



RED ALPHA VR30

RA338 & RA405 HPFP TUNING GUIDE

AMS Performance RA338 & RA405 VR30DDTT HPFP Fuel System Overview & Dealer Tuning Guide

The VR30DDTT engine found in the Infiniti Q50 and Q60 utilizes direct injection which injects fuel at up to 20MPa (200Bar, or ~2900 psi) directly into the combustion chamber of the engine. In order to achieve these pressures, the powertrain utilizes a low-pressure and high-pressure fuel system.

The low-pressure system consists of one 12-volt in-tank pump which maintains approximately 5 bar fuel pressure at the inlet of the high-pressure fuel pump (HPFP). The HPFP then increases that pressure up to 20 MPa at the fuel rail. This is done via a piston that follows a specialized lobe on the camshaft. The piston in the HPFP moves a fixed volume of fuel per stroke, determined by its displacement and when fuel demand is low, excess fuel is returned to the inlet of the HPFP via a control solenoid. This solenoid returning fuel to the low pressure side of the pump is how the ECU controls the rail pressure, and if unplugged or failed in any way, it will default to open and the pressure on the outlet side of the pump will be the same as the inlet side (~0.5MPa). Additionally, the fuel pump contains an internal bypass valve: This bypass valve is a mechanical device built into the body of the HPFP and, on the Nostrum HPFP, it is set to open at pressures is commanded, it cannot be above ~27 MPa for RA405 and ~24 for RA338. This means that no matter what fuel pressure cannot increase past the point where the bypass valve opens. The bypass valve is a safety device intended to prevent over-pressure of the high-pressure fuel system, and as such it should not be relied upon for pressure control. Repeated activation of the bypass will cause its internal spring to weaken, making the valve open at increasingly lower pressures.

What Is The Alpha Performance High Performance Fuel Pump?

The Red Alpha HPFP is a complete fuel pump upgrade that replaces the OEM HPFP for a larger unit that flows ~47.5% more for RA 405 and ~23.2% for RA 338 over the OEM pump. The flow number are based on a RPM of 7250. The RA 405 HPFP flow 405 lph @ 7250 RPM and the RA338 flows 338 lph @ 7250 RPM. The upgraded pump is 100% Ethanol compatible to ensure longevity when running E85. It is a direct bolt-on component with minor modifications and installs in the factory location (always refer to the installation guide) and while it does not require tuning in order to work it is recommended to optimize the performance of the pump. See tuning recommendations below.

Limitations Of The Stock Fuel System

The HPFP is directly driven by the camshaft meaning that pump speed and its ability to move fuel increases proportionally with engine speed. Therefore, the capacity of the HPFP is lowest at low engine speeds and highest at high engine speeds. If a loss of fuel rail pressure is observed at low RPMs it is likely that the maximum capacity of the HPFP has been exceeded at that engine speed. Conversely, the low-pressure fuel pump operates independently of engine speed and has a constant maximum flow rate. If fuel rail pressure drops at high RPMs, when horsepower and thus fuel demand are at their highest, the maximum capacity of the low-pressure pump has likely been exceeded. In order to take full advantage of the Alpha Performance HPFP it is recommended that you upgrade your in-tank fuel pump.

The AMS Performance Red Alpha low pressure pump upgrade is recommended. This kit includes all the parts required for installing a Walbro 450 which can supply up to 450 LPH of fuel and it is ethanol rated. This kit can also be used to install a Walbro 525 which can supply up to 470 LPH of fuel however we have found that the increased current required to run this pump can burn out the stock fuel pump controller. This will require custom wiring for the fuel pump if the 525 is used.

Tuning Of The High Performance Fuel Pump

Fuel Pump Base Angle

As mentioned previously the HPFP pumps a constant volume of fuel every stroke and when fuel demand is low it returns excess high-pressure fuel back into the low-pressure system through the HPFP's solenoid. The actuation of the solenoid is controlled by fuel pump **target angle** which is calculated by the ECU and is based on engine speed and injection duration. The calculation of **target angle** uses the calibratable fuel pump **base angle** table as an input (feedforward) and then modifies it using closed-loop feedback (PID) from the fuel rail pressure sensor. The target angles vary between 320° to 200° and lower target angles will increase the amount of fuel that is pumped into the rail meaning that 200° is the maximum capacity of the pump. If one observes that a target angle of 200° in a data log, fuel demand must be lowered. This can be accomplished by reducing the boost target or increasing AFR in that region of the engine map.

