Engine – "Start"

Do not operate the starter for more than 10 seconds.

At ambient temperatures below -22°C it is possible that the engine will not run at the first attempt. In this case wait 60 seconds between the start attempts.

5. Oil Pressure rise within 3 seconds.
6. Voltage, Electric Load – Check indication
7. Alternator switch – "ON"

The alternator switch should not be turned ON before starting the engine. Turning the alternator switch ON while the engine is not running reduces the service life of the alternator system and drains the battery unnecessarily.

5.1.3 Warm Up

1. Oil Pressure – "CHECKED" (refer to chapter 3.5.2.1 and 3.5.3.1 Oil)
2. rpm (Propeller) – "CHECKED" 710 +/- 30 rpm
3. Idle – 30 seconds
4. 50 % load until 50 ºC (> 122 ºF) Oil temperature and
   60 ºC (> 140 ºF) Coolant temperature and 35 ºC (> 95 ºF) Gearbox Oil temperature.

At low oil temperature high oil pressure may occur which could lead to an oil pressure warning. In this case reduce power setting until the caution disappears and conduct the warm up with this reduced setting.

At low gearbox oil temperature it may occur that the ECU-Self Test is not performed successfully. In this case warm up the engine and retry the ECU-Self Test at higher gearbox temperatures.

5.1.4 Before Takeoff Check

1. Engine Instruments – CHECKED
2. Fuel Temperature – CHECKED (refer to chapter 3.5.2.3 and 3.5.3.4 Fuel)
3. Power Levers – "IDLE"
4. ECU-Self Test – PERFORM

The ECU cockpit switch (voter switch) must remain in the "Auto"-Position throughout the whole self test procedure. Manually selecting ECU "A" or "B" prevents the self test from successfully testing the switch-over functionality causing the self test to abort with an error indication ("ECU Caution"-Lamp will remain ON).

5. Power Lever Max (100% / 10 sec) – CHECK LOAD, CHECK RPM, CHECK Fuel Flow

5.1.5 During Flight Check

Engine/propeller speed and all temperatures and pressure must be monitored constantly during flight. For operation optimums refer to chapter 3.5.Technical Data Sheet.

5.1.6 Engine OFF

The engine has to run for minimum 1 minute at maximum 10% of full load, before shut down.

After turning the engine master OFF, wait until 20 sec. before turning the battery master OFF unless otherwise defined in the aircraft flight manual. This ensures that engine and flight data can be written to non-volatile memory before removing power.

5.2 Low Oil Pressure

It may occur that operation of the engine after landing at idle speed and high oil temperature leads to a low oil pressure warning. If this is the case push the power lever forward until the caution disappears.

6. Emergency Procedures

6.1 Power loss and abnormal engine behaviour

- Power lever "FULL FORWARD"
- Select the fuel tank with sufficient fuel level.
- Continue engine operation
- If abnormal engine behaviour is still evident land as soon as possible

In case of electrical failures in power generation the internal EECU voter switches automatically to the ECU which provides the better engine performance.

In case of doubt the automatic decision can be overruled manually by switching to the ECU A or ECU B voter position. If the manual override does not provide a better performance it is strongly recommended to switch back to the automatic voter position.

Depending on the failure it is possible that the EECU uses default values for further operation. Refer to chapter 7.6.3 for detailed error handling information.

6.2 Low Oil Pressure

- Power lever "FULL FORWARD"
- if the oil pressure rises into green continue operation in the green range

- if the oil pressure remains low Power Lever "IDLE"
- Land as soon as possible
- expect sudden engine stoppage

6.3 High Oil Temperature

- Reduce power
- Monitor oil temperature
- Land as soon as possible

6.4 High Gearbox Oil Temperature

- Reduce power
- Monitor oil temperature
- Increase gearbox cooling by e.g. increase airspeed
- Land as soon as possible

6.5 Low fuel pressure

Fuel pressure indication is provided.
The internal EECU voter switches automatically to the Standby-ECU further the corresponding fuel pump will be switched active.
Both fuel pumps can be activated by a switch if the behaviour is not considered as sufficient.

6.6 High Fuel Temperature

- Reduce power
- Monitor fuel temperature
  - if the fuel temperature decreases into green continue operation in the green range
  - otherwise land as soon as possible

6.7 High Coolant Temperature

- Reduce power
- Monitor coolant temperature
  - if the coolant temperature rises into green continue operation in the green range
  - otherwise land as soon as possible

6.8 Engine Fire

- Fuel shut-off valve closed
- Engine master switch off
- Prevent continued rotation due to wind milling, if possible.

6.9 Electric power supply out of range

- switch-off alternator
- switch–on alternator
  If the failure persists continuous operation is possible as long as battery power supply is sufficient.

7. System Description

7.1 Intake System

The intake air is cleaned by an air filter and then compressed by the turbo charger. During compression the intake air gets hot. An intercooler between turbo charger and engine is provided to cool the intake air down thus the desired engine performance can be obtained.

At the intake manifold the intake air temperature and pressure are measured. To provide the intake air pressure corresponding to the desired engine power and ambient EECU pressure a waste gate valve direct at the turbo charger is operated

The influence of intake air temperature and ambient EECU pressure on engine power output is shown in chapter 3.5.6

7.2 Exhaust System

The exhaust gases are guided through the exhaust manifold to the turbo charger. In the turbo charger the exhaust gases are expanded to power the compressor for charging the intake air. After the turbo charger the exhaust gases are released direct into the environment via an exhaust pipe.

