View Full Version : Tuning VANOS timing and Ignition timing

thambu19 Mon, Aug-01-2016, 02:08:13 AM

Hey guys,
Has anyone have any experience tweaking the cam timing and ignition timing of the US spec cars to gain more HP or torque in mid-range?
Looking at the Intake and Exhaust timing maps I cant believe they are all the way optimized for peak performance. For example at peak power the Intake is advanced 60deg ie full advance. I would think the intake needs to be somewhat retarded to catch the ram effect of air. Granted the runners are almost non existent so not much of a ram effect exists.
I am wondering if someone has spent some time tweaking the parameters. I am a calibrator by profession and I can start tweaking but with the limited number of flashes I cant just keep adjusting things endlessly.
Let me know what you guys have done. I know Evolve has found some extra HP from the engine. Obviously they would be running leaner than 12.5 AFR to get that. I am still running CATS so I would not dare go lean at this moment.
Thanks

jozy Mon, Aug-01-2016, 02:49:43 AM

use paffy's mssflasher and you can flash indefinitely....

are you saying 12.5 afr is already lean?

thambu19 Mon, Aug-01-2016, 11:03:23 AM

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I am saying I will not be super comfortable going leaner than 12.5-13.0 on OEM cats. I work for an OEM and I see EGTs near 900C and CAT temps near 950C at peak power and 12.5 AFR. When people post logs showing AFR close to 14.0 it scares me. Those exhaust valves are taking all that heat and the brick of the CAT would start disintegrating.

thambu19 Mon, Aug-01-2016, 11:15:11 AM

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SliM3 Mon, Aug-01-2016, 01:42:12 PM

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Actually, 60-deg is full retard for the intake. Peak cam lift position equates to 130-degrees ATDC crank angle, including +/- offsets.

thambu19 Mon, Aug-01-2016, 08:10:36 PM

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So 0deg for Intake is full advance? What about Exhaust?

SliM3 Mon, Aug-01-2016, 10:45:47 PM

So 0deg for Intake is full advance? What about Exhaust?

Intake:
60ø Full Retard (home position @ idle) / Peak Lift @ 130ø Crank Angle ATDC
0ø Full Advance / Peak Lift @ 70ø Crank Angle ATDC

Exhaust:
0ø Full Advance (home position @ idle) / Peak Lift @ 83ø Crank Angle ABDC
45ø Full Retard / Peak Lift @ 128ø Crank Angle ABDC

thambu19 Tue, Aug-02-2016, 02:42:33 AM

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Exhaust:
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45ø Full Retard / Peak Lift @ 128ø Crank Angle ABDC

Awesome thanks!
Have you tried using EURO cams timings and spark on US spec cars? Any idea which one feels better? The cam timings seem way different. Not sure if the actual cam lobe themselves or exhaust headers are different. I know US had close coupled CATs vs EURO which wasnt so restrictive from an exhaust hot end stand point

thambu19 Tue, Aug-02-2016, 10:57:21 AM

Comparing the US vs EURO cam positions at WOT it appears the Euro cal has the exhaust phased retarded from 3000rpm on wards compared to the US cal. Almost as if for the US they had to limit scavenging in the area for emissions regulations or something.

I also see a lot more swings in the exhaust timing between 800rpm-2800rpm in the Euro cal. This is probably why they had to open up the exhaust cam phasing rate limit to 60. The US cal may not benefit from opening up that limit.

I cant believe the exhaust timings can be this different between 1500rpm and 2000rpm. Euro cal wants max retard and US cal is almost full advance. This could be due to NVH restrictions due to intake noise.

The intake timing at peak power region is more retarded for US spec cal. Considering the intake runner lengths to be the same I cant see why unless they wanted to park the intake cam at its end stop (max retard position) to avoid cam phasing at that high an engine speed (cam control may not be easy at those engine speeds and CARB needs a good cam control at all times)

The ignition on the US spec cal is more advanced that EURO and it drops a touch at 4900rpm. This drop could be to avoid pre-ignition. Most high compression engines with high VE can enter pre-ignition at their peak torque rpm.

BBRTuning Wed, Aug-03-2016, 05:49:13 PM

Being a calibrator, you'll know that there's little to no use in playing with the cam timing without using a dyno. Also, the US cars with the integrated cats vs the euro headers with higher flowing cats further downstream will have very different scavenging effects so the cam timings should surely be different if only for this reason.

I too agree about not running the engines leaner than they need to be. I have tuned lots of these cars, albeit only on standalone ECUs (AEM Infinity), mostly SCCA or NASA race cars, and they don't make more power past .85 lambda (12.5 gAFR) anyway, so it's silly seeing people running them much leaner than that, especially when they see extended WOT use like in racing. With enough bolt-on mods, however, you'll start running out of injector at high RPM around .85 lambda though. I've hit low 90s % duty cycle on mine on pump gas before I upgraded to ID725 injectors.

I target high .80s lambda at lower RPM WOT and taper to .83 by redline, and trim richer than that for extended WOT runs, because I too have cats, albeit aftermarket 200cell.

Below are my Vanos Intake and Vanos Exhaust target maps in the Infinity on a race car I did recently. OEM euro headers, no cats, full exhaust, and CSL style intake. These are in actual degrees of advance/retard, not backwards like the factory maps. This was tuned for peak torque from 1500-8200 RPM. For this particular setup, they're within 3* of optimum I'd say. Takes over an hour just to dial in the cams, and that's with a standalone that allows instant live tuning adjustments (great for tuning steady-state).

Also this thread might be useful for you:
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Interestingly, this car did not make any additional torque with 60* intake vs 55*, although it did want more fuel (leaner lambda). Likely some fuel short-circuiting going on.

https://s31.postimg.org/4arcoo94b/Vanos_ST_E46.png

thambu19 Wed, Aug-03-2016, 10:01:43 PM

Absolutely! Even with a dyno it is time consuming to pick the right cams.
Most OEMs make some compromises in the cam timings at the scavenging region due to HC and NVH limitations so I was wondering if anyone had pushed the boundary of scavenging.
At peak power I see the intake cam all the way retarded (almost parked at full retard) I thought they did that for cam position control. I see that you are running Intake cam of 15deg advance from full retard at peak power. With a very short intake runner that is what I would assume should happen. The OEM cals fully retarded intake closing is something that suits a longer intake runner. What sort of spark are you running at peak power? I am not comfortable changing cam timings on my stock car without any idea how much the cam movement affects spark/knock. With closing the intake earlier at 15def vs 0deg (stock) advance you are running much higher effective compression ratio so will be hitting knock earlier. I think the stock spark at peak power is 28deg BTDC.
Regarding lambdas I completely agree that going leaner beyond a point does not improve power. With the sort of power/L this engine makes the exhaust should be opening a lot earlier than the engines I calibrate to get the breathing done which raises exhaust temps needing more cooling to keep the valves cool. If someone wants to genuinely go leaner id highly recommend running colder coolant temps (maybe using fan control?). Go from 100C to 85C and the engine should breathe higher Vol. Eff and tolerate more spark although it will affect fuel economy.
Even if I go CATless with a nice stainless steel exhaust header I will still worry about valve temps for long term durability.

One thing I do know for a fact is that as engines age the following happens
1. Exhaust back pressure increases if you are running CATs
2. Airflow drops although not as much as power drop off
3. Higher leakdown
4. Combustion slows down (higher leakdown and lower airflow can cause this along with older plugs)
5. Exhaust temps will be hotter due to higher back pressure and slower combustion
6. Engine can tolerate more spark due to slower burn

I am running at degree more spark at WOT in my car (I have 160K miles) and it definitely feels like an improvement. I would like to run a degree more but kinda cautious. Definitely don't want to hit pre-ignition at 4900rpm for sure.

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True. When tuning based on a lambda sensor on these engines, in the lower RPM high load areas where peak overlap occurs, I know the lambda sensors are showing falsely lean data due to some fuel and air "short circuiting". Since I run the car in full-time closed loop with a wideband, and have it set up Alpha-N, my plan next time I hit the dyno is shape the VE curve based on logged MAF data vs simply trusting the lambda senor. I know I'm wasting some fuel in the high-overlap area tuning purely off lambda values and increasing emissions unnecessarily. I'm sure that's a lot of the reasoning for the OEM cam curves as you said.

I can't really answer you properly regarding the spark advance.. I haven't properly synced the timing on my engine, mainly because it's quite hard to do so properly on these and I've been a bit lazy about it. There may be a few degrees offset from the maps vs actual timing at the crank, although of course you can still find MBT on the dyno. I'm showing around 18* advance by 4500 and stays mostly flat from there. I'm used to engines wanting more advance with RPM but these don't seem to like it. For dyno pulls, I'm able to hit MBT before detonation even on our CA 91AKI fuel, although if the IATs are up a bit, or on longer pulls (higher cyl temps) it will definitely pick up some det, so I have it backed off from MBT about 1-1.2*, and then run per-cylinder knock feedback all the time. On E85, I gained ~10whp with zero tuning changes, just from the fuel, and another ~6whp from additional spark, although it only wanted 1.5-2* more advance, for a total peak of 20* on E85. This is quite a lot lower than what people are seeing on OEM DMEs, but the power is right where it should be, so either the actual/final advance on the DME is not nearly what is shown in the maps, or my sync is quite far off. I'd believe either one about equally..

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These engines do like a lot of transient/accel ignition retard, as you'd expect with the high CR. I actually believe the OEM maps use exhaust cam retard at low RPM and higher load to reduce the effective CR and to allow a bit more timing. Without doing this, I've had to go into low ATDC spark (sometimes 0 to 3* ATDC) to prevent knock on 91 octane below 1000 or so RPM!

thambu19 Thu, Aug-04-2016, 02:22:59 AM

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You dont have to add a lot of spark or could even be running a lot lower spark timing and still hitting MBT or peak power higher than stock engines because of your intake timing. Since you are running 15deg intake advance compared to stock engines running 0deg intake advance or full retard you are using much higher dynamic compression ratio.

So if you change the cams at high speed low load you have to change the spark with it as it can get either more or less knock limited based on which direction you are going. From an exhaust side OEMs will retard exhaust at high speed low load to get better expansion and better FE but if performance is all you care about then you can copy the WOT cams all the way down to the lowest load and let the throttle control the load instead of cams. WOT cams are usually the most knock limited cams. At lower loads the overlap volume is higher to improve fuel economy by reducing pumping losses. So copying WOT cams into lower loads will make the engine even more responsive and snappy to some extent.

