



3M Model 53cc
TOC-53 Gasoline Engine
Owner's Manual



Planet Roger official website: <http://www.rogerlee.net.au>

Revision History¹

Date	Version	Author	Change log
2007-04-29	1.00.0000	Roger Lee	Initial draft.

¹ All texts in the document are original work of Roger and remain the property of Roger.

Warning!!!

This engine is not a toy! This is a highly efficient internal combustion engine. It is a high performance precision instrument that is designed to generate a substantial amount of horse power and spins a very large propeller at very high RPM (revolutions/rotations per minute).



Serious and/or fatal injury can occur if misused! It is extremely important to read and understand this safety instruction thoroughly before operating the engine. Please familiarise yourself with the engine's controls and operations and learn to identify and avoid potential hazards. Always strictly adhere to engine safety procedures and operate within its limits.

As the owner of this engine, you alone are responsible for the safe operation of the engine. Act responsibly and with care at all time. Ensure safety of yourself and others.

If in the future the ownership of this engine is transferred to another person, please pass on these safety instructions to the new owner.

Safety Instructions

- You must never touch, or allow any object to come into contact with the rotating propeller. A rotating propeller carries a great deal of kinetic energy that will be transferred to any object in its path and cause severe injury.
- You must never crouch over the propeller. Always walk behind the propeller to adjust engine setting.
- A loose or weakened propeller may disintegrate or be thrown off at great speed. Severe injury may occur on impact with human body. Always check the tightness of the propeller fittings, and retighten if necessary, before each flight. A weakened propeller must be discarded.
- Fuel (premium unleaded petrol) and oil used by this engine is poisonous. Never allow it to come into contact of the eyes. Store in clearly marked container and keep it out of reach of Children.
- Fuel is highly flammable. Keep it away from naked flame, spark, or anything that might cause it to ignite.
- Do not smoke, and do not let anyone else smoke, near the engine, fuel tank and fuel storage.



- Never touch any part of the engine, especially the cylinder head and exhaust manifold, until it has cooled. A running engine generates considerable heat and may cause severe burn upon contact with human skin.
- Always operate the engine in an open area with good ventilation. Exhaust fume contains deadly chemicals such as carbon monoxide. Breathing in of significant amount of carbon monoxide can cause long term injuries or death.
- This engine is designed for use on large scale model airplanes. Never use it for any other purpose.
- Mount the engine to your model securely using the supplied engine stand off, bolt and nut. Apply thread lock to the threads to prevent engine installation from coming loose due to vibration.
- Always use a top quality and undamaged propeller with appropriate diameter and pitch. Because of the size of the engine, a carefully balanced wooden propeller is recommended.
- Use of a balanced, precision made spinner is encouraged because it significantly reduces the chance of propeller flying off during an unlikely event of engine back fire.
- The electronic ignition unit (CDI) may generate significant radio interference to your receiver, even when the CDI is shielded. Always use top quality radio equipment. A PCM radio is highly recommended over PPM/FM as it is more susceptible to radio interference.
- Always mount receiver as far away from CDI unit as possible. Check the reception of the model before every take off. A model out of control can cause significant damage.
- Always ensure that there is enough battery power left in the CDI ignition battery pack before each flight. Lack of appropriate battery power during flight can lead to dysfunction of the CDI unit and the engine, causing the model to crash
- Make sure that all the leads and fuel tubes are securely fastened and do not come into contact with the propeller.
- Do not operate the engine near sand or small pebbles. The propeller may throw these small objects in your face or eye and cause injury.
- For the safety of other people, keep onlookers, especially small children, well clear of the engine and the propeller plane. A distance of 6 metres is recommended.
- Always fit an isolation switch (also known as kill switch) to your engine.



Limited Warranty

We provide a standard 12 month warranty on the engine, from the date of purchase. This warranty is strictly limited to the replacement of defective parts that are results of faulty material or manufacturing. The warranty will be voided if a defect is caused by non-compliance with installation or operation procedures, mishandling, unskilled repairs or third party spare parts.