7.3 Fuel System

In the following picture a typical Fuel System of the AE300 engine is shown.

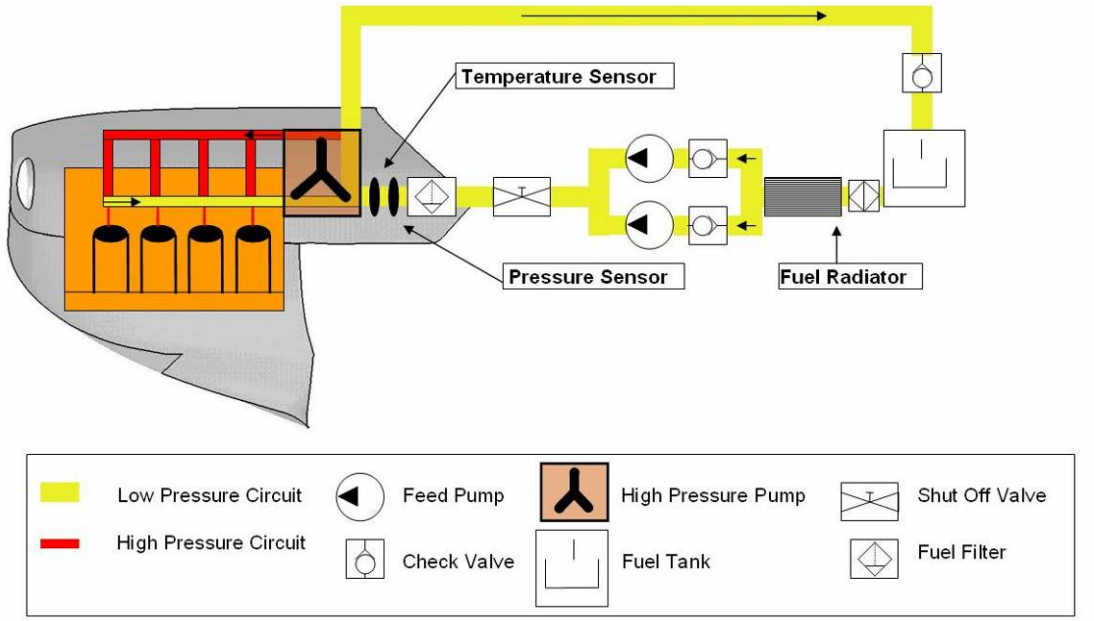


Fig. 7.1: Fuel System

In the fuel feeding line two feeding pumps are provided which deliver fuel at low pressure to the high pressure pump. Between feeding pumps and high pressure pump a fuel filter is installed which is able to cope with the contaminants expected to occur during 100 hours of operation. Direct at the high pressure pump inlet the fuel temperature and pressure is measured. In case of a pressure loss the EECU, which actuates both feeding pumps switches automatically to the inactive pump.

The high pressure pump supplies fuel at maximum 1600 bar to the fuel rail and further to the injectors.

At the high pressure pump a fuel metering unit is installed which ensures that only the required quantity of fuel is compressed. The necessary rail pressure, which is measured directly at the rail, is controlled by the rail pressure valve.

Excessive fuel of about 4,5 l/min quantity is used to cool and lubricate the high pressure pump. This excessive fuel is warmed up and flows back through the return line into the fuel tank.

For approved fuel grades refer to chapter 3.5.6.4

Operation with Diesel Fuel

In case of operating the engine with Diesel Fuel according to EN 590 specific fuel temperature limits have to be observed.

At low temperatures Diesel Fuel may flocculate and block the fuel filter. The referring critical temperature is called "Cold Filter Plugging Point" (CFPP).

Depending on the established CFPP Diesel Fuel is classified in different classes, which are given in EN590. The defined class for each country is provided in an own national appendix to EN590.

7.4 Coolant System

In the following picture the cooling system of the AE300 engine is shown.

