# 340CC

## ASTM CERTIFIED ENGINE

## OPERATIONS MANUAL

TITAN

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# 1.0 Description

## 1.1 General

The TITAN® 340CC engine has been tested and are manufactured in accordance with ASTM F2339-06. The TITAN® 340CC engine is a 4-cylinder, direct-drive, horizontally-opposed, and air-cooled engine. In referring to the engine, the front is described as the propeller flange, the accessory case is at the rear of the engine, the oil sump is located on the bottom, and the pushrod shroud tubes are located on the top of the engine. Reference to left and right side of the engine is made with the observer in the pilot (rear) position facing the accessory section of the engine. The cylinders are numbered from front to rear with odd numbers on the right. The direction of rotation of the crankshaft (as viewed from the rear) is clockwise. Rotation of accessory drives is determined with the observer facing the drive pad.

The cylinders are of conventional air-cooled construction with 2 major parts: head and barrel, which are screwed and shrunk together. The heads are made of aluminum alloy castings. Rocker shaft bearing supports are integrally-cast in the head with an electro-polished stainless-steel rocker cover sealing the upper valve train from the environment. The cylinder barrels are made of thru-hardened steel that will have a Nickel+Carbide® coating for additional corrosion and wear prevention.

A conventional camshaft is located above and parallel to the crankshaft. The camshaft actuates the hydraulic lifters to operate the valves via pushrods and rocker arms. The rocker arms actuate about a floating rocker shaft, and the valve springs are retained via hardened steel retainers and lower seats and standard split keepers.

The crankcase assembly consists of 2 separate cast aluminum crankcase halves, which are mated and machined together for precision fit with the crankshaft and mating parts. The separate halves and the attaching structure are secured together using floating thru-bolts, studs, bolts, anchor bolts, and nuts. The mating surfaces of these 2 separate halves are joined without the use of a gasket, and the main bearing “saddles” are machined to use standard SAE sleeve-type bearings. No gasket or sealer material is allowed at the bearing bosses of the crankcase, but some sealer materials are allowed at the upper and lower split line. Reference is made to ECi TN 09-1.

The crankshaft is manufactured from 4340 VAR steel which has all bearing and forged surfaces nitrided. Connecting rods are H-type alloy steel forgings also using standard SAE sleeve-type bearings at the interface with the crankshaft and bronze bushings at the interface with the piston pin. The connecting rod is bolted around the crankshaft pins via 2 bolts and nuts through each connecting rod cap.

The pistons are machined from aluminum alloy and are secured to the connecting rod via a floating steel piston pin, each manufactured with integral aluminum plugs to prevent wear against the cylinder barrel wall. Each piston has 2 compression rings and a single oil control ring.

The 340CC lightweight accessory case does not have provisions for accessories, and is made from a magnesium casting. The housing forms part of the oil pump and a cover for the rear of the engine.

The oil sump attaches to the bottom of the engine and has at least one drain plug. The sump has internal air passages for the cylinders and an oil galley to provide engine lubrication and with a suction screen to prevent debris from circulating through the engine. The sump has a pad on the bottom to attach the carburetor. The 340CC oil sump is fabricated from aluminum sheet with welded construction.

The TITAN® 340CC engine is designed to be cooled via air pressure forced from the top of the engine to the bottom of the engine during flight. Air is directed over the cylinder heads via baffles, which attach between each cylinder pair. The air is exhausted out the rear of the engine via baffles associated with each airframe installation. The engine is designed to be operated with at least 6.5 inches of water cooling air pressure drop across the engine in the most adverse flight and operating conditions. An oil cooler that can extract up to 500 BTU/min of heat energy is required.

The 340CC engine uses a MA4SPA (or equivalent ASTM approved) carburetor, which is a single barrel float-type carburetor equipped with a mixture control and an idle cut-off. The carburetor requires fuel delivery to the carburetor inlet between ½ and 5 psi. Approximately 18 inches of fuel head provides ½ psi for gravity feed systems.

## 1.2 Lubrication System

The 340CC engines utilize a pressurized wet sump lubrication system that is actuated by an impeller-type oil pump contained inside the rear (accessory) housing.

## 1.3 Priming System

Priming is achieved by a priming system or a throttle pump on engines utilizing a carburetor.

## 1.4 Ignition Systems

The ignition system used on the TITAN® 340CC engine is an electronic system produced by Lightspeed Engineering. The cylinders are machined for 14mm spark plugs. Other electronic ignition systems or magnetos may be used on the engines, but must be either FAA Approved or be shown compliant to ASTM F2339-06. No traditional drive gears or mounting pads have been provided in the 340CC Engine.