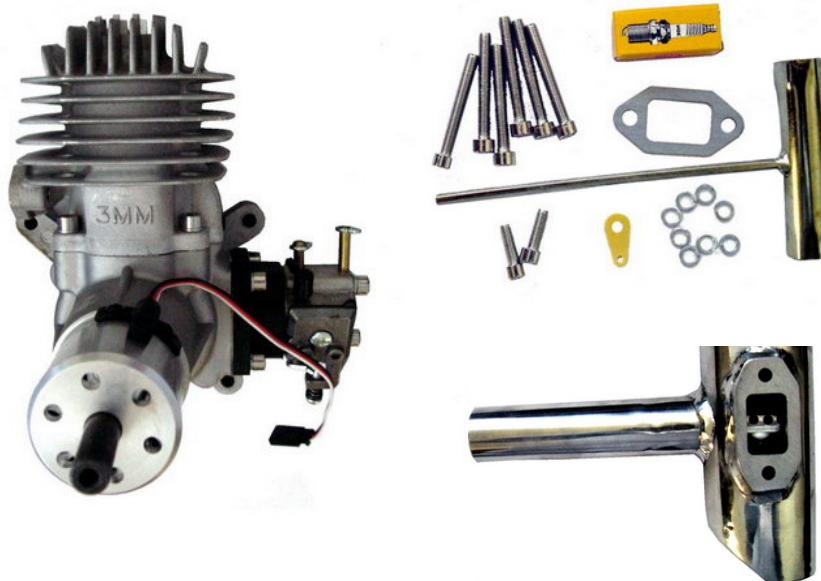
This engine is designed specifically as power plant for large scale model airplanes only. It should not to be used in other applications. Use in other applications will void the warranty immediately.

Any alternation, modification or addition to this engine will void your warranty immediately.

In case of defect during the warranty period, return the product to Planet Roger at your own cost. Repaired model or parts will be shipped to you at no cost. In no circumstances will the liability to the distributor, Planet Roger, exceed your original purchase cost of the engine. The guarantee does not cover any damage caused by misuse, neglect, accidents, abrasion, exposure to extreme temperature, solvents, acid, water, normal wear and tear or damage by the postal/courier service.

Package Contents

Item	Item Count
3MM 53cc Gasoline Engine	1
Carburettor (preinstalled)	1
Muffler	1
Muffler Gasket	1
Spark plug	1
Standoff + bolt + nut	4
Propeller bolt washer	6
Propeller bolt	6
Alan key + Spark plug hex key	1
CDI unit	1



Engine Installation

- You must break in (run in) the engine on a test stand first before installation on a real model. Refer to the engine (run in) break in guide to break in your engine properly.
- You must build a strong and properly designed engine box for your model. The conical shaped (wider at the base) engine box is the best because it provides better air flow.
- The surface of the firewall must be flat. In case of ARF models, make sure the supplied firewall on the engine box is flat and properly glued. You may need to reinforce the engine box on some ARF models.
- The reason for mounting the engine on an engine box and not the fuselage directly is to provide enough clearance around the engine to let air flow over and away from the engine. It is essential to keep your engine running as cool as possible.
- Sometimes you need to give the engine a few degrees right thrust to compensate for the engine torque. Use a properly designed angled firewall. Never use washers or spacers to make up the angle, as this will create stress on the crank casing and can cause premature engine damage, and doing so will void the warrantee immediately.
- In case of a composite engine box, make sure the engine box is strong and flat. You may need to glue a piece of aviation grade plywood, using 30min epoxy, to the inside of the engine box to provide as additional engine support. Use of a low quality engine box with uneven surface will void the warrantee immediately.
- Find the dead centre of the position of the propeller shaft on the firewall. Refer to the measurement supplied on the bolt mounting pattern in this manual and mark the positions of the bolts. Drill 3.9mm holes on the firewall. Drop thin CA into the holes to harden the wood.
- Ensure there is enough clearance of the engine and exhaust in the engine cowling, and ensure adequate airflow over the engine to provide enough cooling to both the engine and exhaust.
- Securely mount the engine to the model using supplied engine stand-off, bolts and nuts. Make sure you tighten the bolts evenly. Apply thread lock to the bolt to ensure the engine will not come loose due to vibration.
- Mount the DC-CDI to the model. Make sure it is securely attached. Make sure there is adequate cooling for the CDI unit as well. Make sure your radio receiver is as far away from the CDI as possible.
- Connect the crank angle sensor lead (on the engine) to the blue cable on the CDI. Connect the red cable on the CDI to an isolation switch first, then to the battery pack. Ensure the battery pack is wrapped in shock absorbent material.
- Check the spark plug and fasten it securely to the engine.
- Securely mount the ignition cap of the CDI to the spark plug.
- Make sure the fuel supply plumbing is done correctly and securely. Make sure there is no leakage in the fuel supply plumbing. Incorrect or poor plumbing will void the warrantee.
- Always install an inline filter between the fuel tank and the engine. This prevents impurities from entering the engine and cause unwanted wear and tear.