At lower speeds higher loads there are two ways to tune.
1. Retard intake cam and Exhaust cam - This lowers CR allowing more spark timing and CA50 this also improves expansion stroke efficiency
2. Retard exhaust but advance Intake - This is only possible if there is a scavenging tuning peak at that engine speed. The higher CR achieved at this condition should be offset by the scavenging effect which reduces chances of knock. Our M3 engines do not scavenge at low speeds so this cannot be used. This method is suitable for lower compression ratio engines too which the S54 isnt.

So the only viable solution below 2K is to retard intake timing to avoid pre-ignition or increase the tuning length of exhaust and move scavenging earlier but that will limit peak power. I believe the OEM keeps the throttle at an angle at these speeds to increase turbulence without sacrificing VE inorder to improve flame speed and torque

paulclaude Thu, Aug-04-2016, 08:11:22 AM

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Thanks for chiming in, great to see tuners sharing information and tips :thumbsup2:

Interestingly, your targets are quite similar to where I ended up when tuning my S54 with stock M3 camshafts, at least at the high load points, so I'm obviously doing something right.

Recently, i've fitted some Schrick 288/280's and will be making a visit to the Dyno soon for tuning. Right now the engine runs well with stock CSL ECU Vanos and Ignition. I have made adjustments to WOT fuel based on my on-road wideband readings. Do you have any experience of tuning the Vanos higher load points with these kind of spec cams, i.e. for optimum power do they usually require additional intake advance at higher load as per the stock cams, or is a different technique/approach required? Obviously i'm dealing with a lot more overlap, so figure the targets may be quite different for best power output.

This is quite a lot lower than what people are seeing on OEM DMEs, but the power is right where it should be, so either the actual/final advance on the DME is not nearly what is shown in the maps, or my sync is quite far off.

The stock DME does all sorts to pull timing, based on adaptions, engine temp etc. From my own data logging, it's not common to see the WOT targets ever being reached, at least not without disabling/altering some of the limiters/safety controls.

thambu19 Thu, Aug-04-2016, 11:32:13 AM

At peak power no matter what cam you use all it matters is the intake closing angle. For a given set of intake runners and engine speed the intake closing angle at peak power will be more or less similar. So if your cams are 20% more open than stock cams then you have to advance your cam centerline by 10% to achieve the same closing.

When you ran stock cam with the vanos timings shown by BBRTuning what sort of ignition values did you use? With an intake advance of 15deg Im sure I will have to pull timing to prevent the engine from detonating

paulclaude Thu, Aug-04-2016, 12:42:45 PM

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Good info, thanks. I'll make some estimations based on the cam duration differences from this, which should put things thereabouts optimal.

Ignition wise, WOT targets were 2-3deg over stock on average. Of course, due to DME compensation, the actual targets met are quite a bit lower than what is set in the table. All tuning carried out on 98/99 Fuel here in the UK.

thambu19 Thu, Aug-04-2016, 02:22:24 PM

Does anyone know what the actual compensations are and how much they are? Do we have an active knock sensor? I hope we have because that will give me more confidence to push the spark knowing that the sensor will always be the failsafe

paulclaude Thu, Aug-04-2016, 02:34:42 PM

Does anyone know what the actual compensations are and how much they are? Do we have an active knock sensor? I hope we have because that will give me more confidence to push the spark knowing that the sensor will always be the failsafe

There are active knock sensors, so it is be difficult to reach heavy detonation with the MSS54 as long as you aren't excessive in raising the knock control factor maps. On top of this, you have the adaptive ignition points, where the ECU will compensate +/- on the per cylinder timings and specific load points. Both functions can be disabled/enabled individually, I believe some members run knock control only, without the adaptive functions. The ignition control has been covered in some detail in the past by some experienced members - you'll find in depth posts via the search :thumbsup2:

The ignition temperature compensation is a table based on engine vs. IAT temperature. It's much less aggressive at pulling timing on the CSL ECU software, so you usually find the CSL

ECU ends up much closer to the actual WOT ignition targets as a result.

SliM3 Thu, Aug-04-2016, 06:04:46 PM

Here are my current maps, carried over from a previous tune, with a little more adjustment in the areas with less than desirable torque. I haven't dyno'd yet but these were the product of some discussions I've had with a few folks & tuner.

Previous dyno with identical settings, but only with headers as a bolt-on mod.
http://i45.photobucket.com/albums/f90/bmech211/current_dyno.jpg_zps8aje2bew.png

Current cruise and WOT fuel
http://i45.photobucket.com/albums/f90/bmech211/current_fuel_zpskngivyrg.jpg

Current WOT ignition
http://i45.photobucket.com/albums/f90/bmech211/current_ignition_zps9u1kstjn.jpg

Finally, current VANOS (pretty narrow 100ø LSA @ max rpm). Trying to take advantage of the freer flowing exhaust with little more scavenging up top than normal.
http://i45.photobucket.com/albums/f90/bmech211/current_vanos_zpszpjq3wgr.jpg

comp Thu, Aug-04-2016, 06:16:24 PM

Thanks for chiming in, great to see tuners sharing information and tips :thumbsup2:
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I finished a S54 on a non street race car with exactly those cams, CSL like Airbox and custom exhaust with euro headers / euro catalysts.

I did the following steps:

1.) start with the factory setup and set up full load AFR's as a baseline.

2.) Set up your knocks and find a full load ignition baseline without knocking.

Before you walk into vanos timing find a WOT ignition setup near the knock limit over the full rev band.
The S54 is very sensitive reg. knocking and I had "phantom" knocking in the beginning as well.
To achive that I had to walk through a couple of things, but I only slightly changed the knock factors and only on some defined loadpoints.
I even had to apply cylinder specific full load fuel trims to come to that point.
After that I could do full load runs without any knocking but with sligthly reduced full load ignition targets compared with the factory setup.

Before going into that you should check the head gasket - I had not been able to set up my knocks before fixing my head gasked - it had been burned through between some cylinders which is not uncommon on s54 with higher mileage due to the small place between the cylinders.
I strongly recommend not to adjust the knockfactors unreasonable because that will eventually cover mechanical issues and real knocking.

@thambu19 - if your engine did 160tm you might think about a new head gasket.

3.) setup the intake vanos timing based on airflow
For more aggressive cams at high rev the closing timing of the intake valve is the way to go as mentioned by thambu19, but at mid/low rev there are some other factors.
At full load high rev that means further advancing your cam's - increasing airflow and overlap but as well increasing knocking and you have to retard ignition.

4.) fine tune exhaust timing and ignition based on airflow / knocking
With the exhaus vanos timing you can have some impact on knocking and minor impact on airflow

5.) all done ? than go fine tune on Dyno

thambu19 Thu, Aug-04-2016, 08:07:28 PM

Excellent write up! For all of this the most critical instrument to have is a dyno and if possible the ability to tune dynamically.
I would really like to see people who had tuned their cars themselves to come out and share some of their work and where they are at. I know that some of us have used tuners to tune and cannot share their work. Anything that I have specifically done is free to be shared with the community. I am also part of the GT86 community and folks there share tunes and xdf files freely thus making massive strides in tuning in a short time. Somehow in the M3 world stuff is mostly locked down.

thambu19 Thu, Aug-04-2016, 08:10:59 PM

There are active knock sensors, so it is be difficult to reach heavy detonation with the MSS54 as long as you aren't excessive in raising the knock control factor maps. On top of this, you have the adaptive ignition points, where the ECU will compensate +/- on the per cylinder timings and specific load points. Both functions can be disabled/enabled individually, I believe some members run knock control only, without the adaptive functions. The ignition control has been covered in some detail in the past by some experienced members - you'll find in depth posts via the search :thumbsup2:

The ignition temperature compensation is a table based on engine vs. IAT temperature. It's much less aggressive at pulling timing on the CSL ECU software, so you usually find the CSL ECU ends up much closer to the actual WOT ignition targets as a result.

Thank you. This gives me the courage to tune my cams without having the worry of blowing up the motor.

paulclaude Thu, Aug-04-2016, 08:35:07 PM

I finished a S54 on a non street race car with exactly those cams, CSL like Airbox and custom exhaust with euro headers / euro catalysts.

I did the following steps:

1.) start with the factory setup and set up full load AFR's as a baseline.

2.) Set up your knocks and find a full load ignition baseline without knocking.

Before you walk into vanos timing find a WOT ignition setup near the knock limit over the full rev band.
The S54 is very sensitive reg. knocking and I had "phantom" knocking in the beginning as well. To achive that I had to walk through a couple of things, but I only slightly changed the knock factors and only on some defined loadpoints.
I even had to apply cylinder specific full load fuel trims to come to that point.
After that I could do full load runs without any knocking but with sligthly reduced full load ignition targets compared with the factory setup.

Before going into that you should check the head gasket - I had not been able to set up my knocks before fixing my head gasked - it had been burned through between some cylinders which is not uncommon on s54 with higher mileage due to the small place between the cylinders.
I strongly recommend not to adjust the knockfactors unreasonable because that will eventually cover mechanical issues and real knocking.

@thambu19 - if your engine did 160tm you might think about a new head gasket.

3.) setup the intake vanos timing based on airflow
For more aggressive cams at high rev the closing timing of the intake valve is the way to go as mentioned by thambu19, but at mid/low rev there are some other factors.
At full load high rev that means further advancing your cam's - increasing airflow and overlap but as well increasing knocking and you have to retard ignition.

4.) fine tune exhaust timing and ignition based on airflow / knocking
With the exhaus vanos timing you can have some impact on knocking and minor impact on airflow

5.) all done ? than go fine tune on Dyno

Nice to hear from someone else who has a similar setup. I find it odd that you have had to retard timing due to knock. I'm still running stock WOT ignition targets, but with slightly elevated KF maps. With around 12.5 average WOT AFR and the stock Vanos maps, i'm seeing the ignition adaptations hitting the limit of +2.0deg. Absolutely no audible/logged knock, so at least on my engine it looks like there is some decent ignition tuning possibility. How is your fuel quality where you stay? I assume most fuel in Germany is decent as per UK?

Based on some calculations from previous Dyno visits with stock camshafts, I've just put together some estimated Vanos maps. I'll be trying these out soon, and paying a visit to the Dyno for final tuning.

On another note, i'm just back from the Nurburgring, Germany for a few days on track. Power difference was very clear to see on the tarmac vs. M3's with largely stock engines. The Schricks really do open up the S54!