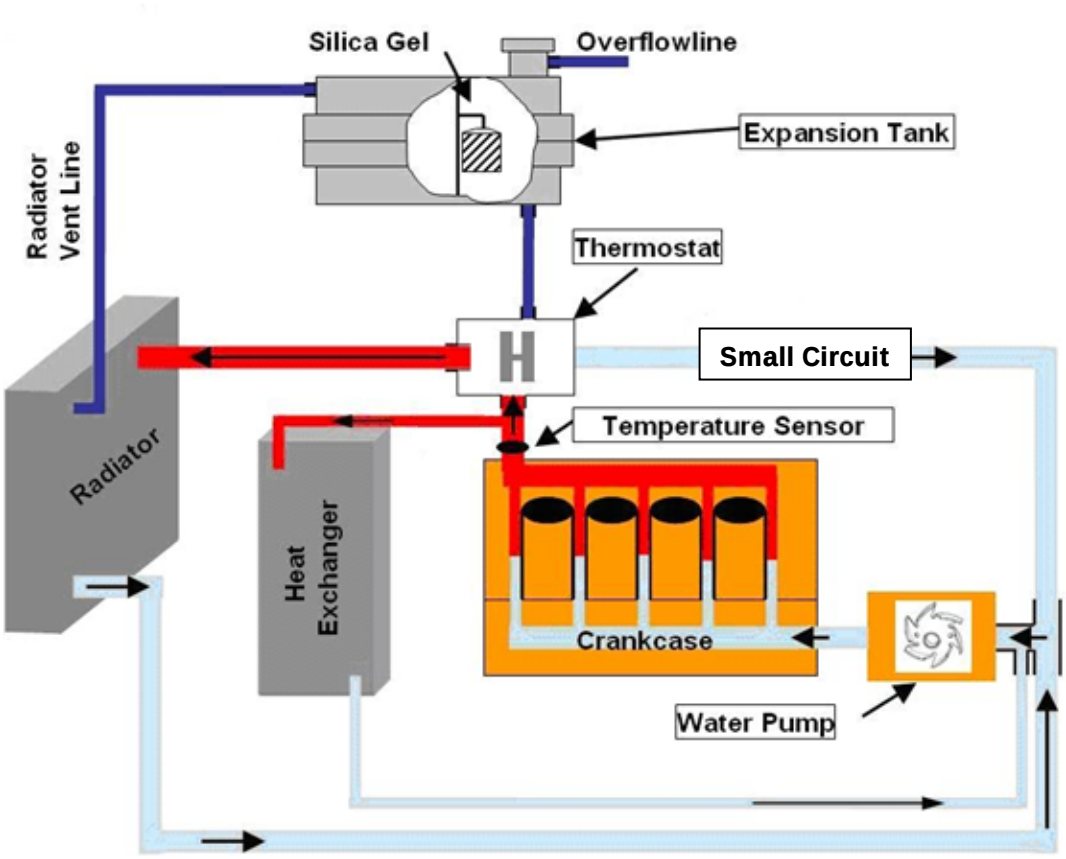


Fig. 7.2: Cooling system

The water pump pumps the coolant through the engine. The coolant leaves the engine at the heat exchanger connection point and at the thermostat. If a heat exchanger is installed this circuit is always flown through.
At the thermostat there are two circuits connected, the small circuit, which is flown through as long as the engine is cold and the radiator circuit, which starts to be opened as soon as a coolant temperature measured direct at the thermostat is above 80 °C (176 °F). Above 95 °C (203 °F) coolant temperature the radiator circuit is full open and the small circuit totally closed.

An expansion tank is provided which contains a silica reservoir to provide the necessary corrosion protection. The expansion tank has an overpressure valve installed which limits the relative pressure in the coolant system to max. 2,3 bar. In addition a low pressure valve is installed to protect the coolant system from negative pressure.

For approved coolant refer to chapter 3.5.7.3

7.5 Lubricating System

The lubricating system of the engine consists of an internal oil pump, which pumps the engine oil through the oil filter, the coolant-oil heat exchanger and the lubrication ports of the engine.

In front of the oil filter the oil pressure is measured. The oil temperature is measured in oil sump next to the oil filler neck. As the coolant temperature is regulated the coolant-oil heat exchanger provides regulated oil temperatures.

The breather air out of the crankcase is guided through an oil separator. After the oil separator the crankcase air is released through the breather line into the environment.

In front of the engine a gearbox is provided. This gearbox has its own lubrication circuit. An internal oil pump pumps the gearbox oil to the lubrication points of the gearbox and to the governor flange. Thus the propeller pitch adjustment is provided by the gearbox oil.

For approved engine and gearbox oil refer to chapter 3.5.6.1

7.6 Electrical System

The Electrical System consists of the following major Components:

- Starter
- Generator
- GPC – Glow Plug Control Unit
- EECU – Electronic Engine Control Unit
- Sensors & Actuators

The EECS Block Diagram shows the connection between the EECS components which are used in the AE 300 Engine and displays also the Interface from the Airframe to the EECS of the AE 300.

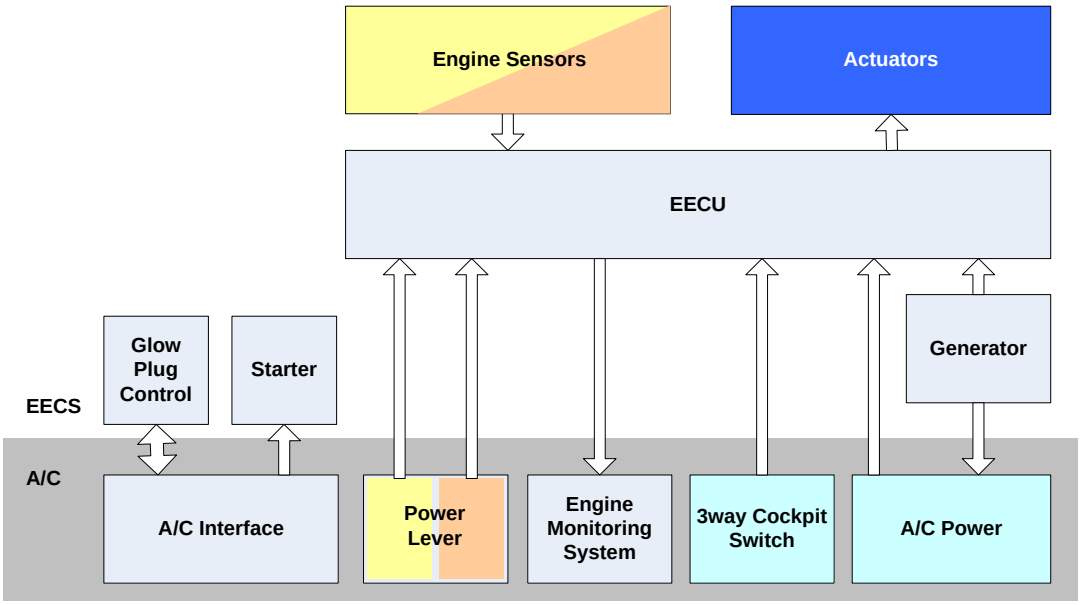


Fig.7.3: EECS Block Diagram

The starter is manually controlled by the pilot. The EECU will detect a running engine at 600rpm (Propeller) and further activation is not necessary.

