# Building a 4 Door Celica – The Coronavirus
# 3SGE BEAMS Returnless Fuel System

Phil Bradshaw: 33woodie@gmail.com

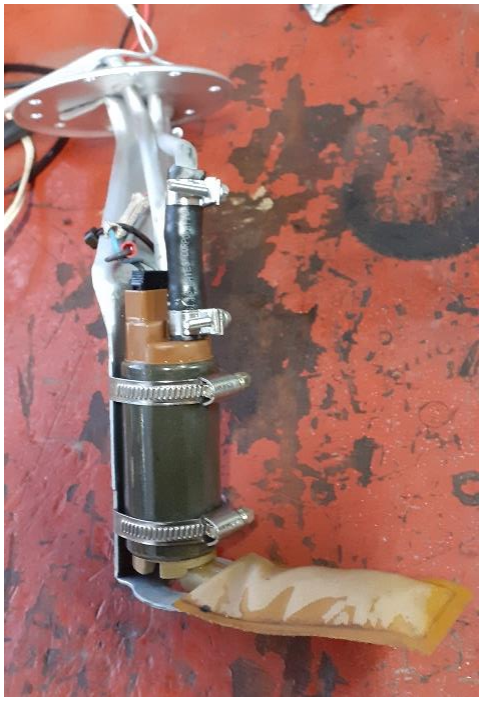
I'm fitting a 1999 Toyota Altezza SXE10 210 PS 3SGE BEAMS engine and J160 6 speed into a 1983 TT141 Corona sedan. My Corona was built originally with an 1800 cc carburettor fed 3T pushrod engine.

This is a budget project so I will be running the 3SGE on a factory ECU and EFI System. I needed to convert the Corona to a returnless EFI fuel system compatible with the factory ECU and injectors.

# Altezza Fuel Pump

The Altezza fuel pump is part of an integrated module that contains the pump, filter, pressure regulator, saddle tank venturi and fuel gauge sender.

# EFI Fuel Tank



I managed to find a fuel tank from a rotten facelift 1983 GA61 Supra that will fit the Corona floor pan and has an in tank pump and surge tank. Pre-Facelift had external pumps.

I fitted the pump from the Altezza as the Supra pump was dead, but it needed an external fuel filter/regulator as there was no way to fit the Altezza set up into the tank.

# C5 Corvette External Filter Regulator

An online search revealed C5 Corvette external filter/regulators have been used for 3SGE BEAMS swaps but most use programmable aftermarket ECUs to tune out any injector flow issues.

$32.45 USD on eBay (plus shipping) later I had a C5 unit advertised as being suitable for a LS swap complete with adapters for 6-AN fittings.

It was described as having an internal bypass that regulates fuel output pressure to 58 PSI, with 3/8 male inlet, 5/16 male return and a 3/8 female supply fittings. Many websites have the connections incorrectly identified so be careful.

# Fuel Pressure and Flow

The listing stated the C5 Filter/Regulator as capable of flowing 255 litres per hour; beyond that there is apparently potential for fuel pressure creep as the flow rate can overwhelm the regulator.

Online experts claim both C5 and 3SGE Beams operate at 62 PSI. This is not even remotely correct. The Toyota IS200/IS300 Repair Manual states that the fuel pressure with the engine shut off and pump operating on battery voltage is 44 - 50 psi. With the engine operating at idle the pressure should be same.

An online video of someone testing pressure at the fuel rail on a stock 3SGE Altezza at idle showed it was 50 PSI on their gauge also.

I found a lot of conflicting information and much of it I knew to be wrong, so I decided to do some testing to establish the facts.

# DIY Fuel Injector Test Rig

I built an injector test rig for 4AGE injectors for my AE86 project. This uses a fuel rail and regulator from a 4AGE big port, with a 5 litre fuel container feeding an external fuel pump from a TA63 3TGTE Twin Cam Turbo Celica. I connected the pressure gauge from an EFI test kit to the cold start injector port on the fuel rail. Some 150 ml glass measuring cups from a homeware store completed the mechanical side of the rig. This fuel return style set up maintains 42 PSI fuel pressure as per Toyota's specifications.

# Injector Test Rig Controller


A friend built a programmable controller that enabled pulse width, RPM and number of pulses to be set. Toyota's standard test for the 4AGE is to measure the flow from the injector for 15 seconds.

The AE86 JDM injectors have a spec of 182 cc flow per minute (i.e. 45.5 cc in 15 seconds) with the TSRM stating that a flow of 40 - 50 cc with no more than a 5 cc spread across an injector set is acceptable.