SliM3 Thu, Aug-04-2016, 09:13:05 PM

I would really like to see people who had tuned their cars themselves to come out and share some of their work and where they are at. I know that some of us have used tuners to tune and cannot share their work. Anything that I have specifically done is free to be shared with the community. I am also part of the GT86 community and folks there share tunes and xdf files freely thus making massive strides in tuning in a short time. Somehow in the M3 world stuff is mostly locked down.

Look a couple post back.

Sent from my iPhone using Tapatalk

thambu19 Thu, Aug-04-2016, 09:17:20 PM

Look a couple post back.

Sent from my iPhone using Tapatalk

Hey sorry. I was looking at it while at work and the firewall there blocks images so I didnt see those.

thambu19 Thu, Aug-04-2016, 09:21:29 PM

Nice to hear from someone else who has a similar setup. I find it odd that you have had to retard timing due to knock. I'm still running stock WOT ignition targets, but with slightly elevated KF maps. With around 12.5 average WOT AFR and the stock Vanos maps, i'm seeing the ignition adaptations hitting the limit of +2.0deg. Absolutely no audible/logged knock, so at least on my engine it looks like there is some decent ignition tuning possibility. How is your fuel quality where you stay? I assume most fuel in Germany is decent as per UK?

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On another note, i'm just back from the Nurburgring, Germany for a few days on track. Power difference was very clear to see on the tarmac vs. M3's with largely stock engines. The Schricks really do open up the S54!

He is running different headers and CSL intake all of which will increase airflow and so will be hitting knock sooner than you are. I thought you said you have the car mostly stock except for the cams?

SliM3 Thu, Aug-04-2016, 09:22:50 PM

The maps read differently than stock, based on A2L compu-methods, but i can explain if need be.

@BBR, what are those values in your VANOS map?

Sent from my iPhone using Tapatalk

thambu19 Thu, Aug-04-2016, 09:43:52 PM

@SliM3 Hey thanks for sharing. I dont have the AFR maps on my XDF but I think your AFRs are spot on for long term reliability. I dont understand why some people push it so much leaner.

I see that you are scavening the heck out of it at the lower rpms. I can tell your mid range torque is quite meaty too. The stock car feels flat under 2200rpm. Did you modify the throttle plate angle at the lower revs?

Thanks a lot for sharing. My only mod so far is a degree more spark overall. This is just based on data I have seen with engine ageing and combustion flame speed dropping with age. I may have to check my head gasket like someone here mentioned. I am planning to move the Intake cam away from end position to 15 deg from it like most people have done. Well I might go 10deg first.
One more thing I am planning to try is to copy the WOT cams into the lower loads so as to get into the cams early and let the throttle control the load/airflow. Bit scared about knock by doing that.

My car seems to kick into some sort of power management phase once I hit peak power. It only started after I turned on shift lights and other things. Any one has the same problem? It feels like the car thinks it hit the redline although it is atleast 500rpm below the redline and the throttle seem to shut off.

thambu19 Thu, Aug-04-2016, 09:46:55 PM

Based on how BBR explained it and how the map looks like at idle.
Intake 0 = Full retard and 60 = Full advance
Exaust 0 = Full advance and -45 = Full retard

thambu19 Thu, Aug-04-2016, 09:57:46 PM

I must say that working for an OEM I cannot understand why BMW would leave something on the table at peak power untapped (on stock car without headers). Most OEMs shape the torque curve for drivability, emissions and NVH but haven't seen many cases where peak power was left out. I am talking about cases where people pushed the Intake angle 10-15 deg from max retard and found better power.

SliM3 Fri, Aug-05-2016, 12:10:00 AM

@SliM3 Hey thanks for sharing.
No problem :thumbsup2:

I don't have the AFR maps on my XDF but I think your AFRs are spot on for long term reliability. I don't understand why some people push it so much leaner.

This is the CSL tune, and it's a different animal compared to the US/Euro tunes. It doesn't focus heavily on the cruise map because it switches to the open loop maps a lot sooner. Whereas, the US/Euro tunes require you to really dig into the car to get it into open loop. The early switch is also why the CSL cruise maps are globally set to 1.0 lambda. Not much adjustment needed, other than intake temp and adaptations. The O2 sensors are pretty good at maintaining stoich and decent emissions control.

But really, if your even half way driving the car on the CSL tune you're in open loop.

But to your point, I've noticed that BMW wanted to target a best lean torque mixture for better emissions as opposed to best rich torque, which would raise the HC's and overwork the cats. I actually have a thermal barrier coating on my pistons, chambers and ports, so in cruise I can take advantage of the benefits of running best rich torque, while lowering HC's because of the higher EGT's.

I see that you are scavening the heck out of it at the lower rpms. I can tell your mid range torque is quite meaty too. The stock car feels flat under 2200rpm. Did you modify the throttle plate angle at the lower revs?

So I pretty much kept it stock here.
Based on my continued learning, I assume the timing strategy on the intake side is to target peak valve lift @ max cylinder pressure differential. At low engine speeds that occurs roughly around 60-80 degrees ATDC, and the air/fuel mixture is moving at relatively the same speed behind the piston for efficient filling. The early closing prevents reversion and raises the dynamic compression ratio.

On the exhaust side, here I assume we're looking to keep the valve closed as long as possible. Basically to extract every last bit of work out of the higher cylinder pressures that result from a low rpm/WOT [high-load] condition. BTW, I believe this is the source of rasp! By opening the exhaust valve later, when the piston is pretty much at the bottom of the cylinder, the resonance from blow down gasses exiting the ports pings off the hard cylinder walls at that unique frequency.

My above assumptions are obviously open for discussion, in fact please comment. I really want to open-up this kind of dialog, see how other guys strategize their timing. I'd also like to better understand how they'd prioritize the valve events in relation to tuning.

I didn't touch throttle plate angles much, but I did reduce the throttle angle where the open loop switch occurs.

Thanks a lot for sharing. My only mod so far is a degree more spark overall. This is just based on data I have seen with engine ageing and combustion flame speed dropping with age. I may have to check my head gasket like someone here mentioned. I am planning to move the Intake cam away from end position to 15 deg from it like most people have done. Well I might go 10deg first.
One more thing I am planning to try is to copy the WOT cams into the lower loads so as to get into the cams early and let the throttle control the load/airflow. Bit scared about knock by doing that.

No problem.

Interesting move in the lower loads; I'd be curious to see how that works out.

My car seems to kick into some sort of power management phase once I hit peak power. It only started after I turned on shift lights and other things. Any one has the same problem? It feels like the car thinks it hit the redline although it is atleast 500rpm below the redline and the throttle seem to shut off.

Not quite familiar with those symptoms per se, but there is the possibility of cat protection kicking in.

paulclaude Fri, Aug-05-2016, 04:43:55 AM

He is running different headers and CSL intake all of which will increase airflow and so will be hitting knock sooner than you are. I thought you said you have the car mostly stock except for the cams?

My S54 is running Karbonius CSL intake, decatted exhaust and euro headers (obviously as i'm in the EU), along with the 288/280's. Just read that Comp is running the Euro cat's, so I have a more free flowing exhaust setup, and similar intake.

paulclaude Fri, Aug-05-2016, 05:07:21 AM

I even had to apply cylinder specific full load fuel trims to come to that point.
After that I could do full load runs without any knocking but with sligthly reduced full load ignition targets compared with the factory setup.

Another point to add, with the Schrick's i've had to set the stock CSL full load cylinder trims all to 1.0 as I was experiencing a slight hesitation issue during transition to full load at lower RPM's. I played with a lot of things to try and iron it out, but this is what fixed it. Seems the Schricks don't like that additional fuel BMW has tuned in for the CSL cams.

On the exhaust side, here I assume we're looking to keep the valve closed as long as possible. Basically to extract every last bit of work out of the higher cylinder pressures that result from a low rpm/WOT [high-load] condition. BTW, I believe this is the source of rasp! By opening the exhaust valve later, when the piston is pretty much at the bottom of the cylinder, the resonance from blow down gasses exiting the ports pings off the hard cylinder walls at that unique frequency.

Sli - I concur. I've found that through playing with the low end Vanos timings, you can get the 'rasp' to be audible a lot lower in the RPM range. Also, I find that the rasp is more pronounced if the AFR's are optimal too, i.e. not too rich/lean.

The maps read differently than stock, based on A2L compu-methods, but i can explain if need be.

If you don't mind me asking, what calculation are you using on those fuel maps?

thambu19 Fri, Aug-05-2016, 10:29:54 AM

@SliM3
Wow I didnt know the rasp itself had anything to do with the exhaust timing and resonance. I thought it was just a muffler design thing. Good to know.

SliM3 Fri, Aug-05-2016, 11:43:33 AM

If you don't mind me asking, what calculation are you using on those fuel maps?

Not at all bro..

The bold is the original A2L compu-method
14.7/(x/128)

Your final gauge AFR's may not necessarily match the map verbatim, once some of the other factors are applied to the injector PW calculation.

SliM3 Fri, Aug-05-2016, 01:48:07 PM

Also guys wanted to add my current VANOS offsets. These parameter act much like those adjustable cam gears. You'll still maintain the 0-60ø & 0-45ø timing thresholds, but depending on what you set the offsets to, will change the overall cam timing.

http://i45.photobucket.com/albums/f90/bmech211/current_vanos_offsets_zpspuuqtzqj.jpg

The offsets above are adjusted per the recommended timing spread for Schrick 280/272's. For the intake side we're adding +2, which is actually retarding the cam -2ø; i.e. (0-60ø) + 2 = 2-62ø -or- 72-132ø using crank angle as reference. Exhaust is left at 0, so it will be the standard 0-45ø timing spread.

Basically the offsets give us the opportunity to change the narrow and wide lobe separation angles. Let's use stock values, 0 offset:

Intake Cam Spread - 0-60ø
Crank angle (øCA) spread - 70-130ø

Exhaust am spread - 0-45ø
Crank angle (øCA) spread - 83-128ø

Narrow LSA - intake full advance / exhaust full retard
((180ø - exhaust øCA) + intake øCA) / 2
((180 - 128) + 70) / 2
61ø LSA

Wide LSA - intake full retard / exhaust full advance
((180ø - exhaust øCA) + intake øCA) / 2
((180 - 83) + 130) / 2
113.5ø LSA

Lobe Separation Spread (VANOS adjustments)

113.5ø - 61ø = 52.5ø
http://i45.photobucket.com/albums/f90/bmech211
/current_vanos_pres_setpoint_zpsh4rygsnj.jpg

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/current_vanos_pres_setpoint_zpsh4rygsnj.jpg

By moving the LSAs we have the ability to shift our powerband around, either to the left or right depending on your values.

paulclaude Fri, Aug-05-2016, 01:49:47 PM

Not at all bro..