The Generator is a 28V/70A power supply which consists of an alternator mounted to the engine and an external regulator. This power supply is used to supply the EECS and the airframe.

The Glow Plug Control Unit is only used to enhance the cold starting behavior of the engine on ground. It controls the power which is dissipated by glow plugs. These quick start glow plugs help to ignite the compressed fuel/air mixture because of their hot surface temperature.

The EECU is a 28V supplied device which consists of two similar parts, called ECU A and ECU B. Each ECU is able to control the engine itself. At each self test both ECU channels will be tested.
Depending on the operating hours count the active ECU will change at each engine start. The other ECU channel is in hot standby that means active, evaluating sensor values but not operating actuators.
In case of a detected failure on one ECU an internal voter can switch over to the alternate channel.
If different kinds of failures are active at the same time, the switch over decision is based on failure priorities.
This switch over decision can be overruled by the pilot by manually forcing one channel.

The interface to the engine indications in the A/C is realized via a serial Bus (CAN-Bus).

The pilot interface is realized over Power Lever Sensors. Each ECU has it´s own sensor. Each sensor has two outputs which are used to perform plausibility checks of the sensor.

7.6.1 EECU Functions

Sensors and Actuators

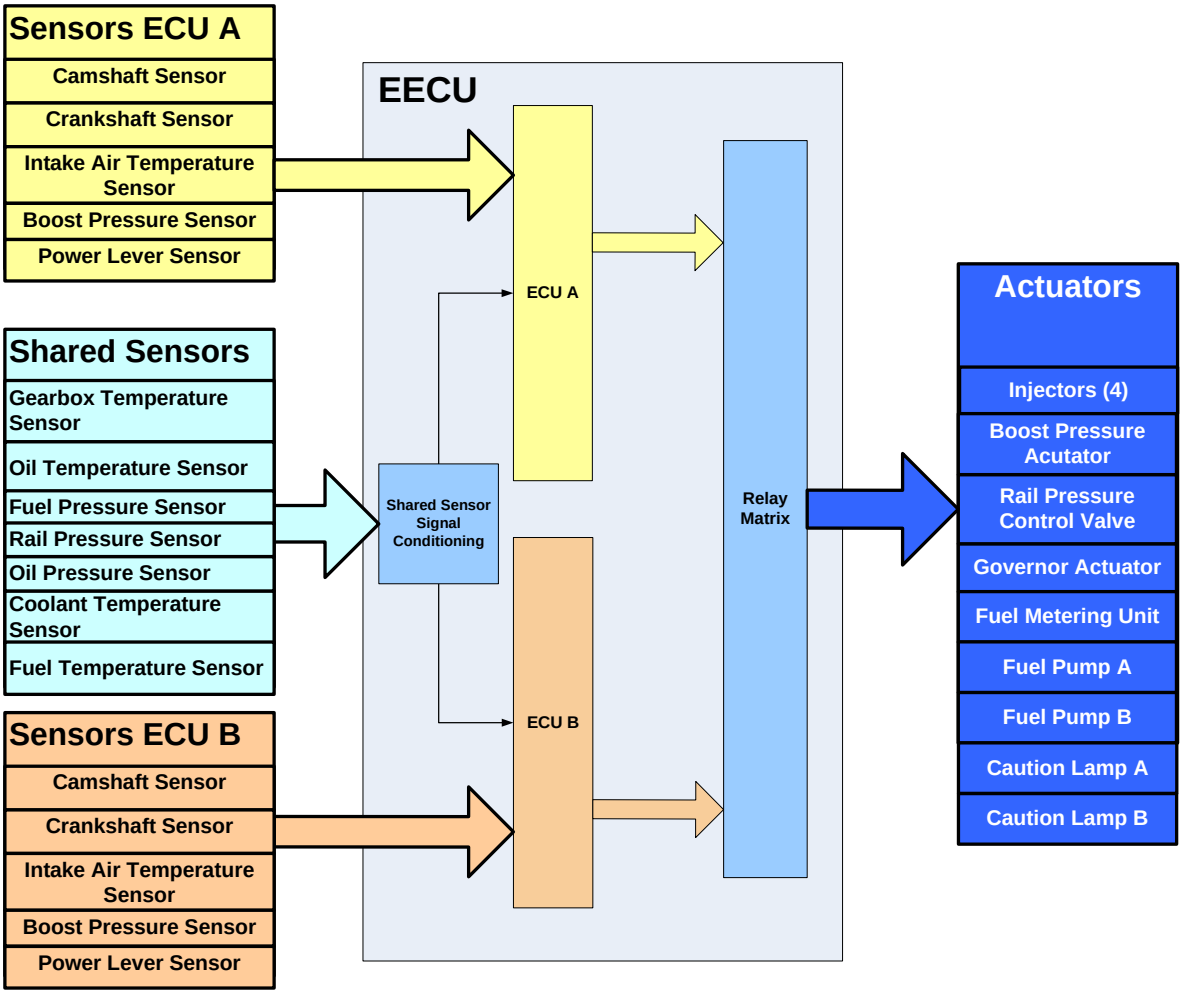


Fig. 7.4: Sensors and Actuators

Sensors

- Power Lever Sensor
  - Power Lever Sensor position evaluation
  - Hall Effect Sensor with dual output
- Crank Shaft Sensor
  - Engine speed evaluation
- Cam Shaft Sensor
  - Engine position evaluation
- Fuel Pressure Sensor
  - Used for evaluation of the fuel pressure after the pre-supply pump
- Oil Pressure Sensor
  - Used for evaluation of the engine oil pressure
- Rail Pressure Sensor
  - Used to evaluate the rail pressure
- Boost Pressure Sensor
  - Boost (Intake Air) Pressure evaluation
- Coolant Temperature Sensor
  - Used for coolant temperature evaluation
- Fuel Temperature Sensor
  - Used for fuel temperature evaluation
- Gearbox Oil Temperature Sensor
  - Used for gearbox temperature evaluation
- Engine Oil Temperature Sensor
  - Combinant Sensor used for engine oil temperature evaluation