Engine Installation Do Nots

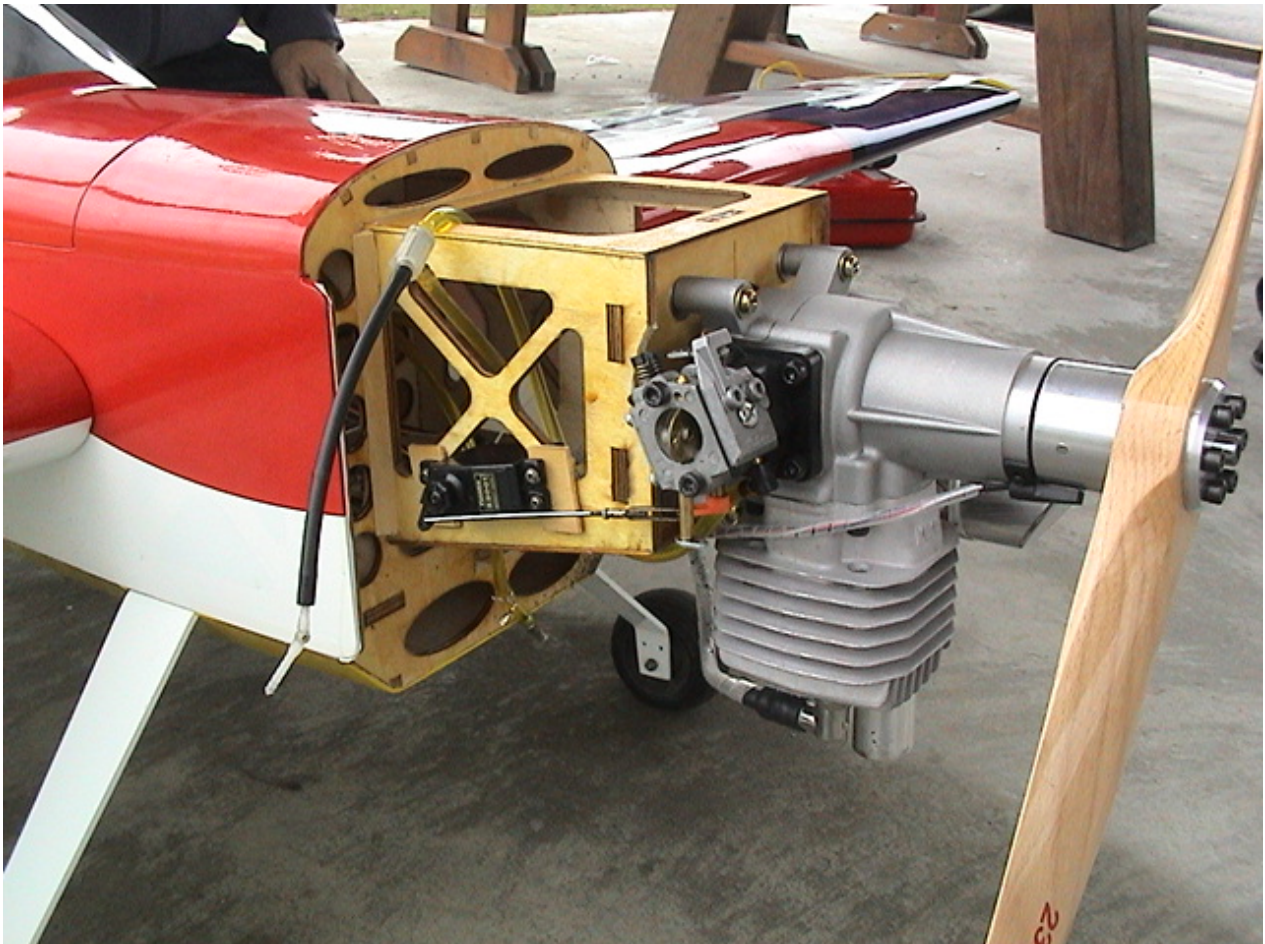
- Do not mount the engine to a large firewall or former directly, as this will prevent proper circulation of air around the engine for adequate cooling.
- Do not mount engine on an uneven surface.
- Do not use washers or spacers to create down/side thrust, as doing so creates tension on the crank case and will lead to metal fatigue and premature engine damage.
- Do not mount the CDI close to the receiver unit. CDI generates a lot of radio interference and will cause receiver malfunction and may cause a model crash.
- Do not mount the CDI against a hot surface or in the path of hot exhaust air. Overheated CDI will cause the engine to malfunction, or destroy the engine.

Building an Engine Box

To ensure proper cooling of the engine in flight, it is highly recommended to mount the engine on top of an engine box (also known as motor box). The engine box is built with high quality, thick plywood.