Figure 2 View of TITAN-340CC with Lightweight Sump

# 2.0 Specific Model Specifications

## TITAN-340CC (9:1 CR)

| | |
|---|---|
| ASTM Engine Specification | 340S |
| Takeoff horsepower | 180 |
| Takeoff engine speed, RPM | 2700 |
| Take-off manifold pressure, In.-Hg | 28.5 |
| Maximum Continuous horsepower | 80 |
| Bore | 5.125 |
| Stroke | 4.125 |
| Displacement, cubic inches | 340.4 |
| Compression ratio | 9:1 |
| Firing order | 1-3-2-4 |
| Maximum Ignition Timing | 25º BTDC |

### The TITAN-340CC Engine Provides for the Following Accessories

| Accessory | Direction of Rotation | Drive Ratio to Crankshaft | Max. Torque (in-lbs) | | Max. Overhang Moment (in-lbs) |
|---|---|---|---|---|---|
| | | | Continuous | Static | |
| Starter | CCW | 16.56:1 | N/A | 450 | 150 |
| Alternator | CW | N/A | 60 | 120 | 175 |

## Weight

| Component | Weight | Arm[2] | Moment |
|---|---|---|---|
| Basic Engine[1] | 223.00 | 14.50 | 3,233.50 |
| Add Oil Filter | 1.39 | 29.30 | 40.73 |
| Add the Starter | 7.85 | 4.97 | 39.01 |
| Add the Alternator | 5.50 | 4.97 | 27.34 |
| MA4-SPA Carburetor | 3.50 | 18.80 | 65.80 |
| Ignition Harness | 1.50 | 14.30 | 21.45 |
| Spark Plugs | 1.32 | 13.98 | 18.45 |
| Coils + Bracket + Hardware | 1.75 | 12.48 | 21.84 |
| Starter Ring Gear and Support | 5.50 | 1.90 | 10.45 |
| Total Weight and Moment | 251.3 | | 3,478.57 |

1 Basic Engine Configuration:

- Cub Crafters oil sump and induction tubes
- Hollow front main crankshaft with plug for fixed pitch propeller

* Starter ring gear and support, caburetor, magnetos, ignition system and spark plugs not included. The plasma II is not included because it is installed on the airframe.

2 Arm Datum is the front of the propeller ring gear support.

## Method for Computing Engine Weight and Center of Gravity:

1 Start with basic engine weight and moment.

2 Add or subtract weight and moment of components added or removed.

3 The new total moment is divided by the new total weight to establish the new complete engine center of gravity.

# 3.0 Operating Instructions

## 3.1 Starting

1. Perform pre-flight inspection:
   a. Check oil level. The maximum oil level acceptable for flight is six quarts, and the minimum level is three quarts. Some engines tend to throw oil out the breather if completely full. Engine characteristics should be monitored to determine optimum oil level. For best results, 4 quarts is recommended.
   b. Visually look at all areas of the engine that can be seen through the cowling. Check the breather line area to see if significant blow-by is evident. Check the area behind the starter ring gear if possible to ensure that the front oil seal is not leaking. Oil dripping from the cowling in any location, or even evidence on the ground that oil is leaking is cause for concern that should be addressed. Ensure that the induction air filter is clear and intact. Older foam type filters should be pinched to ensure that they are not deteriorating, which draws particles into the engine. Integrity of the air filter system should be checked to ensure that dirt or other debris is not being drawn into the engine. Make sure no obstructions such as bird nests or insect nests are in evidence.
2. Fuel Valve: ON
3. Carburetor heat: OFF
4. Mixture: FULL RICH
5. If a boost pump is installed: ON
6. Throttle: CRACKED ABOUT ¼ TRAVEL
7. Prime:
   a. If a pump primer is installed, then prime 1–4 strokes. Each engine has an optimum prime depending on temperature, altitude, etc. Experience with the engine will help establish this procedure.
   b. If a pump is not installed, priming can be accomplished by pumping the throttle. This is more effective in warmer climates.
8. Ignition: Both
9. Starter: ENGAGE
10. Throttle: Set at 1000 RPM
11. Oil Pressure: VERIFY MINIMUM OIL PRESSURE WITHIN 15-20 SECONDS

## 3.2 Warm Up and Taxi

1. Engine cooling is dependent upon airflow through the cowling and oil cooler. The section of the propeller in front of the cowl cooling inlet is generally very ineffective, and forward speed of the airplane may be necessary during high temperature conditions to keep the engine from overheating. Overheating during ground operation can produce a condition called "Glazed Cylinder Bores" at any time in the engine's life, but the cylinders are most susceptible during the first few operating hours. Reference is made to SB 88-7-1 and Manual M101:

   Break-In Instructions for Cylinder Overhaul or Cylinder Replacement

2. The engine should be warm enough for taxi as soon as it takes throttle with no hesitation. Trying to keep taxi distances short is not always possible, and there should be no significant engine distress from long taxi distances after engines are properly broken-in. However, the engine temperature should be monitored, especially during hot weather. Additionally, taxi safety should not be compromised! If high temperatures are noted during taxi, then the engine installation should be examined to establish and fix the root cause.