The bold is the original A2L compu-method
14.7/(x/128)

Your final gauge AFR's may not necessarily match the map verbatim, once some of the other factors are applied to the injector PW calculation.

Thanks. That calculation actually makes more sense in terms of actual AFR targets. Added to my XDF :thumbsup2:

Are you still on stock cams Sli?

Also, did anyone ever determine what the actual CSL camshaft durations are? I've read mixed reports of 272/272 or 280/272 which do appear to tie into the Vanos mapping, based on estimated calculation from the stock M3 targets.

paulclaude Fri, Aug-05-2016, 01:59:49 PM

Also guys wanted to add my current VANOS offsets. These parameter act much like those adjustable cam gears. You'll still maintain the 0-60ø & 0-45ø timing thresholds, but depending on what you set the offsets to, will change the overall cam timing.

http://i45.photobucket.com/albums/f90/bmech211/current_vanos_offsets_zpspuuqtzqj.jpg

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By moving the LSAs we have the ability to shift our powerband around, either to the left or right depending on your values.

Brilliant :hattip:

I'll be experimenting with this on my Dyno visit. As I understand it, as a general rule of thumb is that more overall retard (higher offset values) should shift the curve towards higher RPM, and more advance shifts things lower.

SliM3 Fri, Aug-05-2016, 02:19:25 PM

Brilliant :hattip:

I'll be experimenting with this on my Dyno visit. As I understand it, as a general rule of thumb is that more overall retard (higher offset values) should shift the curve towards higher RPM, and more advance shifts things lower.

Hey paul, please let us know what you find. Once I get going I'll post as well.

paulclaude Fri, Aug-05-2016, 02:26:51 PM

Hey paul, please let us know what you find. Once I get going I'll post as well.

Sounds good, will do! Got a visit booked in a couple of weeks when I get home from work. The

Dyno has all my previous plots saved 'pre-cams' so will be able to overlay the curve change :)

exodus454 Fri, Aug-05-2016, 05:15:38 PM

Not at all bro..

The bold is the original A2L compu-method
14.7/(x/128)

Your final gauge AFR's may not necessarily match the map verbatim, once some of the other factors are applied to the injector PW calculation.

I've found with my M3 that 16/(x/128) seems to give the closest to gauge AFR

BBRTuning Fri, Aug-05-2016, 06:39:06 PM

From an exhaust side OEMs will retard exhaust at high speed low load to get better expansion and better FE but if performance is all you care about then you can copy the WOT cams all the way down to the lowest load and let the throttle control the load instead of cams.
At lower speeds higher loads there are two ways to tune.
1. Retard intake cam and Exhaust cam - This lowers CR allowing more spark timing and CA50 this also improves expansion stroke efficiency

Could you elaborate a bit on the high speed low load tuning? I'm familiar with CA50 but not FE unless I don't know that acronym.. I see in the OEM maps that the intake cams are almost fully retarded @ 0 throttle high RPM. On exhaust, CSL maps are 0* retard here until 4600 where it's 20* retarded to redline, and USA maps have 15* from 1200-4400, ramping to 35* by 8000. I'm getting a bit of unburnt fuel popping in the exhaust when getting on and off the throttle at higher RPM, light loads. Part of the issue may be these larger injectors operating at high fuel pressure, I've run into some nonlinearity around 1.45ms (idle is 1.8ms). I know I still have some fuel and injection timing tuning to do there, but I'm curious what OEMs do in these areas with cams and spark advance, and for what reasons.

I'm also curious if you have any insight on what OEMs do to deal with false lambda readings due to large overlap. I get a headache just thinking about having to deal with that. Hoping to play on the dyno some more in the next couple weeks with the high overlap and lean lambda stuff I mentioned in an earlier post.
Thanks for chiming in, great to see tuners sharing information and tips :thumbsup2:
Interestingly, your targets are quite similar to where I ended up when tuning my S54 with stock M3 camshafts, at least at the high load points, so I'm obviously doing something right. Recently, i've fitted some Schrick 288/280's and will be making a visit to the Dyno soon for tuning. Right now the engine runs well with stock CSL ECU Vanos and Ignition. I have made adjustments to WOT fuel based on my on-road wideband readings. Do you have any experience of tuning the Vanos higher load points with these kind of spec cams, i.e. for optimum power do they usually require additional intake advance at higher load as per the stock cams, or is a different technique/approach required? Obviously i'm dealing with a lot more overlap, so figure the targets may be quite different for best power output.

I've only had a chance to tune an S54 with 288/280 Cat Cams, not the Shricks, but I'm tuning an S54 this weekend with euro headers/sec 1, Karbonius CSL airbox, and Shrick 288/280, so I'll let you know how it goes and post up the Vanos maps when done!

Also of note on these cars with euro headers I posted up – I found significant gains opening the throttles to 100% much earlier in the rev range. I kept them at 70% until 2000, and ramp to 100% by 3000 RPM. On a more stock car with USA headers I didn't find much of any additional power opening the throttles past 70% below about 4500RPM if I remember right.

@BBR, what are those values in your VANOS map?

Based on how BBR explained it and how the map looks like at idle.
Intake 0 = Full retard and 60 = Full advance
Exaust 0 = Full advance and -45 = Full retard

Yes that's correct. In most standalones (and most stock ECUs for that matter) the cams are synced to 0* at rest, and values are displayed in positive advance for intake and negative retard for exhaust. The OEM DME maps confuse the hell out of me on these cars. Very different units than just about everything else out there!

comp Fri, Aug-05-2016, 07:34:19 PM

With around 12.5 average WOT AFR and the stock Vanos maps, i'm seeing the ignition adaptations hitting the limit of +2.0deg. Absolutely no audible/logged knock, so at least on my engine it looks like there is some decent ignition tuning possibility. How is your fuel quality where you stay? I assume most fuel in Germany is decent as per UK?

On another note, i'm just back from the Nurburgring, Germany for a few days on track. Power difference was very clear to see on the tarmac vs. M3's with largely stock engines. The Schricks really do open up the S54!

I have learned that the WOT airflow of the S54 is heavily depended on the HW, small changes e.g. in the exhaust could have an significant impact, so I think the best results can only be achieved by individual setup on a modified engine.

The Schrick Cams with optimized VANOS timing required up to 10% more fuel at high revs compared with standard Cams on my engine !

My setup with CAMs/CSL like Airbox and custom exhaust did require a lot of changes and optimizations.
E.g. I had significant bank specific AFR differences at low to mid WOT rev, which required bank specific fuel trims, and as mentioned before even cylinder specific fuel trims. (Knock)
I even had to reconfigure thinks like acceleration enrichment and so on.

First, before going into ignition you need a clear baseline where you are knock free, that is what I achieved without huge changes on the KF.
Therefor I did switch off KA for having a deterministic setup and I always use the same fuel so I don't need that at all.

With my current setup I can achieve knock free WOT ignition advance from 25-27 degrees/6000-8000 rpm but no way going to 31 at 8000 with my revised engine. (Fuel is German 98 octane)

Here are my current maps, carried over from a previous tune, with a little more adjustment in the areas with less than desirable torque. I haven't dyno'd yet but these were the product of some discussions I've had with a few folks & tuner.

Current WOT ignition
http://i45.photobucket.com/albums/f90/bmech211/current_ignition_zps9u1kstjn.jpg

@SliM3, could you please elaborate how you achieved those WOT targets ?
@BBRTuning, thambu19 & paulclaude - your opinion / experience on that ?

BBRTuning Fri, Aug-05-2016, 08:27:00 PM

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@SliM3, could you please elaborate how you achieved those WOT targets ?
@BBRTuning, thambu19 & paulclaude - your opinion / experience on that ?

Yes, it's really incredible how sensitive they are (or any highly tuned NA engine) to changes in exhaust design.

As an example, I currently have on my car some lesser known stepped headers, whose name I won't mention, and have had a slight midrange flat spot I couldn't tune out no matter what I did. After talking to a race header builder, he suggested I add a merge right after the header flange, based on some quick scratch paper calculations he made from engine design and header primary lengths. Interestingly, in an unrelated conversation, talked to another respected S54 tuner who found the same result from empirical testing. I gave it a try, and while it did mostly fix that midrange dip, it created a HUGE hole in the torque curve around 2500 RPM. You could even hear it in the exhaust note.. very quiet and boomy as if it wasn't breathing. Torque was the same from 30% throttle and up (actually slightly better at lower angles).

Several cars I've tuned with euro headers have had beautiful flat torque curves - which is why I'm swapping mine to euro headers this weekend.

With all that extra airflow, I'm really curious to see what injector duty cycle you're hitting on stock injectors. If this isn't a channel that can be logged, at least give us total injector pulsewidth at redline and we can calculate it. I've hit over 85% duty on stock cams at mid .80's lambda so I'd imagine a car with 288/280s will be out of fuel. We're putting ID725 injectors in all these cars to give us more headroom, ability to play with injection timing, and also allows us to run E85.

paulclaude Fri, Aug-05-2016, 08:42:21 PM

I’ve only had a chance to tune an S54 with 288/280 Cat Cams, not the Shricks, but I’m tuning an S54 this weekend with euro headers/sec 1, Karbonius CSL airbox, and Shrick 288/280, so I’ll let you know how it goes and post up the Vanos maps when done!

Also of note on these cars with euro headers I posted up – I found significant gains opening the throttles to 100% much earlier in the rev range. I kept them at 70% until 2000, and ramp to 100% by 3000 RPM. On a more stock car with USA headers I didn’t find much of any additional power opening the throttles past 70% below about 4500RPM if I remember right.

Some great information being discussed in this thread. BBR - that would be much appreciated. I think I have a good idea of where to be based on some calculated values, but would be very interested to see where you end up in comparison. Karbonius/Euro Headers/Schrick 288/280's is exactly my setup.

Very interesting regarding the throttle openings also. Something I haven't looked into in much depth previously.

I have learned that the WOT airflow of the S54 is heavily depended on the HW, small changes e.g. in the exhaust could have an significant impact, so I think the best results can only be achieved by individual setup on a modified engine.

The Schrick Cams with optimized VANOS timing required up to 10% more fuel at high revs compared with standard Cams on my engine !