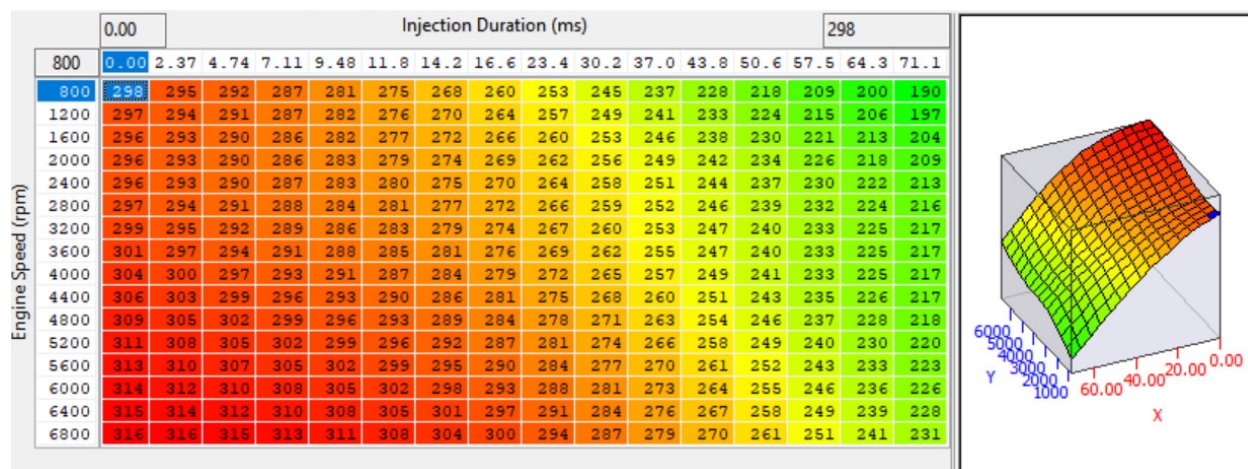
Provided below is AMS and Nostrum's tune for the base angle of the RA 405 HPFP, developed on our RA800 Built Q50 and record setting RA800 Q60 development vehicles. Further tuning of this calibration can be done for each specific vehicle by operating the vehicle at various speeds and loads while logging the fuel pump **base angle** and **target angle** as well as **engine speed** and **injection duration** (called "injection pulse width converted" in EcuTek). With this logged data one can create a table with the same axes as the base angle table that contains the calculated error between the base angle and target angle tables. Finally, this error table can be used to correct the base angle table.

Also shown below is AMS and Nostrum's tune for the proportional and integral gain of the PID feedback used to control the fuel pump target angle.

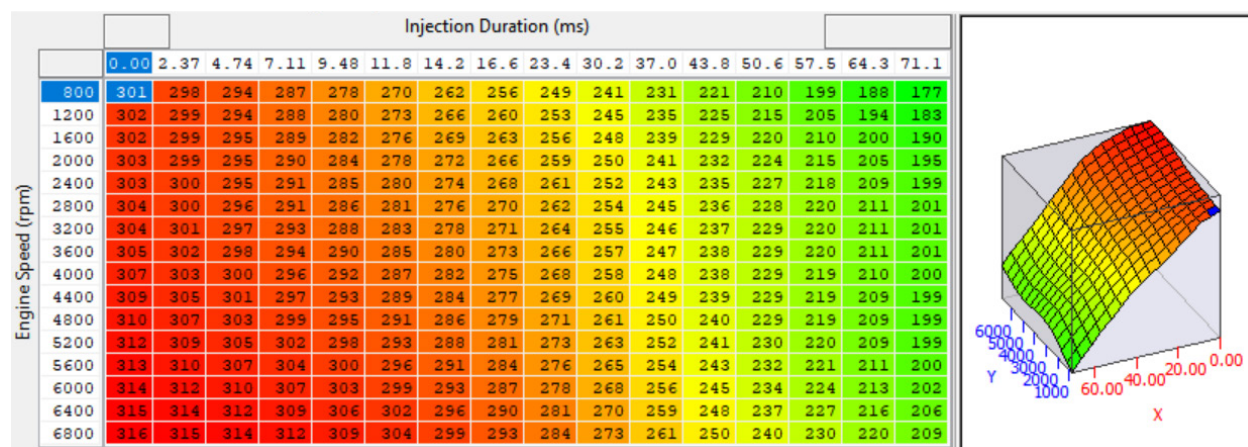
Fuel Pressure			
HPFP			
Control			
☐	Fuel Pump - Battery Voltage for Switching Time	Beta	OEM
☐	Fuel Pump - Delay Time switching Peak Current	Beta	OEM
☐	Fuel Pump - Hold Current 1	Beta	OEM
☐	Fuel Pump - Hold Current 2	Beta	OEM
☐	Fuel Pump - Hold Time Initial Value	Beta	OEM
☐	Fuel Pump - Peak Current Initial Value	Beta	OEM
☐	Fuel Pump - RPM for switching hold current	Beta	OEM
☐	Fuel Pump - RPM for switching hold current hys	Beta	OEM
☐	Fuel Pump - RPM for Switching Peak Current	Beta	OEM
☐	Fuel Pump - RPM for Switching Peak Current hys	Beta	OEM
☒	Fuel Pump Control - Base Angle	Beta	OEM
☐	Fuel Pump Control - Feedback Deadband	Beta	OEM
☐	Fuel Pump Control - Integral Factor	Beta	OEM
☐	Fuel Pump Control - Proportional Factor	Beta	OEM
☐	Fuel Pump Regulator Response Time	Beta	OEM