## 3.3 Run-Up

Follow the airplane manufacturer's recommendations for similar engines. However, the following procedure may be used.

1. If possible, head airplane into wind.
2. Mixture: FULL RICH
3. Throttle: 1700 RPM
4. Ignition: Switch to left and then right, a slight change in RPM is normal but engine should continue to run smooth on either ignitions.
5. Carburetor Heat Control (Carburetor Engines): PULL OUT AND VERIFY RPM DECREASE

## 3.4 Take-Off and Climb

1. Mixture: FULL RICH (Note: at high altitudes, some leaning to obtain smooth operation may be required)
2. Carburetor Heat Control (Carburetor Engines): OFF (Full in position on most airplanes)
   a. Carburetor heat may be required during climb to prevent the formation of ice on the air throttle valve. The use of carburetor heat causes the engine to run slightly richer, and some roughness may be experienced. Sometimes this can be helped by leaning the mixture slightly.
3. Throttle: ADVANCE SLOWLY AND SMOOTHLY (If engine does not respond properly to throttle, then abort take-off and determine cause)

 

4 Depending on the airplane, transition at the proper speed to climb attitude.

5 Throttle: REDUCE TO 2500 RPM WHEN ACCEPTABLE CLIMB ESTABLISHED

6 Airspeed: MAINTAIN ADEQUATE FOR ENGINE COOLING

NOTE: These engines have been designed to cool adequately with airflow sufficient to provide a minimum of 6.5 inches of water pressure drop from above the cylinders to below

## 3.5 Cruise

1 Power: MAINTAIN CLIMB POWER UNTIL CHOSEN ALTITUDE ESTABLISHED

2 Throttle: REDUCE MANIFOLD PRESSURE TO CRUISE SETTING (See figure 4.3 for recommended cruise power settings).

3 Mixture (With EGT Gauge): The mixture should be slowly but deliberately leaned to establish peak EGT if a gauge is available. The mixture should then be adjusted to provide smooth operation at the desired cruise power setting.

4 Mixture (Without an EGT Gauge): The mixture should be slowly but deliberately leaned until engine roughness is noted. The mixture should then be enriched until the engine returns to smooth operation. The cylinder head temperatures should be monitored to ensure proper fuel/air mixture.

5 Carburetor Heat: The use of carburetor heat may be required to prevent the formation of ice on the air throttle valve if the air temperature is between 20 and 90 ºF and the humidity is high.

NOTE: There are some that advocate operating on the lean side of peak EGT. Although theoretically acceptable, it is generally not possible to operate lean-of-peak with an engine using a carburetor.

6 After cruise power and mixture have been set, allow the engine to stabilize and monitor manifold pressure, RPM, and engine temperatures.

NOTE: There are many operating and physical parameters that can affect engine life and airworthiness. Some of the physical parameters cannot always be checked or monitored. One of the best ways to monitor engine health is to have Cylinder Head Temperature (CHT) probes in each cylinder head. An EGT gauge is also very useful, but more so for fuel injected engines.

## 3.6 Let-Down

The let-down should be accomplished by slightly decreasing power and letting the airplane decelerate (to safe airspeeds). Chopping the power should be avoided unless there is an emergency. The reason is that the cylinder barrel walls will receive cold air cooling while the piston is still hot. This can lead to scuffing, glazing, or even barrel deformation with a washboard pattern matching the barrel fin spacing. Rapid cooling of the head is not the major source of structural head failures, but rapid cooling of any reciprocating parts can lead to problems. After the cylinder heads are below 315°F, then the power may be reduced more for a greater descent rate. During the descent, the mixture should be INCREMENTALLY ENRICHED, or from lower altitudes, placed in the FULL RICH position. Occasional temporary power increases should be made to verify the engine is ready to resume full power if required.

NOTE: Reduced throttle exposes more carburetor butterfly to the airflow, and the possibility of carburetor ice is more prevalent. Accordingly, use carburetor heat to prevent ice formation.