- Intake Air Temperature Sensor
  - Intake Air Temperature evaluation

Actuators

- Injectors
- Boost Pressure Actuator
- Rail Pressure Control Valve
- Fuel Metering Unit
- Pre-Supply (electrical) Fuel Pump
- Governor Set Point Actuator
- Caution Lamps

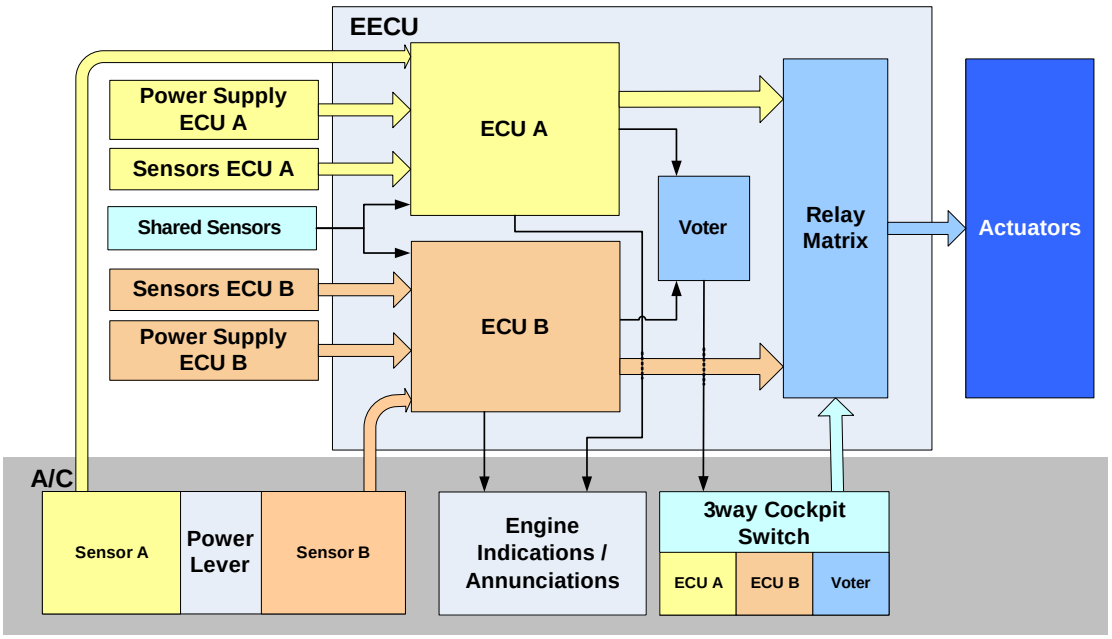


Fig. 7.5: EECU

- Electrical Interfaces
  - Outputs protected against
    - Short Circuit Ubatt
    - Short Circuit GND
  - Diagnosis on Outputs and Sensor Inputs
    - Short Circuit Ubatt
    - Short Circuit GND
    - Open Load
  - Sensor Inputs
    - Linearization of the input voltage
      - According to the sensor characteristics

- Monitoring of external interfaces
  - External interfaces are monitored (sensors, actuators)
  - A recognised failure (e.g. electrical) is internally reported
  - Reported failures may inhibit other functions/monitoring
- SW Function Montoring
  - Separately calculated Values are used for monitoring the main Engine Control Functions (e.g. Engine Speed Calculation, Injection Quantity Calculation)
- EECU Hardware Monitoring provided
  - Internal Supplies
  - Internal Memories
  - Internal communication

- Failure monitoring / Fault Code Memory
  - Reported Failures
    - are stored in the Fault Code Memory
      - Up to 20 entries
    - Can lead in an ECU switch over
    - Can activate the ECU caution
    - Can cause a substitute function (e.g. substitute value)

- ECU Switch Over
  - Reported Failures can lead to an automatic switch over
    - An internal logic (Voter) selects the ECU to be active
    - The Pilot can overrule the decision of the EECU
    - The magnitude of power change can be up to 10%
    - The typical switch over time is 10 ms.
- Diagnosis via defined CAN- Protocol possible
  - AE diagnostic tool (AE 300 wizard)

- Eventrecorder and Datarecorder provided
  - Eventrecorder stores defined „Events" (e.g. reported failures, crossed limits)
  - Datarecorder stores cyclically predefined values
    - Time stamp based on a Real Time Clock
- Statistics
  - Records statistics of 8 physical parameters
  - Engine and ECU uptimes are recorded

7.6.2 Engine Speed and Power Regulation

The desired propeller speed set point is calculated depending on the power lever sensor position. The current engine speed is used to compute the deviation of the actual propeller speed from the set point.