# 4AGE Injector Testing

Setting the controller to 50% pulse width at 2000 RPM for 1000 pulses produces an equivalent to 15 seconds of full low. Overall I tested 24 x 4AGE injectors, and after some ultrasonic cleaning 23 of them flowed to spec, with many only 2-3 cc off the ideal 45 cc flow rate. Given that my measuring cups are hardly precision calibrated scientific instruments that was good enough for me.

# 3SGE BEAMS Injector Baseline Test


The internet states the 3SGE Beams injectors flow 340 cc/min. I had to reconfigure the test rig, as the 3SGE injectors have different electrical connectors and I needed to blank the regulator to make it a returnless system. I used a complete Altezza fuel pump/filter/ regulator assembly in a 4 litre paint tin full of fuel.

# Baseline Test Results

With the controller set to produce the equivalent of 15 seconds of full flow I measured two injectors at 85 cc and two at 90; this equates to 340 and 360 cc/min respectively. I repeated the test several times and got consistent results, and consider the measured flow rate to be within the margin of measurement scale error.

The fuel pressure with the injectors shut off was 46 PSI and when running it dropped to around 42 PSI, but there was significant oscillation of the needle due to the pressure pulses in the fuel rail.

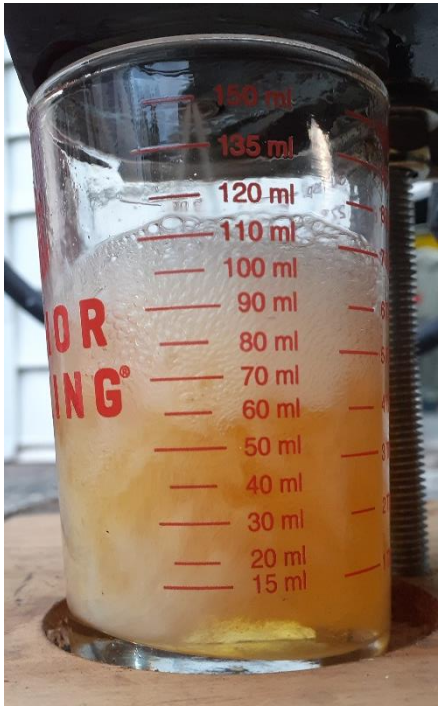
I next simulated 85% pulse width at 7800 RPM to approximate full load at redline, and the fuel pressure smoothed out at 42 PSI.

# C5 Filter Regulator Initial Tests

I swapped the integrated Altezza assembly for an Altezza pump mounted on the Supra hanger with a C5 external filter/regulator.

The test results were identical - 46 PSI at no load dropping to 42 PSI with the injectors operating, and the flow rates were unchanged.