## 3.7 Landing

Landings take many forms and procedures are based on environment and skill. However, all landings should be accomplished with the idea that a go-around may be necessary. This means that the carburetor heat should be off and the mixture set rich when approaching the "Over-the-Fence" position.

## 3.8 Stopping the Engine

The engine will normally cool sufficiently during the landing and taxi. If the engine has operated at an extended time on the ground, open the throttle to 900-1000 RPM for at least a minute before stopping the engine. Pull the mixture control to idle cut-off from an idle speed to shut down the engine. Turn off dual ignition and master power from airframe. It is good practice to close fuel valve from airframe when leaving aircraft parked for extended lengths of time.

 

# 4.0 Operating Conditions and Limitations

## 4.1 Fuel Grade and Limitations

All 340CC engine series are designed to use 100/100LL aviation grade fuel. In the event of an emergency, automotive premium grade fuel may be used. Acceptable fuel pressures are as follows:

| | |
|---|---|
| Fuel Pressure Limits | |
| Inlet to carburetor psi | +0.5 to +8.0 |

## 4.2 Oil Grade and Limitations

### Oil Grades

| Average Ambient Air | MIL-L-6082 or SAE J1966 Mineral Grades | MIL-L-22851 or SAE J1899 Ashless Dispersant Grades |
|---|---|---|
| All Temperature | — | SAE 15W50 or 20W50 |
| Above 80°F | SAE 60 | SAE 60 |
| Above 60°F | SAE 50 | SAE 40 or SAE 50 |
| 30°F to 90°F | SAE 40 | SAE 40 |
| 0°F to 70°F | SAE 30 | SAE 40, SAE 30, or SAE 20W40 |
| 0°F to 90°F | SAE 20W50 | SAE 20W50 or SAE 15W50 |
| Below 10°F | SAE 20 | SAE 30 or SAE 20W30 |

NOTE: In addition to the above grades for normal operation, consult ECi Service Instruction 88-7-1 or Manual M101 for additional recommendations at engine break-in.

### Oil Sump Capacity

| | |
|---|---|
| TITAN-340CC Maximum Quantity | 6 US Quarts |
| Minimum Safe Quantity in Sump | 3 US Quarts |

## Oil Operating Temperatures

| Average Ambient Air | Desired Oil Temperature | Maximum Oil Temperature |
|---|---|---|
| Above 80°F | 180°F | 245°F |
| Above 60°F | 180°F | 245°F |
| 30°F to 90°F | 180°F | 245°F |
| 0°F to 70°F | 170°F | 225°F |
| Below 10°F | 160°F | 210°F |

NOTE: Engine oil temperature should not be below 140°F during continuous operation.

## Oil Operating Pressures

| Operating Condition | Oil Pressure Maximum | Oil Pressure Minimum | Idling |
|---|---|---|---|
| Normal Operation | 90 | 60 | 25 |
| Start-up and Warm-up | 100 | — | — |

# 4.3 Operational Limitations

| Engine Type | Operation | RPM | HP | Fuel Cons. (gal/hr) | Max Oil Cons. (qts/hr) | Max Cyl Head Temp (°F) |
|---|---|---|---|---|---|---|
| TITAN 340CC | Take-Off | 2700 | 180 | 16.2 | 0.25 | 475 Recommended |
| | Cruise | See Below | See Below | Varies | 0.25 | 450 Recommended |

Maximum limiting CHT is 475*F. During Climb-out if CHT exceeds 420*F, reduce power if safely able to do so.

| | Temperature °F | | | | | | |
|---|---|---|---|---|---|---|---|
| | -30 | -20 | -10 | ISA | 10 | 20 | 30 |
| Pressure Altitude | RPM for 80 Horsepower | | | | | | |
| Sea level | 2050 | 2050 | 2050 | 2050 | 2050 | 2100 | 2100 |
| 2000 feet | 2100 | 2100 | 2100 | 2100 | 2100 | 2100 | 2100 |
| 4000 feet | 2150 | 2150 | 2150 | 2150 | 2150 | 2150 | 2200 |
| 6000 feet | 2200 | 2200 | 2200 | 2200 | 2200 | 2200 | 2200 |
| 8000 feet | 2250 | 2250 | 2250 | 2250 | 2250 | 2250 | 2300 |
| 10000 feet | 2300 | 2300 | 2300 | 2300 | 2300 | 2300 | 2300 |

## 4.4 Overhaul Period

The O-340CC engines have been tested to the protocol established in ASTM F2339-06 to an overhaul period of 2400 hours.  Overhaul periods are subject to many factors, and must be accomplished depending on engine condition.

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