The engine box has a conical shape. It is smaller at the front and larger at the end. The surface of the firewall is absolutely flat. An interlocking firewall structure is highly recommended. The engine box must be properly assembled and glued to withstand engine vibration, and ensure that it does not fall off during flight.

The following photo shows a typical installation of the engine on a built up engine box. Interlocking structure absorbs tensile stress so the firewall will not break off during flight. Also note the heavy reinforcement with balsa stripes. Use 30min epoxy for the gluing.



The engine box can also be moulded from fibreglass material, reinforced with carbon fibre stripes.

Engine Cooling

Basic laws of physics

1. Air expands when heated. Volume of hot air is greater than the volume of equal mass of cold air.
2. Volume is an inverse function of density. Increased air volume reduces the air density.
3. Increased air velocity leads to increased air volume over a constant flow area.
4. Air will flow down the path of least resistance.
5. By the law of thermodynamics, because the temperature of air is always lower than the cylinder head of a running engine, heat will be transferred from hotter cylinder head to the cooler air.

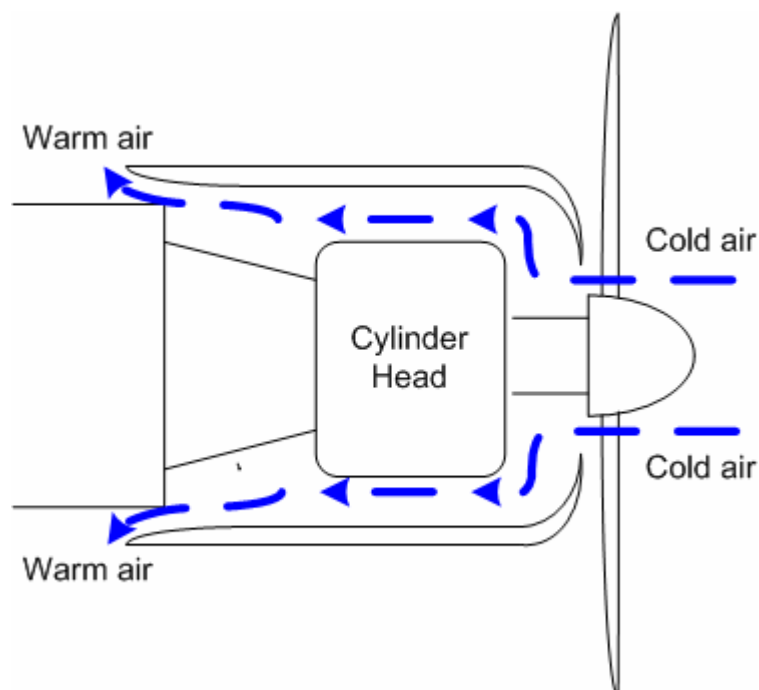
Efficient Engine Cooling

Efficient cooling aims at transferring the largest amount of heat from the cylinder head to the largest amount of cold air surrounding it. The most effective method is called **Baffling**. Baffling is the technique to channel / direct all intake air over the cylinder head, thus forcing air to flow across the engine rather than bypassing it. This is a very effective cooling method on air cooled engines.

To ensure constant flow of cold air around the cylinder, and to reduce the air pressure build-up inside the engine cowl, the hot air exhaust exit must have a much larger cross section area than the cold air intake. As a rule of thumb, allow 4 times the area for exhaust air than intake air, this may be achieved by reducing the intake area (as in a radial type cowl) and expanding the exhaust area. Air entering the smaller cowl opening will expand and cool existing at a lower velocity, further aiding cooling of the engine

