ALPHA Performance Packages

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 calibratible 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.

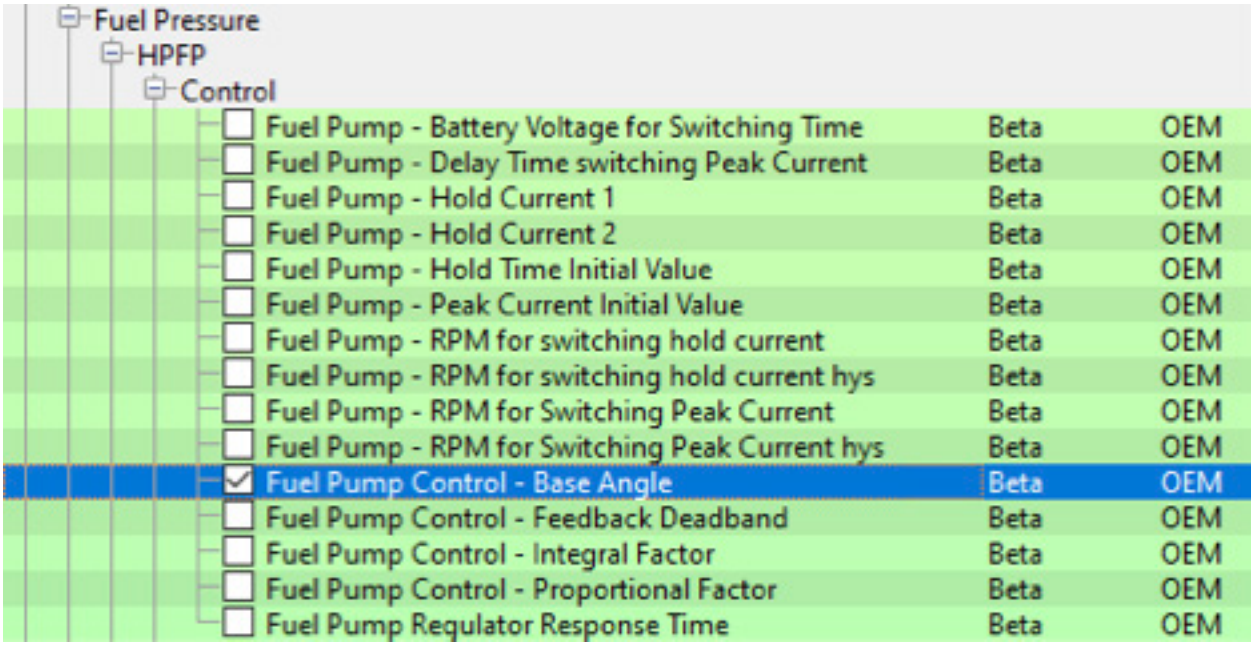


Fig. 1 Ecutek Fuel Pump Control Pull-down

RA405 HPFP

	0	2	4	6	8	10	12	14	20	26	30	35	40	45	50	55
800	298	295	292	290	284	278	273	266	259	253	247	241	233	228	223	220
1200	298	295	293	290	285	280	274	268	261	255	249	243	235	229	225	221
1600	299	296	294	291	286	280	275	269	263	257	251	245	237	231	226	222
2000	300	297	294	291	287	281	276	270	264	259	253	248	241	234	228	224
2400	301	298	295	292	288	283	278	272	266	262	255	249	244	236	230	225
2800	302	299	295	293	289	284	279	274	267	263	257	252	246	241	232	226
3200	303	301	296	294	290	285	280	274	268	264	258	253	248	241	233	226
3600	304	303	299	297	291	287	282	277	271	265	260	255	250	244	235	229
4000	305	305	301	298	293	288	283	278	272	268	263	258	252	247	239	231
4400	306	307	303	300	295	290	285	279	274	269	264	259	254	249	239	230
4800	307	308	304	301	297	292	287	281	277	271	267	263	257	252	242	234
5600	309	310	307	305	300	295	290	285	280	274	270	265	261	256	245	236
6400	311	310	308	306	301	297	292	287	283	278	273	269	264	259	249	240
6800	312	312	309	307	302	298	293	288	284	279	274	271	265	261	251	241
7000	314	313	311	309	304	299	294	290	285	280	275	271	266	262	252	242
7500	316	315	313	311	306	302	297	293	289	283	278	273	269	264	254	245