Fig. 1 EcuTek Fuel Pump Control Pull-down

RA405 HPFP



RA338 HPFP



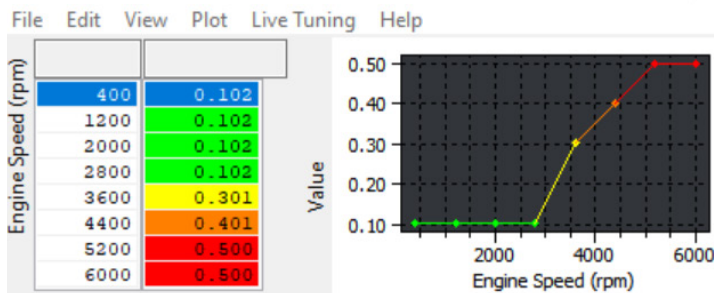
AMS Base Angle Maps

You can download the AMS Base Angle Map tables directly from our web site by clicking the link below...
bit.ly/AMS_base_angle_maps

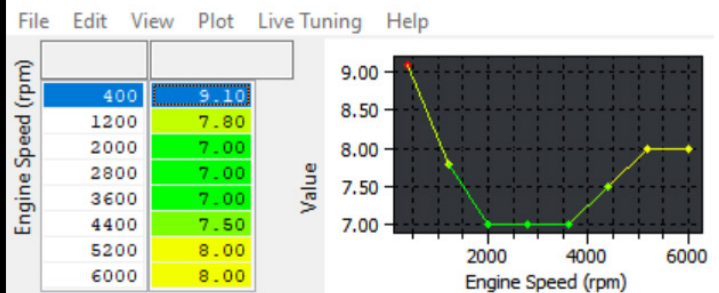
Fuel Rail Pressure

It is recommended that the fuel pressure target not be increased much beyond stock values. The HPFP's built-in mechanical bypass will relieve pressures above approximately 27 MPa on the RA405 HPFP and 24 MPa on the RA338 HPFP. This bypass valve ensures that the fuel rail does not reach pressures higher than what the fuel injectors can open at, or even pressures high enough to cause fuel system component failures. Doing so may void any warranties provided by AMS Performance. Max pressure on the HPFPs are as follows; 20 MPa for the RA338 and 25 MPa for the RA405 HPFPs. Recommended operational pressure is as follows; 18 MPa for the RA338 and 23 MPa for the RA405.

INTEGRAL



PROPORTIONAL



At AMS, we recommend trading carefully when attempting to command fuel pressures in excess of the factory's 20 MPa and watching for signs that you may be hitting the fuel pump bypass, such as an inability to reach target pressure or maintain stable pressure under load. Furthermore, constant stress on the internal bypass can fatigue the spring ultimately causing it to open at lower pressure and further lowering the maximum pressure of the pump. If the HPFPs are commanded beyond what is recommended, AMS at its sole discretion may void the warranty on the HPFP system components.

We have found that on our Q60 with our pump installed and stock injectors we were able to command up to 25 MPa of fuel pressure without hitting the pump bypass and without exceeding the max pressure at which the OEM injectors can open; this provides a nominal gain in injector flow rate, approximately 10%. In order to take full advantage of the RA405 fuel pump at high engine speeds, Alpha Performance high flow rate fuel injectors are required.