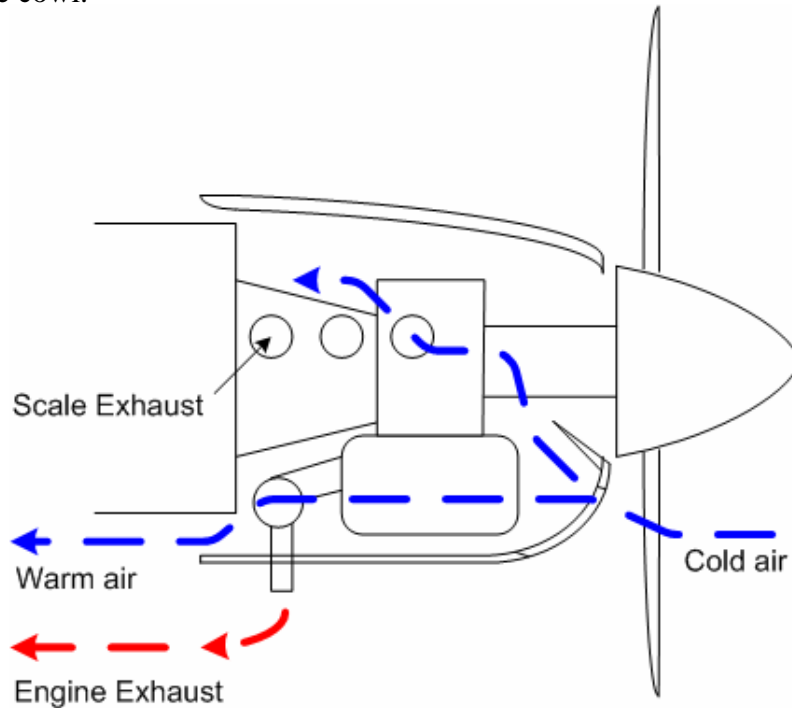
Cooling for Various Engine Configurations

Type 1 – Scale model of planes powered by radial engine. E.g., Corsair F-4, FW-190



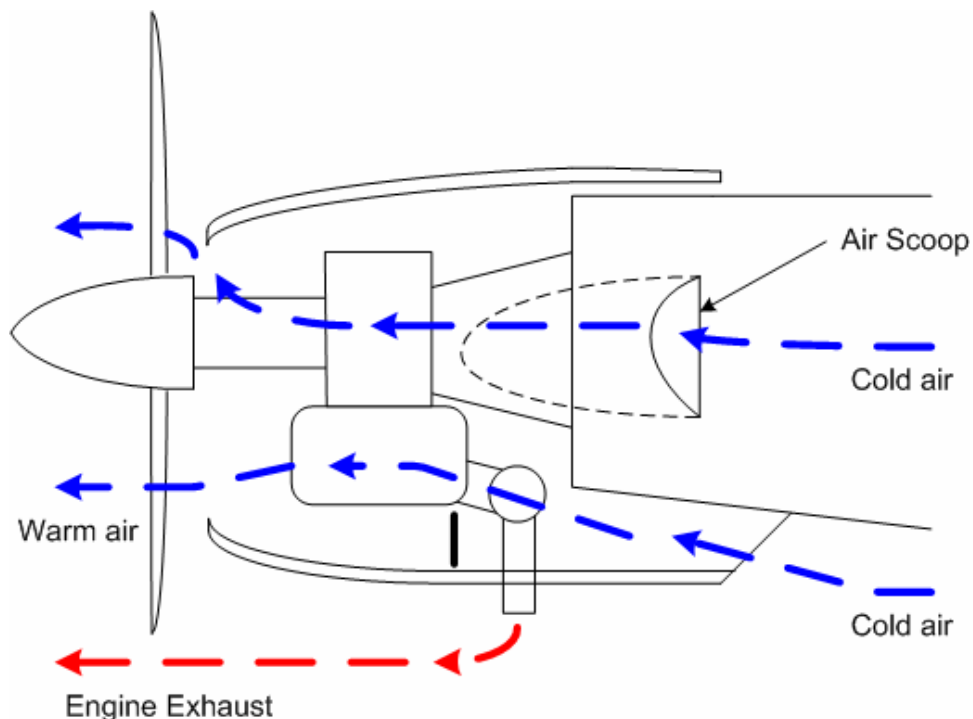
Type 2 – Scale model of planes powered by liquid cooled engines. E.g., Mustang, Spitfire.

Hint: use a baffled intake below the huge spinner to redirect airflow on to and around the cylinder head. Note that the host engine exhaust gas exits below the cooling air. This cooling configuration gives sufficient cooling to the engine. It also helps to keep the model clean during flight. The optional scale exhaust not only gives a scale look, it also functions as additional exits for warm air inside the engine cowl.



Type 3 – Rear pusher propeller configuration. There are two critical problems that need to be solved for planes with enclosed gas engine in rear mounted pusher configuration:

1. Overheating of the engine
2. Inadequate supply of fresh air to the carburettor.



Carburettor Settings

Factory Default

The carburettor setting has been preset by the factory during the quality control process. All engines have been tested and guaranteed to start when configured properly.

High Speed Needle (H): $1\frac{1}{2}$

Low speed needle (L): $1\frac{1}{2}$

Important

Do NOT remove the carburettor spring as the spring helps to keep the carburettor butterfly aligned properly. Simply release the ends of the spring so that it no longer holds the butterfly closed.