The deviation is converted into an output ratio for the set point actuator. The propeller speed set point is set by an electric motor (actuator) in the governor system. This electric motor substitutes the conventionally used Bowden Cable.

The governor itself controls the propeller speed via the propeller blade pitch angle adjustment. The actuator control ensures together with the monitoring a safe and correct actuation.

If the set point is reached the actuator is deactivated (hysteresis provided).

The requested engine torque is calculated depending on the power lever position and the engine-speed.

- Depending on the requested torque the resulting injection quantity (fuel mass) is calculated.
- Depending on the calculated injection quantity the required boost pressure (air mass) is calculated.

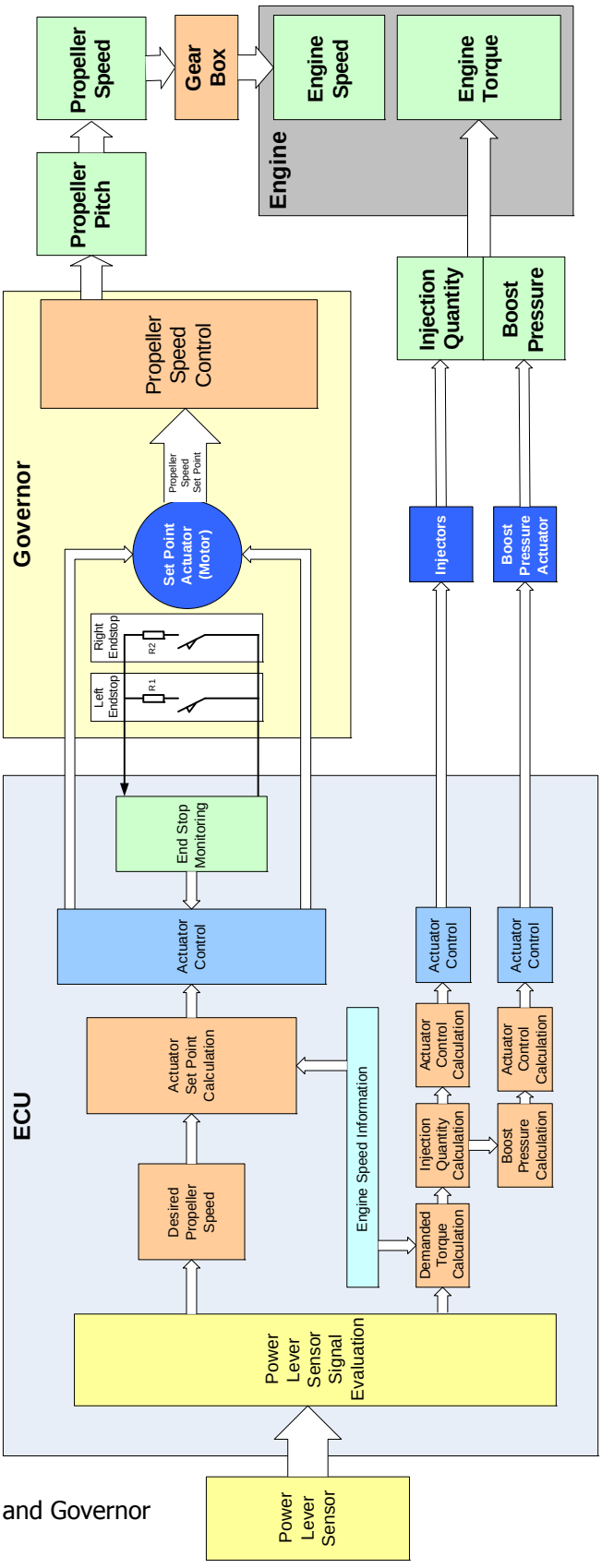


Fig 7.6: EECU and Governor

7.6.3 Error Handling

In the following table the engine control system errors and their error handling is listed. Three different types errors are known:

- Errors which lead to a latched caution indication
- Errors which lead to a non-latched caution indication
- Not indicated errors

In case of a latched caution an unscheduled maintenance is necessary and Austro Engine GmbH has to be informed.