My setup with CAMs/CSL like Airbox and custom exhaust did require a lot of changes and optimizations.
E.g. I had significant bank specific AFR differences at low to mid WOT rev, which required bank specific fuel trims, and as mentioned before even cylinder specific fuel trims. (Knock)
I even had to reconfigure thinks like acceleration enrichment and so on.

First, before going into ignition you need a clear baseline where you are knock free, that is what I achieved without huge changes on the KF.
Therefor I did switch off KA for having a deterministic setup and I always use the same fuel so I don't need that at all.

With my current setup I can achieve knock free WOT ignition advance from 25-27 degrees/6000-8000 rpm but no way going to 31 at 8000 with my revised engine. (Fuel is German 98 octane)

@SliM3, could you please elaborate how you achieved those WOT targets ?
@BBRTuning, thambu19 & paulclaude - your opinion / experience on that ?

Comp - can I just confirm you are running the CSL ECU? Your experience with setting up the 288/280 Schrick's seems quite different to mine, unless like you say some small hardware differences are affecting the outcome.

From my previous tunes, the first thing I did was set the LAA to a level where they will not affect the WOT fuel - this stops the part throttle adaptations affecting WOT targets. Testing AFR with this set, I actually had to pull a little fuel from the WOT table to sit around 12.5 AFR. Roughly -2 non-calc value across the board gave quite a flat curve. I haven't noticed any issue with the acceleration enrichment so this is still stock. Then, as mentioned, it didn't seem to 'like' the per-cylinder fuel trims BMW sets, so I have taken these all back to 1.0 for the time being - WOT transition at lower RPM now seems to be hesitation-free.

The only other running issue of note was a slightly lumpy idle, and the RPM sometimes attempting to dip below idle target when slowing to a stop. For this, I raised the idle a touch to 900rpm and pulled a little fuel from the idle target area on the part throttle map (AFR at idle looked a little rich) - idle is now quite smooth, no dipping, although it looks like the adaptations have compensated here as well so I might revisit this for closer to zero adaptive values.

Regarding ignition, I had no problem hitting stock CSL targets even with untouched KF tables. Adaptions were +ve on all cylinders. I have however not tested this with optimized Vanos mapping yet, so can report back to see if ignition is then limited once this is changed. With previous tunes, i've always been able to run at least a little extra ignition over stock, even with Vanos set for best power output - perhaps the 288/280's will affect the outcome here.

BBRTuning Fri, Aug-05-2016, 08:55:47 PM

From my previous tunes, the first thing I did was set the LAA to a level where they will not affect the WOT fuel - this stops the part throttle adaptations affecting WOT targets. Testing AFR with this set, I actually had to pull a little fuel from the WOT table to sit around 12.5 AFR. Roughly -2 non-calc value across the board gave quite a flat curve. I haven't noticed any issue with the acceleration enrichment so this is still stock. Then, as mentioned, it didn't seem to 'like' the per-cylinder feul trims BMW sets, so I have taken these all back to 1.0 for the time being - WOT transition at lower RPM now seems to be hesitation-free.

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Also, I've noticed the same on the 288 cams regarding idle, due to the larger static overlap. Usually you can command a bit more ignition advance at idle with a more aggressive cam since the VE of the engine is lower there. It helps get around the "weak" idle although it's still nothing compared to the idle you get with a big cam on a "fixed" cam engine..

paulclaude Fri, Aug-05-2016, 09:14:30 PM

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No problem, here they are :) Stock M3 SW has these set to 1.0 across the board. I was experiencing slight hesitation around the 2k and 3k rpm points which is exactly where BMW have factored in the extra fuel. Notice the different targets between each bank;

http://i67.tinypic.com/35i8uts.jpg

More Ignition at idle - now there's an idea! Now, why did I not think of that :screwy:

BBRTuning Fri, Aug-05-2016, 09:21:26 PM

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Ah, thanks. I misunderstood and thought the factory mapping has some per-cylinder trims already built in. I was surprised because even though most factory ECUs have these tables, I don't think I've ever seen them used.

If emissions are not a concern, I will usually try to find MBT at idle (one way is to turn all idle feedback trims off, both IACV and ignition trims, and adjust ignition for highest RPM) and then drop it 5-10* from there. You of course need to allow some headroom for the ECU to increase the advance to maintain a steady idle, and running at or near MBT timing at idle won't allow for that. If the OEM DME isn't live-tuneable or allows these trims to be disabled then this may be a bit difficult to do.

paulclaude Fri, Aug-05-2016, 09:37:25 PM

Ah, thanks. I misunderstood and thought the factory mapping has some per-cylinder trims already built in. I was surprised because even though most factory ECUs have these tables, I don't think I've ever seen them used.

If emissions are not a concern, I will usually try to find MBT at idle (one way is to turn all idle feedback trims off, both IACV and ignition trims, and adjust ignition for highest RPM) and then drop it 5-10* from there. You of course need to allow some headroom for the ECU to increase the advance to maintain a steady idle, and running at or near MBT timing at idle won't allow for that. If the OEM DME isn't live-tuneable or allows these trims to be disabled then this may be a bit difficult to do.

The factory M3 ECU has no trimming, but the CSL ECU has the above trims I posted, so BMW obviously spent a little more time with the fine tuning on the CSL.

Appreciate the tips - as you say, not so easy with the original DME as we can't specifically live map, but with a little trial and error, you can usually get there. A standalone would certainly be nice to play with! :thumbsup2:

comp Fri, Aug-05-2016, 09:40:53 PM

From my previous tunes, the first thing I did was set the LAA to a level where they will not affect the WOT fuel - this stops the part throttle adaptations affecting WOT targets. Testing AFR with this set, I actually had to pull a little fuel from the WOT table to sit around 12.5 AFR. Roughly -2 non-calc value across the board gave quite a flat curve. I haven't noticed any issue with the acceleration enrichment so this is still stock. Then, as mentioned, it didn't seem to 'like' the per-cylinder fuel trims BMW sets, so I have taken these all back to 1.0 for the time being - WOT transition at lower RPM now seems to be hesitation-free.

The only other running issue of note was a slightly lumpy idle, and the RPM sometimes attempting to dip below idle target when slowing to a stop. For this, I raised the idle a touch to 900rpm and pulled a little fuel from the idle target area on the part throttle

yes, and LAA disable at WOT I did also (I skipped to mention all the basic stuff)
Idle is still very good without any rpm dip.
But it seems a bit strange that you had to pull from the WOT fuel table, I had to increase even with default vanos settings. Sure about mechanical cam position ?

Default bank specific adjustments did not work for me ether, so I started setting them to 1 but ended with signifikant bank specific adjustmens on other loadpoints like stock. I think could be a effect caused by the carbon airbox.
You need dual wideband or quick fingers for that....

@BBRTuning, injection time at redline is arround 12.9 ... 13.1, did that help you ?

paulclaude Fri, Aug-05-2016, 09:55:32 PM

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@BBRTuning, injection time at redline is arround 12.9 ... 13.1, did that help you ?

Interesting differences. I'm fairly positive the mechanical timing is set correctly, I checked and double checked it a few times during the install. Also, unless the DME is telling me lies, it is also reporting timing is spot on (was previously showing a few deg out on both cams which I also verified during disassembly). Here's a tool32 screenshot;

http://i63.tinypic.com/2cr6gip.jpg

BBRTuning Fri, Aug-05-2016, 10:08:35 PM

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@BBRTuning, injection time at redline is arround 12.9 ... 13.1, did that help you ?

It's interesting there are bank-specific cylinder fuel trims like that in the OEM mapping. Surely they used individual lambda and EGT sensor per cylinder during initial development, so I would have expected to see some per-cylinder trims entered..

I too have noticed some unusual bank-to-bank fueling differences on cars with carbon airboxes, although it tends to clean up almost perfectly by 4000 RPM and I typically see <1-2% difference across banks beyond that point. From what I've seen it's the airbox more than anything else. I'm sure that different brands/designs of the box have an effect on this, and it's likely that the OEM CSL box is the best "behaved", as you would expect..

If 13.1mS is the absolute final pulsewidth, including injector response/deadtime offset, then at 8000RPM you are at 87% duty, and at 8500 RPM you're at 93% duty.. If that 13.1 value doesn't include the injector offset, then you're already very close to or at 100%. Most injectors deliver full fuel flow (stick open) above 90% duty, with some able to regulate up to 93% but I believe that's the highest I've seen. Technically, it's not ideal to operate the injector past 85% or so for extended periods as it can burn up the injector's solenoid, not to mention the fueling innacuracies and inability to add additional fuel for abnormally dense/cold air etc. Yet, I'm sure there are 1000s of cars out there running around at these values without apparent issue. With ID725 injectors at stock 5bar rail pressure, we're seeing about 45% duty max on gasoline and 60-65% on E85. Ideally the base rail pressure would probably be dropped to 4bar to give a bit better low pulsewidth resolution.

thambu19 Fri, Aug-05-2016, 10:12:58 PM

Could you elaborate a bit on the high speed low load tuning? I'm familiar with CA50 but not FE unless I don't know that acronym.. I see in the OEM maps that the intake cams are almost fully retarded @ 0 throttle high RPM. On exhaust, CSL maps are 0* retard here until 4600 where it's 20* retarded to redline, and USA maps have 15* from 1200-4400, ramping to 35* by 8000. I'm getting a bit of unburnt fuel popping in the exhaust when getting on and off the throttle at higher RPM, light loads. Part of the issue may be these larger injectors operating at high fuel pressure, I've run into some nonlinearity around 1.45ms (idle is 1.8ms). I know I still have some fuel and injection timing tuning to do there, but I'm curious what OEMs do in these areas with cams and spark advance, and for what reasons.

I'm also curious if you have any insight on what OEMs do to deal with false lambda readings due to large overlap. I get a headache just thinking about having to deal with that. Hoping to play on the dyno some more in the next couple weeks with the high overlap and lean lambda stuff I mentioned in an earlier post.

I've only had a chance to tune an S54 with 288/280 Cat Cams, not the Shricks, but I'm tuning an S54 this weekend with euro headers/sec 1, Karbonius CSL airbox, and Shrick 288/280, so I'll let you know how it goes and post up the Vanos maps when done!

Also of note on these cars with euro headers I posted up – I found significant gains opening the throttles to 100% much earlier in the rev range. I kept them at 70% until 2000, and ramp to 100% by 3000 RPM. On a more stock car with USA headers I didn't find much of any additional power opening the throttles past 70% below about 4500RPM if I remember right.