Carburettor Tuning

We highly recommend the use of a tachometer to measure the RPM.



Do NOT adjust the carburettor settings while the engine is running. Always stop the engine first before adjusting the needle settings.

1. Using the tachometer tune the engine for maximum power with the high needle (H).
2. Using the tachometer; enrich the high needle (H) until the motor runs 100-200 RPM below the maximum RPM. Now you are tuned slightly rich on the high needle (H).
3. Let the engine run at idle for one minute. Ensure that the idle RPM remains constant.
4. If the idle RPM drops until the engine stops; the low needle (L) is too rich. Lean the low needle (L) until a constant idle RPM is achieved.
5. Check the transition with a quick throttle advance. The engine should not sound strained at any time. It should sound like it is making quick steady power; without any hesitation.
6. An optimally tuned engine will feel a bit rich after a cold start. It will start to run optimally after it has warmed up for approximately one minute.

Start Procedure

1. Ensure the isolation switch is at off position.
2. Ensure the battery is fully charged.
3. Ensure the throttle is on low setting.
4. Close the choke.
5. Flip the propeller several times to draw fuel into the carburettor. You can see the fuel tube filling up.
6. Turn on the isolation switch.
7. Flip the propeller quickly with a chicken stick or by hand wearing a thick protective glove.
8. Flip until the engine starts and stops quickly.
9. Turn off the isolation switch, release the choke then turn the isolation switch back on.
10. Flip the propeller until the engine starts.

Engine Break-in (Run in) Procedure

To ensure smooth running of your engine and a long service life, you must break in your engine. No matter how well an engine is assembled, its final power output is all up to you!



We will start by preparing the fuel mixture from petrol and oil in a well ventilated area. Strictly observe the no smoking rule! The fume from the petroleum is highly flammable and could be ignited by the flame in the smoke and cause fire hazards or explosion.

Gasoline (Petroleum)



Always use premium unleaded petrol with high octane content for efficient burning. We recommend 98-octane for optimal performance of your engine.

Always use fresh fuel (less than 30 days old). The number one cause for problematic starting is old fuel. Fresh fuel ignites more easily and keeps your fuel system from getting the harmful deposits that stale fuel leaves that may cause hard starting later. Today's gasoline does not have the same chemical makeup as in years past. Testing has shown that significant deterioration can begin in as little as 30 days. The volatile components of the fuel are the first to deteriorate and are needed to help an engine start easily.



Oil (2-cycle)

Always use a natural petroleum based 2-cycle oil for engine break in. Natural oil has mild abrasive particles that help to break in your engine quicker. We recommend running at least 4 litres of gasoline / natural oil mixture before switching to synthetic oil.



A good practise, when preparing for a day's flight, is to top up at a gas station early in the morning and mix the fuel at the petrol station, before driving off to the flying field. This way you are guaranteed to have fresh fuel, and removed from the danger of naked flame igniting the fuel during mixing (no smoking at the gas station).



Break in Procedure

- Make sure the gasoline is fresh (less than 30 days). Mix gasoline and oil thoroughly at 25(gas):1 ratio.
- Fix the engine securely to a test stand. Secure fuel tank, CDI unit and battery behind the engine. Make sure the isolation switch (that cuts battery power to CDI) is set to off position. Connect up the engine according to the set up instructions. Make sure there is no loose object behind or in front of engine.
- Attach a balanced propeller securely to the propeller shaft. We recommend 22x10 for the break in.
- Choke the engine by closing the valve on the carburettor, and flip the propeller (anti-clockwise) a few times to draw fuel into the engine.
- Set throttle setting to idle position, release the choke, and turn on the isolation switch.
- Stand in front of the engine and use a rubber stick (also known as a chicken stick) to quickly flip the propeller in the anti-clockwise direction to start the engine. The engine should usually start within a few flips. You could also use a heavy duty starter if you have fixed a spinner to the propeller. Do **NOT** use your finger or you will be sorry!
- Run your engine 15 minutes at a time at various speed settings. Avoid prolonged wide open throttle.
- Let engine cool down, refuel and resume break-in. Run at least 2 litre of fuel through the engine.
- After several hours of break-in, the engine should deliver close to its maximum theoretical RPM and reach its optimal operational condition. The break-in procedure is complete.

Trouble Shooting

Problem	The engine is flooded (the crankshaft housing is filled with fuel).
Solution	<ul style="list-style-type: none">- Remove the spark plug and drain the fuel completely.