RA405 HPFP

Injection Duration (ms)

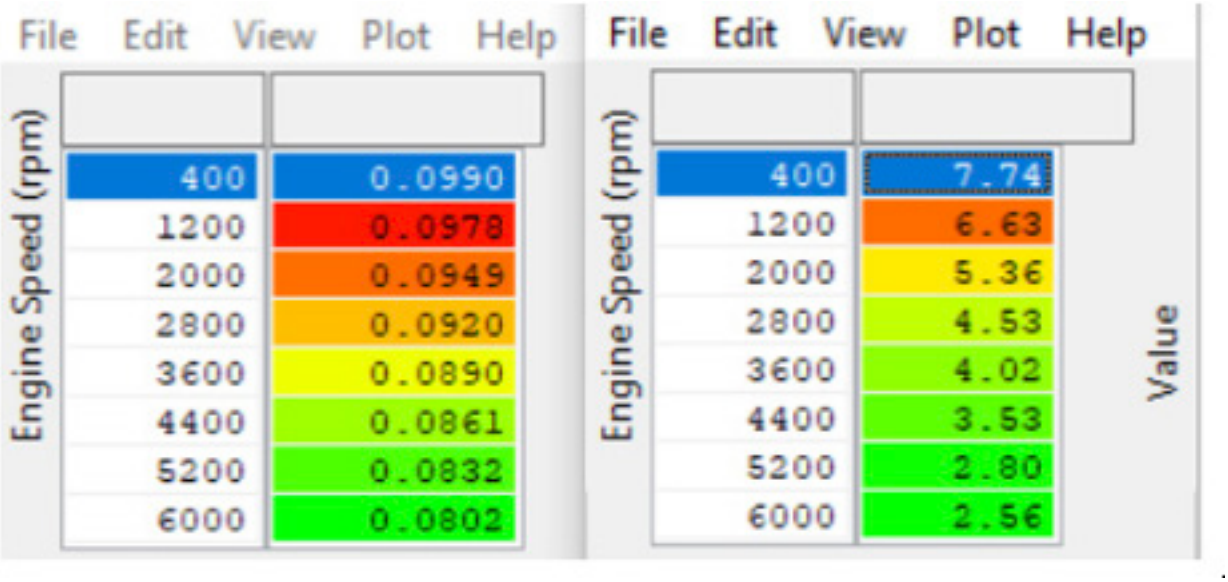
	0	2	4	6	8	10	12	14	20	26	30	35	40	45	50	55
800	292	290	290	289	282	275	268	259	249	240	234	225	214	207	203	200
1200	292	290	290	289	282	276	269	261	251	243	236	227	216	208	203	200
1600	292	291	290	289	283	276	270	262	253	245	238	230	218	210	204	200
2000	293	292	290	289	284	277	271	263	254	247	240	232	223	212	207	201
2400	294	294	291	289	285	278	272	265	256	250	242	234	227	215	208	201
2800	296	295	291	290	286	280	274	267	258	252	243	236	229	221	210	201
3200	297	297	292	292	287	281	274	268	259	252	244	237	231	222	211	201
3600	299	299	294	294	287	282	275	268	260	253	245	238	232	224	212	202
4000	300	303	298	295	289	283	275	269	261	254	247	241	233	228	215	203
4400	300	304	299	297	291	285	278	270	264	257	251	245	237	231	217	203
4800	301	305	300	298	292	286	280	272	266	259	253	247	240	233	218	204
5600	304	306	304	303	297	291	284	276	269	263	256	249	243	237	220	206
6400	306	307	306	306	299	293	287	279	274	267	260	255	248	242	223	208
6800	307	309	307	307	300	294	287	280	274	267	261	254	249	243	225	210
7000	310	311	310	309	302	296	290	283	277	270	262	255	251	244	226	210
7500	314	314	314	313	306	300	293	287	282	274	267	259	254	246	228	212

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 treading 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.