Yes that’s correct. In most standalones (and most stock ECUs for that matter) the cams are synced to 0* at rest, and values are displayed in positive advance for intake and negative retard for exhaust. The OEM DME maps confuse the hell out of me on these cars. Very different units than just about everything else out there!

FE = Fuel Economy. Sorry I should have made it clear.
What I meant is OEMs might retard the exhaust cams at high speed low load to get the best possible expansion work so as to improve FE and reduce exhaust temps and keep things cool as much as they can. At higher loads they advance the exhaust cam to be able to better get rid of the gases.

If performance was the only objective then the exhaust cams at high speed low load can be the same as WOT cams meaning they open earlier and this ensures the cams do not need to travel at all during WOT ON WOT OFF WOT ON maneuvers. So the torque response will be instantaneous.

Regarding scavenging it is customary to inject later during scavenging. This is because if fuel is injected earlier most of it will get lost into the exhaust causing high HC. So a much later injection during scavenging will ensure the fuel stays in the cylinder instead of exhaust.

Also during scavenging the best way to know actual airflow is to look at MAF reading and total exhaust O2%. It is believed that anything over 1% exhaust O2 concentration gives lesser and lesser incremental gains. So the gains diminish with more and more scavenging

If you are getting misfires at high speed low load and you believe it is due to extra fuel due to running large injectors and getting into the non-linear range the only possible solution I can think of is advancing the injection timing so that although the engine is running rich, it is well mixed and will combust more

So a note regarding throttle opening and headers: I believe if you have a header capable of scavenging earlier in the rev range it will benefit from a 100% throttle opening. US headers could be tuning at a higher rpm (are US headers shorter than Euro headers?) and hence may not be seeing the benefit of full throttle opening

thambu19 Fri, Aug-05-2016, 10:24:33 PM

Some great information being discussed in this thread. BBR - that would be much appreciated. I think I have a good idea of where to be based on some calculated values, but would be very interested to see where you end up in comparison. Karbonius/Euro Headers/Schrick 288/280's is exactly my setup.

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To improve idle quality try moving the exhaust cam to 10-15 deg retarded from full advance. I had a problem when I did my Vanos timing my exh timing was 5deg over advanced. Causing me Vanos codes and poor idle. I pushed the exh cam to 10 deg at idle instead of 0 and everything is good so far

thambu19 Fri, Aug-05-2016, 10:54:07 PM

That's interesting - I haven't come across the OEM per-cylinder fuel trim tables. Could you post them up or link me to them?

Also, I've noticed the same on the 288 cams regarding idle, due to the larger static overlap. Usually you can command a bit more ignition advance at idle with a more aggressive cam since the VE of the engine is lower there. It helps get around the "weak" idle although it's still nothing compared to the idle you get with a big cam on a "fixed" cam engine..

With Intake at its most retarded position and exhaust at most advanced positon the idle issue isnt due to overlap but because the exhaust is opening way too early and hence producing less torque than what engine thinks it is making. During idle most of the load on the engine such as compressor load, friction etc are modeled via maps and engine tries to compensate those loads when AC turns on etc. If the engine isnt making the same torque it thinks it is making it will cause idle issues. Best strategy is to pull the exhaust cam back a bit by 10-15 deg. Worst case copy the cams from the cold surface since those are the best cams for combustion robustness and hence they are used when engine is cold.

paulclaude Sat, Aug-06-2016, 06:17:07 AM

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Good shout, i'll do some testing with that. As you have mentioned, the cold start Vanos exhaust map sets exhaust idle area target to 10deg retard, so this makes a lot of sense. I have no Vanos codes and the Vanos test results are good, so I believe everything is good with my installation work.

thambu19 Sat, Aug-06-2016, 01:49:28 PM

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Yes your timings would be perfect but since you are running larger cams it gives the same effect of opening the exh valve too early just like mine did although mine was because I had my exh timing off by 5deg. I have tried setting my timing 3 times and still cannot figure out how to do it right.
I think I am better off calibrating than hands on work

paulclaude Sat, Aug-06-2016, 02:26:04 PM

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It took me a little while to get my head around the Vanos positioning/pre-loading procedure, but it all made sense when I put it back together. The camshaft timing, I found straightforward enough. Once cams are set using the bridge tool and Vanos is in place with hubs tightened down, hand crank the engine by hand a few times and verify the camshaft positions are still correct at TDC. Also, it's worth remembering that as you have placed the cams in full retard for setting timing, the Vanos pistons must also be in the full retard (retracted) position.

I inserted the Vanos splined shafts at the first available spline without need to rotate the hubs anti-clockwise - not 100% sure if this step is critical though, as I have read the Vanos has enough travel to allow for any of the inserted spline positions.

thambu19

Sat, Aug-06-2016, 03:25:35 PM

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Thanks I think I missed the part about the vanos pistons having to be in full retard.

I just adjusted my intake cam at peak power from full retard of 60deg to 55 to see if I get an incremental power boost as I should.

Is anyone doodling with the injection timing? Injection timing on a PFI engine should go hand in hand with the Cam timing in scavenging region

thambu19 Sat, Aug-06-2016, 03:31:45 PM

Based on @SliM3 formula here is my FAR table for normal operation. I find it hard to believe that the AFR at idle is 12.8. That is suicidal for a warm idle interms of CARB and EPA. Are we sure this is the one for warm and not the cold one?
The address for this table was 0x8D2

Can someone also tell me how the Fuel injection end angle is referenced? Based on the numbers I assume this the Crank Angle between the End of Injection and firing TDC.
If that is the case most of the injection happens during the exhaust stroke when the intake valves are closed. So fuel is injected on the valves.
Based on studies the injection can be delayed in the WOT region to achieve open valve injection and hence get a cooling effect of the evaporating fuel during intake stroke. This is a recent idea on PFI engines are were not used at the time the M3 came out. The smallest injection value that can be used will be 260 which is still way below 310 shown in the table. This is only for WOT.
Those running E85 need to put in a larger value to get proper vaporization of fuel by injecting slightly early

I have a question on the electric fan map. Is this temperature vs fan duty cycle or On temp vs Off temp or something of that sort?

Ive seen engines making best power in the 85degC to 90C coolant temp ranges due to improved volumetric efficiency and possibility of running slightly higher spark. This reduces fuel economy but if you do not care about that it is advisable to run the engine slightly colder but not by a whole lot. What are you guys doing interms of this map?

I am going to give this a try.
How many flashes can I do if I use BMWflash? I think I am close to 10 already.

Bert ///M3 Sat, Aug-06-2016, 06:21:29 PM

You should have 20 slots more of you are at 10 flashes.

But really if you are doing a lot of experimenting then you should give MSSflasher a try, IMHO it's worth the money. Simply reset the counter with one mouse click.

thambu19 Sat, Aug-06-2016, 06:27:43 PM

You should have 20 slots more of you are at 10 flashes.

But really if you are doing a lot of experimenting then you should give MSSflasher a try, IMHO it's worth the money. Simply reset the counter with one mouse click.

Yea I have been thinking of it. Its about time.

MartynT Sat, Aug-06-2016, 06:33:58 PM

MSSFlasher also flashes alot quicker than BMWFlash.

paulclaude Sun, Aug-07-2016, 12:38:03 PM

Based on @SliM3 formula here is my FAR table for normal operation. I find it hard to believe that the AFR at idle is 12.8. That is suicidal for a warm idle interms of CARB and EPA. Are we sure this is the one for warm and not the cold one?
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I am going to give this a try.
How many flashes can I do if I use BMWflash? I think I am close to 10 already.

That does appear to be the US part throttle fuel map as far as I can see. As SliM3 has already mentioned, target values in this table won't necessarily end up being the actual measured values.

Interesting comments on changing the injection end angle to aid cooling, is this a technique used at higher RPM only for WOT? I'm fairly sure that the values are BTDC on compression/firing stroke as you have said.

The Electric fan control table is temperature vs. % duty. I'm running an aftermarket Aux fan on mine, and have it running closer to 100% around the coolant thermostat opening temperature, in order to keep things in check.

Paffy's MSSflasher is well worth the money, fast tune flashing and easy reset of the FC without the need for BDM :thumbsup2:

jony787 Sun, Sep-04-2016, 05:27:18 AM

For Those like me having issues visualizing the vanos map, change the factor and offset to these values:

Intake
Factor = -1
Offset = 60

or (x*-1)+60

That will give you
0° Full Retarded
60° Full Advanced.

For the exhaust cam we have a few options depending how you brain works. :lolhit:

You can just multiply to -1

Factor = -1
Offset = 0

That will give you

0° Full advanced
-45° Full Retarded.

I prefer this setup since that is how the cam is moving. but if you dont like it check the second option.

A second option will be

Factor = -1
Offset = 45

or (x*-1)+45

That will give you
45° full Advanced
0° full retarded.

Semper Fi and happy tuning!!!!!!!!!!!!!!!!

SliM3 Sun, Sep-04-2016, 01:43:42 PM

For fuel injection end angle, it's degrees before intake valve closing. If you subtract your cam duration in the conversion formula, you can reference it as degrees before (or after) intake valve opening. That's what I like to use.

Sent from my iPhone using Tapatalk

biela Tue, Sep-06-2016, 08:33:13 AM

Hello

New guy here and great post.

I am studying vanos maps. I have found a document from cat-cams showing diagram.
But exhaust peak valve lift shows BTDC data (wrong), instead of ABDC data (right).

83º ABDC should be 180-83=97º BTDC at rest.

BBRTuning Thu, Sep-08-2016, 06:15:34 PM

For fuel injection end angle, it's degrees before intake valve closing. If you subtract your cam duration in the conversion formula, you can reference it as degrees before (or after) intake valve opening. That's what I like to use.

Sent from my iPhone using Tapatalk

Interesting.. Could you elaborate on this a bit? Looking at your older post below, I was confused because the table values didn't really make sense to me based on the way it was described below. So you're saying that it's always referencing intake valve closing timing on top of this table?

I would be curious see it in degrees BTDC (referenced against TDC compression), minus the intake cam advance..

