



# Multi-Fuel Switchable Maps

'Multi-fuel running at the touch of a button!'

Many platform designers and operators dream of the ability to run on any fuel, anywhere and without compromising the efficiency or reliability of the engine.



*Just imagine it - one day you are in a normal urban environment running from pump gasoline (petrol), next you are at an airport using JetA, a brief spell using diesel (because it's all you had) and finally back on gasoline. All without needing to change anything mechanically, without any additional maintenance and with unaffected performance*

RCV has been able to make this dream a reality. The combination of RCV's ideal HF combustion system, and an ECU equipped with Multi-Fuel Switchable Maps (MFSM) enables operation on any fuel at any time.



To explain why the RCV can achieve this where other technologies struggle requires a brief overview of RCV engine technology. After all the concept of an ECU that can switch between fuel maps is in itself not revolutionary. What is revolutionary is an engine technology that, given the correct fuel map, can run equally well on any fuel - this is what makes the RCV MFSM development unique.

The reason for the excellent running characteristics is the RCV Engine's ideal combustion system. The combustion system is the means by which the engine mixes air and fuel together, burns it within a combustion chamber, and uses the resultant rise in pressure to produce mechanical power.

An internal combustion engine can be thought of as a series of very short-lived bonfires. The "bonfire" is assembled by mixing air and fuel in the combustion chamber. The mixture is then ignited by the spark plug. The flame front then spreads throughout the chamber until the charge is completely consumed. The heat retained within the charge increases its pressure, which then acts upon the piston to perform mechanical work.

For this process to be rapid, reliable and efficient two conditions are essential:

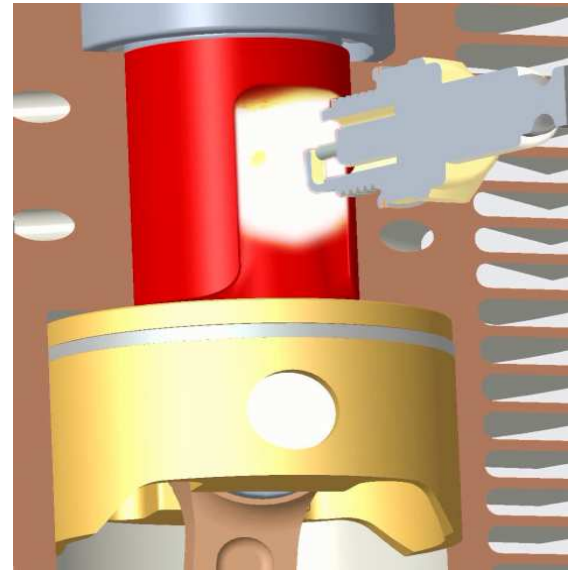
1. The fuel and air must be thoroughly mixed: in the bonfire analogy the wood must be split into small pieces and uniformly stacked with air gaps in between.
2. The combustion chamber must be a compact shape: in the bonfire analogy the wood must be stacked in a compact shape rather than spread over a large area.

The RCV rotating valve fulfils both ideal characteristics:

1. The rotation of the valve generates a high level of turbulence which mixes the fuel and air thoroughly.
2. The combustion chamber within the rotating valve body is very compact. This ensures the burn spreads reliably and rapidly from the ignition point through the entire charge. It also ensures that as much heat as possible is retained within the charge to produce mechanical work.

As a result the RCV is easy starting, powerful, and reliable on all fuel types.

Knowing that the engine effortlessly achieves reliable running on all of these fuel types has meant RCV has been able to develop firmware within the ECU to allow the MFSM function.



*"RCV Engines operate reliably on gasoline, and on all kerosene based heavy fuels including JP5 and JP8. It starts readily, handles well, and is extremely tolerant to changes in air fuel ratio, ignition timing, fuel composition, altitude, and ambient temperature"* Keith Lawes - Technical Director

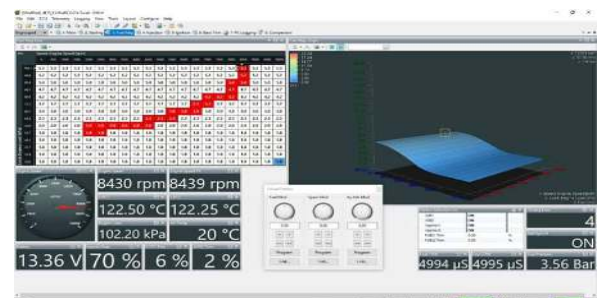
Developing the firmware upgrade was relatively straightforward. The specification was discussed with our ECU partner and then implemented. It was decided to have four independent fuelling maps and associated calibration data (for example cold start enrichment tables which will vary from fuel to fuel). The four tables enable gasoline, JP8, JP5 and diesel calibrations to be included in one ECU if required. The CAN bus was selected as the input method to select the fuelling map.



The ECU itself required no additional hardware changes. Everything was completed within software. All RCV ECUs are now equipped with MFSM. If required firmware updates can be carried out on existing units in the field to implement this feature.

The calibration maps for each main fuel type are based on a standard master calibration. They are individually adjusted for each engine to optimise operation. Engines as standard will leave RCV with a gasoline and JP8/Jet A1 calibration. A JP5 calibration can be supplied if requested.

A DF2 (diesel calibration) can also be supplied if requested. Due to its ideal combustion system the RCV runs well on diesel fuel. It starts readily and produces good power. However RCV currently state that it is an emergency use only fuel because at this stage of development there are some issues. Firstly high levels of smoke during start and warm up periods, and some smoke at normal running temperatures. It is also believed that there could be significant issues with internal carbonisation running on diesel. However it is expected that it could become a primary use fuel at some point in the future.



As far as RCV are aware the ability to switch effortlessly between fuels is not available on any other small engine technology. This makes RCV the perfect choice for any new or existing platform with a multi-fuel or HF requirement.

Current RCV multi-fuels projects involve fixed and rotary wing UAVs, both direct drive and hybrid. Also marine range extenders, and heavy fuel compatible generator sets.

In parallel with the multi-fuel engine development, core RCV technology is being developed by a partner company as a high performance forest and garden power unit. This is due to be launched into the Garden sector in the next 12 months.

This wide range of applications means that the technology is well tested running on HF in some of the harshest environments, and has proven itself time and time again.

Key RCV multi-fuel operating characteristics:-

- Rapid starting on HF. Typically 2 minutes pre-heating and 2 seconds spinning.
- Completely insensitive to changes in air fuel ratio. Will run from 8:1 to 15:1 AFR and produce useful power. Clearly we would not normally run at 8:1 AFR, but the ability to do so demonstrates the robust nature of the combustion system and how it will continue to run under all conditions.
- Completely insensitive to detail changes in fuel composition. Runs well on any brand/source of JP8/JetA1 without any noticeable difference in operation. Removes the need for a specific/shipped fuel supply.
- Completely insensitive to changes in ignition timing. Runs well over a timing range of +/- 20 degrees without detonation. Some loss of power when retarded.
- Runs well on diesel. Not offered as yet as a primary fuel, but demonstrates the level of heavy fuel combustion performance in hand when running on a lighter fuel.
- Insensitive to ambient conditions, temperature and pressure. Regularly flies to 15,000ft operating on JP8 and JP5.

For more information see

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