Problem	The engine won't start.
Solution	<ul style="list-style-type: none">- Check the fuel tubing to ensure fuel is supplied to the engine.- Make sure the engine is not flooded; otherwise drain the fuel from engine as above.- Check the battery and ensure there is enough voltage.- Make sure the isolation switch is turned to 'on' position.- Check carburettor settings. Check high/low speed needle settings.- This may also due to fouled spark plug or dirty carburettor.

Problem	The engine starts briefly and then stops.
Solution	<ul style="list-style-type: none">- The low needle setting is probably set too lean. Revert to factory recommended needle setting and readjust the carburettor.- This may also due to a fouled spark plug or a dirty carburettor.

Problem	The engine vibrates violently.
Solution	<p>Smooth running of the engine depends on many factors.</p> <ul style="list-style-type: none">- Always use a balanced propeller.- Check the fuel supply pipe work for possible leaks.- Check the spark plug for carbon residual and re-align spark plug gap as required.- Make sure the engine is mounted on a level surface and the crank case is free of tension.

Problem	The engine does not reach normal RPM even at full throttle.
Solution	<ul style="list-style-type: none">- The propeller is probably too big. Always use a propeller of the recommended diameter and pitch.- Always use a good quality muffler.- Make sure the engine is not overheated due to lack of appropriate air flow over the piston head.- Check the carburettor settings.- Make sure you have the correct fuel/oil mixture, and you are using top quality premium unleaded petrol.- Check the spark plug for carbon residual and re-align spark plug gap as required.