INJECTOR TIMING

As of late I've been trying to weed thru the plethora of MSS54 fuel control functions in an effort to establish some fuel tuning strategy, based on what we have to work with. One map that I'd like to focus on is the Fuel Injection_INJECTION END ANGLE (8x6) KF_TIENDE_N_RF here:
http://i45.photobucket.com/albums/f90/bmech211/endangle_zps70aa5bae.jpg

This map basically controls injector -- intake valve timing (load based) to essentially achieve the very best mixture possible. From a performance perspective we should be able to adjust these values to achieve better BMEP for a little more power and throttle response in the mid-range. Of course we'd be sacrificing fuel economy and emissions (yeah, yeah - whatever)!!
From what I'm understanding a 3-4% increase in HP/TQ is doable just by fine tuning this map.
<< This is open for discussion

Note that the values represent ATDC crank degrees, AFTER the ignition event. You'll notice that at low-mid range the DME is injecting fuel into an open valve, and thusly, onto a closed valve at higher engine speeds. I won't get into the dynamics/science behind the reasoning, but only to validate that the potential gains lie in the lower operating loads as opposed to "up top".

More gee-whiz info I've collected in trying to understand how some of the injector timing scalars play a roll in the calculations, specifically the timing tau values below. The quote below is not specific to the MSS54 but the principle still somewhat applies.
http://i45.photobucket.com/albums/f90/bmech211/endangletau_zpsa55ebbdd.jpg

paulclaude Fri, Sep-09-2016, 07:20:19 AM

Interesting.. Could you elaborate on this a bit? Looking at your older post below, I was confused because the table values didn't really make sense to me based on the way it was described below. So you're saying that it's always referencing intake valve closing timing on top of this table?

I would be curious see it in degrees BTDC (referenced against TDC compression), minus the intake cam advance..

BBR,

The way I understand it, is the higher values in the table represent the injection ending on a closed intake valve, and lower values result in injection end on a more open valve. If we take the intake camshaft duration formula (as quoted by Sli above) into account on the stock values, then we end up here;

http://i68.tinypic.com/124wjsp.jpg

The top table, accounts for the duration of a 288 Schrick intake cam. I believe the negative values are ending injection on a completely open valve. Looking at the bottom table, this is where we would end up with the stock 260 duration cam. You can see that only at the 2400-3000rpm high load points result in injection on the open valve, whereas if you factor in the 288 Schrick, we have lots of points injecting on the open valve.

I've read several different views for tuning end angle, so not quite sure on which approach to take. For high load fine tuning, I was planning on adjusting values for richest AFR, and correcting the WOT map from there. For the mid range, I would assume with a higher duration cam, you would want to offset values so there is less injection towards open valve (similar to stock). I may be way off the mark here, so please chime in.

My tuning progress has come to a bit of a halt lately, due to a couple of mechanical issues - i'll be back in action soon though. I did actually get to test the camshaft offset theory on the Dyno - and indeed it works as expected - curve shifts up/down dependant on the overall retard/advance.

P.S - BBR, how did you get on with the 288/280 Vanos tuning?

BBRTuning Wed, Sep-14-2016, 09:39:31 PM

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Hm, ok thanks. I'm going to have to think about this some more. Referencing EoI timing against IVC angle makes sense from a theoretical standpoint but it's an odd way to display the values in an ECU table so it took me a while to try and convert these values into what I'm used to seeing (EoI timing referenced to engine TDC).

If I'm understanding this right, in order to reference against engine TDC from these values, we have to subtract IVC angle (which I believe is 247* ATDC for stock cams, by looking at that Cat Cams doc, is this correct?). Then, add the VANOS intake cam advance angle at that particular load/RPM (deg advance from full retard, or cam rest point). That gives me EoI advance from overlap TDC, or then add additional 360* to reference against TDC compression.

When I do this, the shape of the table looks right, but the numbers are almost exactly 180* advanced from what I found works best on my car with standalone ECU. That's a bit suspicious, making me think I did some math incorrectly, or otherwise the OEM DME is injecting purposely early for emissions or whatnot.

Now that I have some factory tables I'm going to try a few different ones out and see what works best. Looking for not only richest lambda but also best throttle response. When the EoI is set wrong you'll see a lean spike and poor response getting back on the gas after a shift, similar to not having enough accel fuel (since fuel is "missing the boat" and getting into engine once cycle too late).

BBRTuning Wed, Sep-14-2016, 09:49:36 PM

P.S - BBR, how did you get on with the 288/280 Vanos tuning?

Didn't have the best luck with this yet.. to be continued. Previously tuned this car with stock cams, stock airbox (just drop-in filter) and euro headers/cats. Car now has Shrick 288/280, Karbonius box, and Bimmerworld 3" catless exhaust.

Car went from having a nice smooth flat torque curve with previous setup to having a massive hole between roughly 2600-3800 RPM. Right at 4000 RPM it takes off like a rocket. In this low RPM area, the engine wants very little cam overlap and even makes more torque at lower throttle angles telling me there's a horrible reversion issue and the engine is not scavenging properly. We're going to work on the exhaust design a bit to see if we can recover the bottom end. The exhaust goes straight to 3.5" after the header flange so we're wondering if this is at least part of the problem.

It gained about 20-25 whp up top, but I didn't even bother writing down exact numbers or taking pics of the dyno chart yet since something obviously isn't right. Hope we can get it figured out soon and finish the tuning.

SliM3 Thu, Sep-15-2016, 01:34:16 PM

Interesting.. Could you elaborate on this a bit? Looking at your older post below, I was confused because the table values didn't really make sense to me based on the way it was described below. So you're saying that it's always referencing intake valve closing timing on top of this table?

I would be curious see it in degrees BTDC (referenced against TDC compression), minus the intake cam advance..

BBR:

Here's a snip-it from the Function Description. It doesn't go into much more detail than this, so it may leave a lot to interpretation.

1.5 Loading of Injection Time into the Time Processor Unit (TPU)
If the condition for a pre-injection (B_VSP) is satisfied, the output is as follows:
Considering the condition for sequential injection B_SSP is satisfied the TPU will update parameters for
injection timing at 90° CA and 120° CA. Parameter tasks for TPU injection end time are now

updated
every 720° CA.

1.6 Injection End Timing
The injection end time is calculated relatively close to intake valve closing, ie. Injection end time at 200° CA is actually 200° CA before the intake valve closes. There is one constant for each of the injection end time operating states as follows:
K_TI_ENDE_MAN
K_TI_ENDE_START
K_TI_ENDE_VL
KL_TI_ENDE_0(bis 5)
K_TI_ENDE_11

SliM3 Thu, Sep-15-2016, 02:14:51 PM

revising post

paulclaude Fri, Sep-16-2016, 01:50:50 PM

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The way i'm understanding those values, the stock values/cams are indeed resulting in early injection, possibly for emissions like you say - unless there is some sort of additional ECU calculation on that EOI map that i'm not aware of. Of course, the added camshaft duration from aftermarket cams like the Schricks results in more of the stock targets ending injection on the open valve. I'll do more testing with this map at some point and will see what the results bring.

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Cheers for the feedback - certainly sounds like it could be the exhaust setup like you say. Bad luck makes two of us - i've had the exact opposite result with the 288/280's in mine - massive gain in low-mid range over stock cams, then huge hole towards upper RPM (or at least dropping to almost back towards stock cam HP), before lifting for peak gain at 7-8000RPM. After messing with my 'calculated' Vanos targets amongst other things, I could never really iron out that dip. We were also experiencing a bad stutter/misfire at low RPM when planting it, which I couldn't really replicate on the road.

Cutting a long story short, it seems that despite my anal setting and checking of cam timing, the timing bridge tool I used has resulted in inlet cam timing being out by 9.5deg. Interestingly, inlet/outlet adaptations in the ECU were showing +/- 0deg, so I assumed all was good. I since realised that due to the inlet timing being outside the ECU adaptation limit of 8 deg, it defaults to 0 adaptation. Amazingly, no codes thrown and everything seemed good via diagnostic. Increase of the ECU adaptation limit to 10deg resulted in the adaptations showing 9.5deg inlet, zero exhaust, confirming the issue. Doh! :facepalm:

I've since got hold of the Genuine BMW bridge tool, and the difference in pin alignment between the non genuine tool is clear to see, even by eyeballing it. Lesson learned with that one, Genuine tools only. Will be back on the Dyno soon for round 2 testing/tuning, this time with the addition of some SS V2 stepped headers :thumbsup2:

What can I say, every day is a learning day! :)

Man, I really hope all that garble makes sense. My thoughts may not be expressed very well.

You've just minced my head with that one Sli :D

SliM3 Fri, Sep-16-2016, 03:05:50 PM

You've just minced my head with that one Sli :D

I know :lolhit:

I'll have to revise that on a less foggy minded day!

BBRTuning Fri, Sep-23-2016, 12:16:04 AM

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Wow that is interesting to hear, hopefully it's just the base cam timing! Did you happen to get a picture of the dyno plot? We too were not blown away by the top end power with the 288/280, curious to see what yours looks like.

Also, one thing i forgot to ask.. In the injection timing tables in the factory DME, is the load input to the table (Y-axis below) a rf value, Throttle % value, or is it something else?

http://i68.tinypic.com/124wjsp.jpg

comp

Fri, Sep-23-2016, 05:20:36 PM

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I have never seen a performance increase with a s54 engine due to changed exhaust system; with the best systems on the market e.g. from supersprint you can reduce weight but not increase performance.

Very important is the exact position of the middle silencer and the connection between both exhaust pipes bevor catalyst due to resonance effects.

BBRTuning Mon, Sep-26-2016, 06:31:46 PM

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I agree with further down the stream, but there is potential for a MASSIVE change in the engine's powerband from changes in header design (lengths, diameters, etc) as well as section 1, with diameters, secondary merges, etc. After the secondary merge, as long as there isn't a restriction, there's little to no potential to affect powerband.

We know the OEM Euro headers are not the issue as these have worked fantastically for many setups. Going from OEM Euro catted sec 1 to a 3.5" merged catless sec 1 has the potential to cause at least some of the issues, although at high RPM we should expect to see only gains due to the reduction in backpressure.

As an example, I put a crossover pipe in sec 1 immediately after the header flange on my car as an experiment, with no other changes, and the entire powerband changed. It fixed a midrange dip in the torque curve but created a new drastic dip around the 2500 RPM area. This is after completely retuning the VANOS and fuel maps to suit the exhaust change.

332ijunkie Tue, Sep-27-2016, 02:45:29 PM

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I see performance gains with exhaust changes much more than intake ones. Hell you can slap a CSL box on a stock header car and it will net you nearly nothing... S54 is extremely exhaust sensitive as others have stated. For example the typical S54 track car setup (mega headers and BW race exhaust) has no balls <4k but makes huge power up top even with stock plenum....