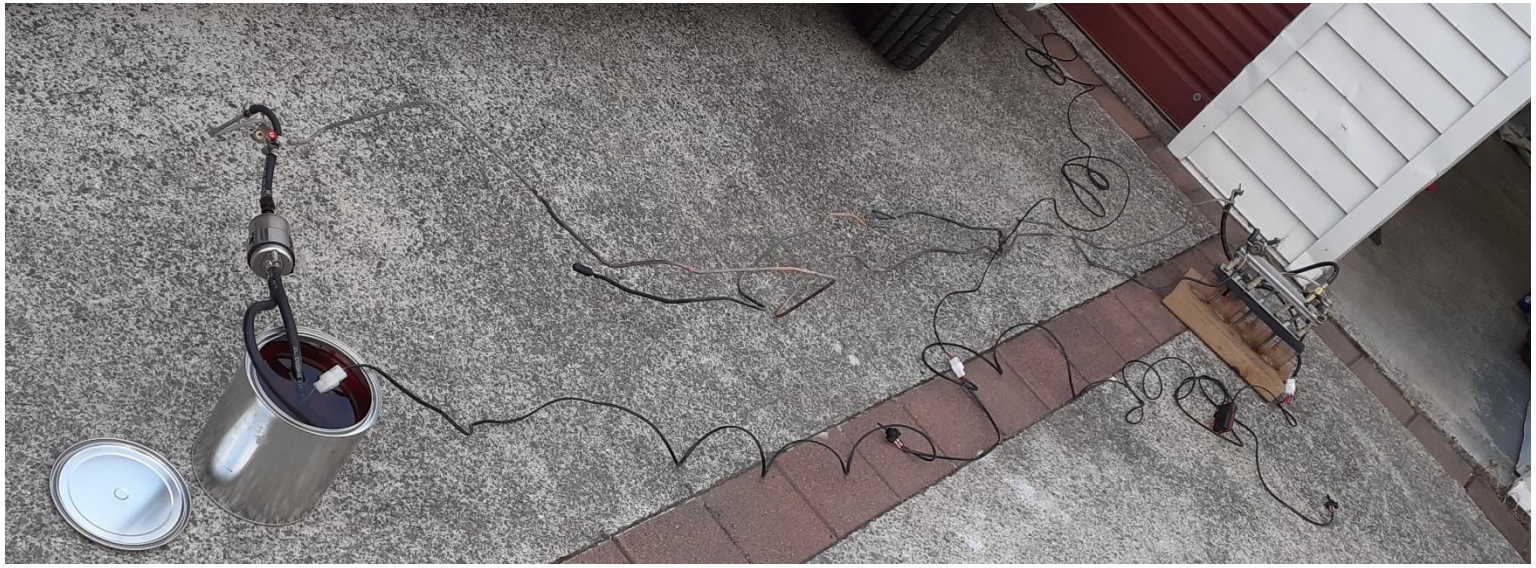
# Stress Testing




I wanted to be certain that the C5 unit was suitable, so I changed the 4AGE fuel rail pulsation damper to a 3SGE BEAMS one to ensure the test rig was replicating an Altezza as close as possible, and replaced the programmable controller with a digital timer.

I did a number of tests with all four injectors at full flow for 15.0 seconds as this would stress the system beyond what it would encounter in normal use.

# Voltage Drop



The difference in pressure and flow between operating the test rig at battery voltage vs having the car I was drawing power from idling was significant, so I kept the car running for all the tests.

This is in part likely to having around 8 metres of wire contributing to the voltage drop at the pump and injectors, but I figured this length of wiring is more representative of a car installation.

# Altezza Test Results

I ran each of the tests several times to ensure consistency.

Using an Altezza integrated pump/filter/regulator assembly the fuel rail pressure with the injectors not operating was 46 PSI (the spec is 44-50 psi), and with all four injectors wide open it dropped to 34-36 PSI, but all four injectors flowed 87-89 cc in 15 seconds.

I swapped in another complete Altezza integrated pump/filter/regulator assembly and the results were identical.

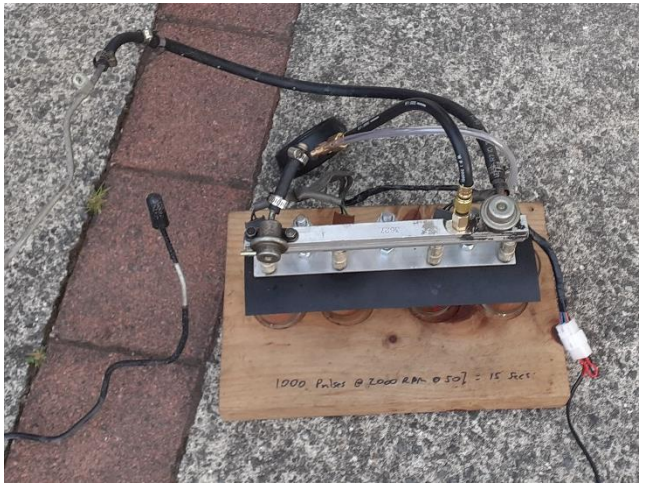
# C5 Filter Regulator Tests

I next tested the C5 external filter/regulator with another Altezza pump and found that the pressure at no load was 48 PSI, dropping to 38 at full load, with the injectors each flowing 89-90 cc in 15 seconds.

Ultimately I used 4 x Altezza pumps – two in complete Toyota pump/filter/regulator etc assemblies, and two pumps on their own with the C5 Corvette external filter/regulator, so I am confident of the consistency in the results.

# 6 mm Fuel Line test

The final test was with the system as it will be in the car – Altezza pump with C5 Filter/Regulator and the stock carburettor feed 6 mm steel fuel line. The theoretical reduced flow due to the smaller cross sectional area of this compared to the stock Altezza 8 mm hard line is significant, but in reality the system pressure was unchanged and the injectors still flowed to spec.



# Conclusion

As a result of these tests I am confident that the combination of Altezza EFI pump mounted in the fuel tank with an external C5 Corvette filter/regulator will easily supply sufficient fuel at a pressure compatible with the factory EFI system and ECU – and for a lot less money and complication than fitting an aftermarket external return type fuel pressure regulator.

Toyota tends to be conservative when it comes to engineering but I was still (pleasantly) surprised that the 6 mm hard fuel line was sufficient to maintain full flow, which is more than the engine will ever see in reality.