Latched Caution Indication

Failure description	Failure Code	Caution Indication	Caution Latched	ECU Switch Over
Analogue-digital converter failure	2319	YES	YES	YES
Power lever sensor 1 failure	1222	YES	YES	YES
Power lever sensor 2 failure	1234	YES	YES	YES
Atmospheric pressure sensor failure	1105	YES	YES	YES
Actuator supply voltage failure	1A04	YES	YES	YES
Battery voltage failure	1615	YES	YES	YES
Boost pressure actuator power stage failure	2526	YES	YES	YES
Boost pressure sensor failure	105	YES	YES	YES
Coolant temperature sensor failure	115	YES	YES	YES
ECU identity failure	1D11	YES	YES	YES
ECU temperature sensor failure	2361	YES	YES	YES
Cam shaft sensor failure	2043	YES	YES	YES
Crank shaft sensor failure	2045	YES	YES	YES
Event: Boost pressure operating range	1E12	YES	YES	YES
Event: Fuel pressure operating range	1E13	YES	YES	YES
Fuel pressure sensor failure	2006	YES	YES	YES
Fuel temperature sensor failure	180	YES	YES	YES
Gearbox oil temperature sensor failure	1B11	YES	YES	YES
CJ940 power monitoring chip failure	2329	YES	YES	YES
ECU EEPROM failure	1617	YES	YES	YES
ECU hardware encapsulation failure	2386	YES	YES	YES
ECU recovery has occured	2356	YES	YES	YES
ECU recovery has occured	2357	YES	YES	YES
ECU recovery has occured	2358	YES	YES	YES
CJ940 power monitoring over voltage failure	2350	YES	YES	YES
Intake air temperature sensor failure	110	YES	YES	YES
Injection limitation occured	2352	YES	YES	YES
Injection valve Bank 1A failure	2123	YES	YES	YES
Injection valve Bank 1B failure	2139	YES	YES	YES
Injection valve Bank 2A failure	2124	YES	YES	YES
Injection valve Bank 2B failure	2140	YES	YES	YES
Injector driver chip failure A	2324	YES	YES	YES
Injector driver chip failure B	2325	YES	YES	YES
Cylinder 1 - Injection valve failure	201	YES	YES	YES
Injection valve Cylinder 1B failure	2141	YES	YES	YES

Failure description	Failure Code	Caution Indication	Caution Latched	ECU Switch Over
Cylinder 2 - Injection valve failure	202	YES	YES	YES
Injection valve Cylinder 2B failure	2142	YES	YES	YES
Cylinder 3 - Injection valve failure	203	YES	YES	YES
Injection valve Cylinder 3B failure	2143	YES	YES	YES
Cylinder 4 - Injection valve failure	204	YES	YES	YES
Injection valve Cylinder 4B failure	2144	YES	YES	YES
MOK-sensor hardware failure	2061	YES	YES	YES
MOK-sensor PWM-signal failure	2062	YES	YES	YES
Metering unit, electric current monitoring	2149	YES	YES	YES
Metering unit, power stage open circuit	2197	YES	YES	YES
Metering unit, power stage short to BATT	2198	YES	YES	YES
Metering unit, power stage short to GND	2199	YES	YES	YES
Watchdog communication failure	2321	YES	YES	YES
Main relay path 1 failure	1A01	YES	YES	YES
Main relay path 2 failure	1A02	YES	YES	YES
Main relay path 3 failure	1A03	YES	YES	YES
Engine oil pressure sensor failure	1B13	YES	YES	YES
Oil temperature sensor	2014	YES	YES	YES
Injection monitoring failure	2322	YES	YES	YES
Redundant engine speed monitoring failure	2343	YES	YES	YES
Boost pressure governor failure	2359	YES	YES	YES
Rail pressure control valve, electric current monitoring	2151	YES	YES	YES
Pressure control valve power stage failure	2500	YES	YES	YES
Pressure control valve power stage failure	2501	YES	YES	YES
Pressure control valve power stage failure	2502	YES	YES	YES
Propeller governor-actuator power stage failure	1C02	YES	YES	YES
Propeller governor-actuator failure	1C03	YES	YES	YES
Propeller governor-actuator end stop switch failure	1C04	YES	YES	YES
Electric fuel pump actuator failure	2100	YES	YES	YES
Common rail pressure sensor failure	190	YES	YES	YES
Test of redundant shut off paths	2122	YES	YES	YES
Sensor supply voltage 1 failure	1611	YES	YES	YES
Sensor supply voltage 2 failure	2306	YES	YES	YES
Sensor supply voltage 3 failure	2332	YES	YES	YES
Engine master switch signal failure	1612	YES	YES	YES
TPU monitoring failure	2342	YES	YES	YES
Voter relay failure	1D14	YES	YES	YES
Watchdog connection failure	2323	YES	YES	YES

Non-Latched Caution Indications

Failure description	Failure Code	Caution Indication	Caution Latched	ECU Switch Over
ECU XA connector failure	1D01	YES	NO	NO
ECU actuator connector failure	1D02	YES	NO	NO
ECU XB connector failure	1D03	YES	NO	NO
Cam shaft and crank shaft synchronisation failure	2606	YES	NO	NO
Power lever position sensor 1 of ECU A and B not consistent	1B01	YES	NO	NO
Power lever position sensor 2 of ECU A and B not consistent	1B02	YES	NO	NO
Barometric air pressure sensing of ECU A and B not consistent	1B03	YES	NO	NO
Boost pressure sensing of ECU A and B not consistent	1B04	YES	NO	NO
Cam shaft speed sensing of ECU A and B not consistent	1B05	YES	NO	NO
Crank shaft speed sensing of ECU A and B not consistent	1B06	YES	NO	NO
Coolant temperature sensing of ECU A and B not consistent	1B07	YES	NO	NO
Fuel pressure sensing of ECU A and B not consistent	1B08	YES	NO	NO
Fuel temperature sensing of ECU A and B not consistent	1B09	YES	NO	NO
Gearbox oil temperature sensing of ECU A and B not consistent	1B0A	YES	NO	NO
Intake air temperature sensing of ECU A and B not consistent	1B0B	YES	NO	NO
Engine oil pressure sensing of ECU A and B not consistent	1B0C	YES	NO	NO
Engine oil temperature sensing of ECU A and B not consistent	1B0D	YES	NO	NO
Common rail pressure sensing of ECU A and B not consistent	1B0E	YES	NO	NO
Main relay (ECU) failure	1610	YES	NO	NO
External CAN bus failure	600	YES	NO	NO
Internal CAN receive message failure	1D04	YES	NO	NO
Internal CAN transmit message failure	1D05	YES	NO	NO
External CAN transmit failure	2214	YES	NO	NO
Engine oil pressure failure	1B14	YES	NO	NO
ECU initialization failure	1D12	YES	NO	NO
ECU switchover due to internal CAN message timeout	1D13	YES	NO	NO
Common rail, metering unit failure 0	2047	YES	NO	YES
Common rail, metering unit failure 1	2015	YES	NO	YES
Common rail, metering unit failure 2	2016	YES	NO	YES
Common rail, metering unit failure 3	2017	YES	NO	YES
Common rail, metering unit failure 4	2018	YES	NO	YES
Common rail, pressure control valve failure 0	2051	YES	NO	YES