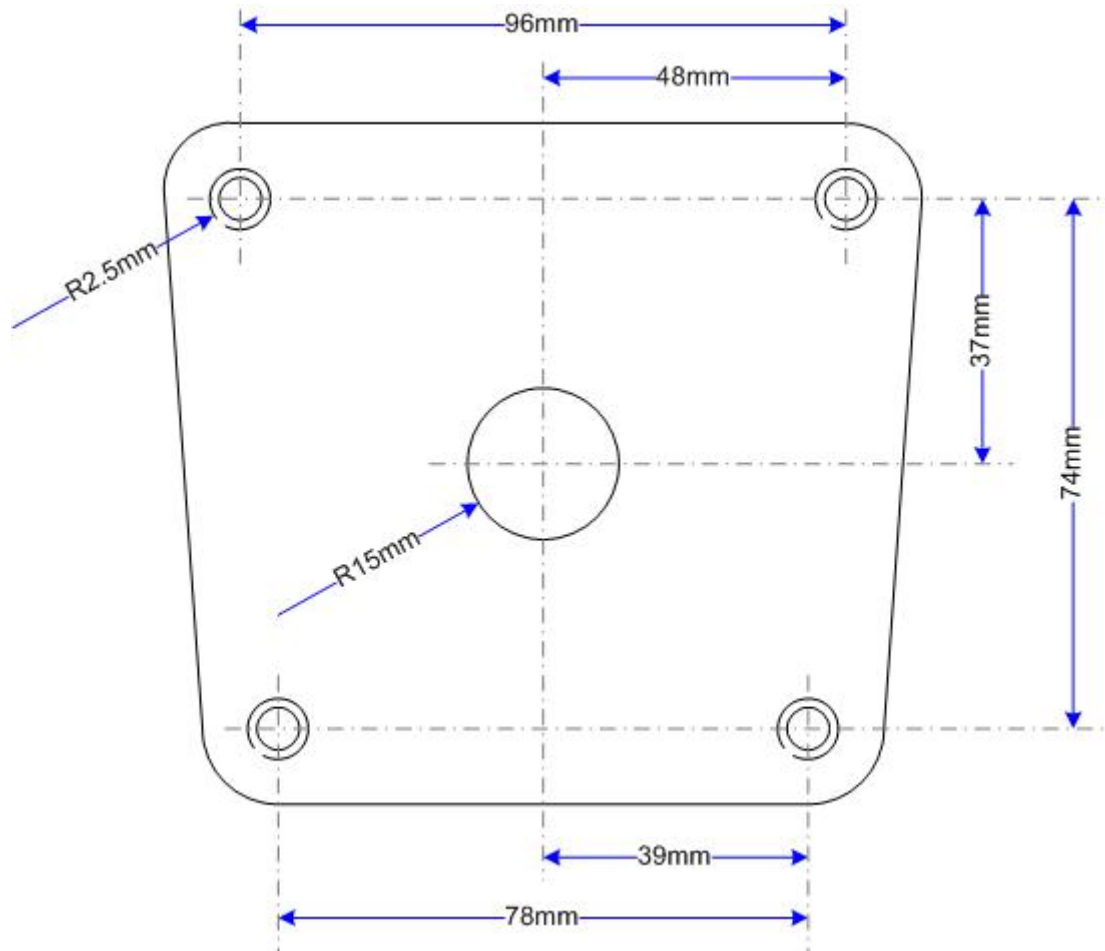
Technical Specification

Engine Type	2 cycle piston type gasoline engine for use on model airplane only
Displacement	53cc (3.234 cu in)
Bore	44mm (1.732 in)
Stroke	35mm (1.377 in)
Cowl clearance (height)	140mm (from centre of propeller shaft to spark plug)
Cowl clearance (width)	200mm (including carburettor and supplied muffler)
Gross Weight	1880g (including muffler and ignition unit)
Carburettor	Walbro
Maximum Output	5.5hp @ 8000rpm
Operational RPM Range	1200 - 7800rpm
IIS - Ignition	DC-CDI with auto timing advance
Ignition Power Supply	4.8 ~ 6V DC NiCad
Fuel Type	Pre-mixed fuel. Mixture ratio 25-40(98 octane):1
Lubrication Oil	2 cycle engine oil. <i>Only use natural petroleum based oil until break in.</i>
Propeller	2 bladed – 22x8, 22x10, 23x8 3 bladed – 20x8, 20x10, 22x8
Cooling System	Air Cooled

Engine Dimensions



3MM 53cc Bolt Mounting Pattern



IMPORTANT

This drawing is NOT in scale! You must do your own measurement on the firewall using the above as a reference only.

CDI - Electronic Ignition System

The 3MM 53cc gas engine is shipped with an intelligent electronic ignition system that has auto-timing capability. The electronic ignition system is also referred to as a CDI unit, which stands for Capacitive Discharge Ignition. To ensure optimum operation of the engine, the CDI unit must be connected to the spark plug to ensure correct spark discharge timing.

How does electronic ignition work on 3MM 53cc?

Electronic ignition is the control of ignition of the fuel/air mixture in an internal combustion engine by use of electronic circuits. Timing of ignition is critical for an internal combustion engine to function correctly. Timing advance refers to the number of degrees, before the piston reaching top dead centre, that the spark will ignite the fuel/air mixture in the combustion chamber.

The ignition is set off, at start up, when the piston has just reached dead centre. However as RPM increases, you need to advance ignition timing to cause the fuel to achieve full burn just after the piston begins it's descend. If the fuel/air mixture is ignited too soon, a detonation will happen that will eventually destroy the engine. If the ignition happens too late then the engine will lose power and efficiency.

The 3MM 53cc has a precision crank angle sensor built into the engine hub to measure the angle of the crank. The angle measurement is translated into a square wave that feeds into the CDI unit. The CDI unit has a simple processor to determine the correct timing of the ignition based on the frequency and position of the wave, which translates into engine RPM and crank angle.

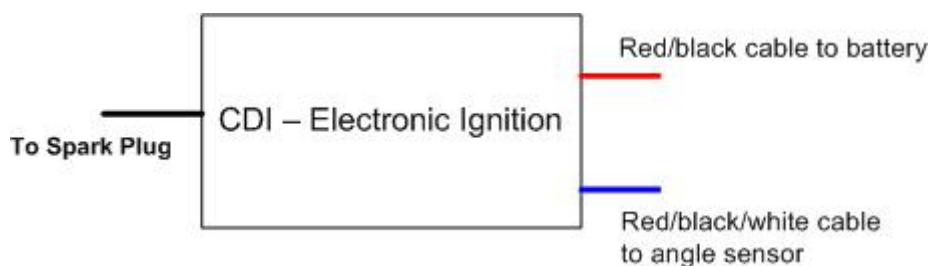


The CDI unit uses capacitor discharge current output to fire the spark plug and ignite the fuel/air mixture. The 3MM 53cc is supplied with a DC-CDI unit with ignition circuit completely enclosed within a metal enclosure. The CDI is powered by battery.

WARNING: do not touch the ignition unit during operation. The discharge voltage is above 20kv. Always switch off the isolation switch when not running.

Technical Specifications

Temperature Range	-40°C to +60°C ambient temperature
Voltage Range	4.8V to 6.0V
Operating Voltage	4.8V – 6.0V NiCad or LiPo can be connected directly to the CDI
Battery Capacity	> 1700mAh
Current Consumption ¹	20mA - 1000mA
Ignition Voltage	> 20kV
Maximum RPM	8500



A spare cable is supplied with JR/Futaba type connector to help building your own battery pack.

¹ Current consumption is an inverse function of battery voltage. Higher the voltage, lower the current consumption.