Failure description	Failure Code	Caution Indication	Caution Latched	ECU Switch Over
Common rail, pressure control valve failure 1	2019	YES	NO	YES
Common rail, pressure control valve failure 2	2020	YES	NO	YES
Common rail, pressure control valve failure 3	2021	YES	NO	YES
Common rail, pressure control valve failure 4	2023	YES	NO	YES
Common rail, pressure control valve failure 5	2052	YES	NO	YES
ECU self test timeout failure	1D07	YES	NO	NO
Propeller self test failure	1C01	YES	NO	NO

Description of ECU Switch Over

In case of an ECU switch over, the other ECU channel takes over the control of the engine.
This control mode change can lead to slightly different power settings (0-100% power available, but initial power setting may deviate up to 5 %), due to the tolerances of the sensor mounting to the power lever.
This switch over can lead to a temporarily (less than 1 sec) and slight deviation in the desired speed till the ECU internal control functions are aligned to the engine operation state.

If a failure occurs which results in reduced engine control capability (e.g. injector failure) the power performance is also reduced with the now active ECU channel.

If a failure occurs and the now active ECU can rely on plausible values (e.g. Boost Pressure Sensor defect) the performance of the engine will remain unchanged.

Because both ECU´s are similar, also two warnings are provided to display that one or both channels detect a failure

Not indicated faults

Failure description	Failure Code	Caution Indication	Caution Latched	ECU Switch Over
Data logger failure	1E02	NO	NO	NO
Caution lamp power stage failure	1C11	NO	NO	NO
Record manager failure	1E01	NO	NO	NO
Real time clock failure	1D06	NO	NO	NO
Indicator: ECU self test is active	1D08	NO	NO	NO

Default Values in case of a failure

Failure description	Failure Code	Default Value	Effect on Engine Performance	Engine power display
Power lever sensor 1 failure	1222	Sensor 2 or if both fail 80%	No effect, or if both fail about 80% available ,	Correct
Power lever sensor 2 failure	1234	Sensor 1 or if both fail 80%	No effect, or if both fail about 80%,	Correct
Atmospheric pressure sensor failure	1105	800mbar	Limitation of the engine	Correct
Battery voltage failure	1615	24V	No effect	Correct
Boost pressure sensor failure	105	2600mbar	About 80%of the engine power shall be available.	Deviates
Coolant temperature sensor failure	115	-20°C or 60°C depending on oil temperature	No effect	Correct
ECU temperature sensor failure	2361	100°C	No effect	Correct
Fuel pressure sensor failure	2006	2,5bar	No effect	Correct
Fuel temperature sensor failure	180	21°C	No effect	Correct
Gearbox oil temperature sensor failure	1B11	0°C	No effect	Correct
Intake air temperature sensor failure	110	60°C	As stated in the Performance Diagrams at 60°C Intake Air Temperature	Deviates
Engine oil pressure sensor failure	1B13	0,03bar	No effect	Correct
Oil temperature sensor	2014	70°C	No effect	Correct
Common Rail pressure Sensor faiilure	190	Control Set Point	About 80%of the engine power shall be available	Deviates

8. Additional Information

8.1 Propeller Self Test (Automatic Run-Up Test)

Description:

The propeller governor self test has been designed to emulate the manual run-up test performed by the pilot of an aircraft equipped with a conventional (mechanical) propeller control lever. With the single power lever installation of the AE300 engine, the self test button must be pressed during the automatic run up. The self test button in the cockpit has to be released once before a new (subsequent) self test can be initiated by pressing the button again.

Release Criteria:

The propeller governor self test will only be released if the following release conditions have been met:

- Aircraft on the ground.
- Prop speed = idle (below 1000rpm).
- Power lever = idle (below 5% power lever position).
- No errors pending.
- Self test button active (and pressed during the whole test run).

The EECU will increase the prop speed to about 1900 rpm producing thrust. Therefore the brakes have to be applied during the whole test run to prevent the A/C from moving.

The engine oil temperature and gearbox oil temperature shall be within the green range of the respective engine indicators before initiating the self test.

Test Abortion:

The propeller governor self test will abort immediately and the prop speed will be reduced to idle for the following reasons:

- "Self test"-button has been released by the pilot.
- "Weight on wheels"-switch has been released for more than 1 sec.
- Power lever has been moved above the 5% position.
- An error has been detected by the EECU (see "Diagnosing Self Test Failures" for failure analysis).

Cockpit Indications:

For the proper sequence of cockpit indications and possible caution alerts during the self test, refer to the approved Aircraft Flight Manual.

Copyright