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got a before/after dyno chart for reference ?

Edit: referencing a street legal car with euro headers/cat.

332ijunkie Tue, Sep-27-2016, 09:21:14 PM got a before/after dyno chart for reference ?

Edit: I had been talking about a street legal car with catalyst.

http://www.r3vlimited.com/board/showthread.php?t=327183

As far as playing with just the 'after headers' stuff. Yes moving/eliminating the merge does do crazy stuff with the powerband. I havent tried it myself back to back on stock headers, most of the cars we play with the exhaust on have aftermarket headers...

paulclaude Fri, Oct-14-2016, 09:11:26 AM

Wow that is interesting to hear, hopefully it's just the base cam timing! Did you happen to get a picture of the dyno plot? We too were not blown away by the top end power with the 288/280, curious to see what yours looks like.

Also, one thing i forgot to ask.. In the injection timing tables in the factory DME, is the load input to the table (Y-axis below) a rf value, Throttle % value, or is it something else?

BBR/Sli/All, here's the Dyno plot of where i'm currently at from my visit yesterday. Quite pleased with how they are performing, gained just shy of a 20hp over the stock cams, along with a flatter torque curve. Had to add substantial exhaust retard at the upper RPM to get the power out of them, along with the expected additional advance on inlet. I actually had more HP/TQ at 4600-5900rpm on my previous visit and less of a dip, so will need to mirror timing from that session - as usual ran out of time. Could really do with a standalone :shifty:

http://i68.tinypic.com/29qock1.jpg

Can't seem to pull it out of that 6500 dip, unless I need to try some wilder Vanos adjustments. From other runs I have seen, the curve seems typical of the 288/280's. Any development on your own 288/280 tuning?

Regarding Injection end angle - the load axis is a RF value. I still need to play with that, have to save it for the next visit now i've got the main maps optimal. Are we thinking perhaps lowering the values (injecting more on the open valve) could benefit performance?

Comments welcome :thumbsup2:

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paulclaude Fri, Oct-14-2016, 11:23:55 PM

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BBRTuning Sat, Oct-15-2016, 12:08:25 AM

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Nice numbers and good looking curve!! I too had to have a lot of exhaust retard in the upper range - at 8000 RPM, I'm at 30* exhaust and 16* intake advance (0 being full rest/retard position) on the Shrick 288/280 car I did. Other than the lower RPM issues we had, our curves look pretty similar, including a slight dip at 6500, and the power going flat right around 8000 RPM. This is actually what I'm most surprised about - the stock cams tend to peak around 7900-8100, and seems to be about the same with the 288/280. I would expect the peak to be moved up closer to 8500 or so. Wonder what it would take to get more power past ~8100.. big bore throttles and head porting?

Haven't got back to that car yet, but I did look at tons of dyno curves online with the BW race exhaust, and it appears that the large diameter and immediate merge of the BW race system seems to cause massive torque losses below 4000 RPM, which is exactly what we're experiencing. Customer is likely going to go back to a factory-style exhaust layout like he had before, albeit without cats this time, as they will start to be more of a restriction now with the extra flow the 288/280 provide.

What is your injector duty cycle (or if that's not available to datalog we can calculate it from final/total fuel pulsewidth) at redline? If you're on the stock injectors I'd expect them to be maxed out at that power level, meaning that injection angle likely won't really have any effect. We're running ID725 injectors on most of these cars which gives us a bit more room (~45% duty max on 91 octane, ~60% duty on E85), although with the stock base fuel pressure of 5 bar, it's not too hard to run into the injector's minimum stable pulsewidth when just barely breathing on the pedal above 3000 RPM.

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Cheers pal, i'm happy with how it's running now, on the road feels quite strong indeed. Great low down torque too, which is something I thought i'd lose with these cams. I also tried a few things up top to try and lift the HP beyond 8000rpm peak, but no real change. It certainly surprised me too! Like you say, I'm thinking porting or bigger TB's would be the answer there. Then again, I think the big ends will welcome the 8000rpm limit :D

Ended up with very similar redline targets to you - i'm at 28 exhaust advance and 18 intake, so within 2 degrees! I need to get my head around pulsewidth and duty cycles a bit more, but from what I can see, calculated duty cycle at redline is 81 and 12.17 pulse width - not sure if this is maxing them out, care to elaborate?

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That's awesome to see the cam targets are so close at redline! What are you seeing for actual ignition advance up there? What fuel? With stock compression I typically see the same as you where peak advance can be reached even without knock. That's why the practise of advancing timing until knock occurs is usually not a good one!

12.17ms at 8500 RPM nets ~86% duty cycle on the injectors, which is actually lower than I expected but is pretty close to maxed out. Is this 12.17 value from the fuel map or an actual data logged live value? The ECU not only applies some trims beyond the main map but also an injector response time offset so only the datalogged value is actually meaningful for this calculation. Depends on injector design, but injectors typically go static around 85-95% duty cycle (i.e. they stick open, essentially providing the same amount of fuel as if the duty cycle was 100%). Luckily the injectors on these cars from what I've seen seem to go static a bit higher than most, at least 92%, so you just have a little headroom there.

What AFR/lambas are you seeing at high RPM? You're likely running a bit leaner than I do since I've seen higher duty cycle than that with the stock injectors even on stock cams. Also, our fuel has ~10% ethanol so that requires a little more fuel flow. I typically target a richer lambda at high RPM as it doesn't really affect power but provides a nice cushion for sustained WOT and high RPM.. usually .89 lambda down low and about .84 by redline (13.0 down to 12.4 AFR). That richer lambda of course requires more fuel, and doubtful the stock injectors would be able to achieve that with the high airflow you see with the 288/280.

comp Sun, Oct-16-2016, 06:44:51 AM

Indeed I did. 2deg advance over stock seemed to give best, any less was same curve with less peak power, any more and drop in HP. Played with Vanos targets and no real change.

Realistically, it matters little as I usually shift at 8k on track.

what ignition advance values did you log ?

I had been able to get stable 25-27 degrees/6000-8000 with my 288/280 schrick cams, 12.0 AFR, logged pulsewidth 12.9...13.0ms at 8000.

That seems to be the ignition advance limit, with further increase I get knocking.

SliM3 Mon, Oct-17-2016, 01:14:52 PM

Great numbers paul!!

Injection end timing is not going to have much effect at higher rpm's because of the injector duty cycles. The stock injector is pretty much 'ON' continuously (though it's still roughly >85%). The mid load is a good place to start, and from my understanding you basically adjust end of injection timing (EOI) to max enrichment. This would indicate that all the fuel is making it into the cylinder and very little condensing on the port & cylinder walls (droplets falling out of suspension). Go back and readjust the global maps to pull AFR's back to your target.

Adjusting EOI at higher rpm's can be accomplished easier with larger injectors that have a lower duty cycle, like the 1100cc's I'm running. The pulse widths are so short you can better/precisely adjust timing as opposed to trying to control what's almost like batch firing of the stockers at high revs.

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BBRTuningtiming until knock occurs is usually not a good one!

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What AFR/lambas are you seeing at high RPM? You're likely running a bit leaner than I do since I've seen higher duty cycle than that with the stock injectors even on stock cams. Also, our fuel has ~10% ethanol so that requires a little more fuel flow. I typically target a richer lambda at high RPM as it doesn't really affect power but provides a nice cushion for sustained WOT and high RPM.. usually .89 lambda down low and about .84 by redline (13.0 down to 12.4 AFR). That richer lambda of course requires more fuel, and doubtful the stock injectors would be able to achieve that with the high airflow you see with the 288/280.

Ok, so this is making a lot of sense. I'm hitting around 12.5-12.6 AFR at redline, and now I think about it, I do recall trying to go richer to see how it affected things, but saw no change in lambda up top despite increased targets. I didn't think too much of it at the time, but it seems to confirm that the injectors must be maxed out by that point. I did see a few HP gain lifting it towards 13, but decided to keep it safer as I use this M3 on track.

The PW/duty cycle were just by calculation from the targets set in the tune, so for reference I'll do some data logging when i'm back from work in a few weeks, see what the real PW value is :thumbsup2:

Ignition wise, my table is set around +2deg over stock CSL, which is 30deg peak, but an actual logged value of 27-28deg I recall (due to IAT compensation I assume). This seemed to give optimal power - as mentioned adding another degree lost me a couple of HP, although i still wasn't showing any knock. I'm running 98/99 Octane UK fuel.

Certainly amazing we have ended up within 2 degrees Vanos target wise (and glad to confirm same approach!). I actually didn't expect to have to add so much retard exhaust side, but I guess it makes sense. My last session had a meaty low-mid end due to setting an advanced inlet cam offset while leaving exhuast stock (2deg). I'm thinking that now I have found the optimal top end timings, it's possible to have the best of both curves by setting an advanced inlet offset and calculating where the upper targets should be.

what ignition advance values did you log ?

I had been able to get stable 25-27 degrees/6000-8000 with my 288/280 Schrick cams, 12.0 AFR, logged pulsewidth 12.9...13.0ms at 8000.

That seems to be the ignition advance limit, with further increase I get knocking.

As above comp, kind of similar values as you for peak HP i'd say, although i'm not seeing any knock with mine even with more advance. Not a massive difference in HP between stock and adding a couple of degrees, circa 4hp, but it all helps.

Great numbers paul!!

Injection end timing is not going to have much effect at higher rpm's because of the injector duty cycles. The stock injector is pretty much 'ON' continuously (though it's still roughly >85%). The mid load is a good place to start, and from my understanding you basically adjust end of injection timing (EOI) to max enrichment. This would indicate that all the fuel is making it into the cylinder and very little condensing on the port & cylinder walls (droplets falling out of suspension). Go back and readjust the global maps to pull AFR's back to your target.

Adjusting EOI at higher rpm's can be accomplished easier with larger injectors that have a lower duty cycle, like the 1100cc's I'm running. The pulse widths are so short you can better/precisely adjust timing as opposed to trying to control what's almost like batch firing of the stockers at high revs.

Cheers Sli! Yeah, that totally makes sense, cheers. I had read that mid range is where correct EOI timing can really help, so I will give this a shot next. How is your own build running?

comp Mon, Oct-17-2016, 05:34:27 PM

Ok, so this is making a lot of sense. I'm hitting around 12.5-12.6 AFR at redline, and now I

think about it, I do recall trying to go richer to see how it affected things, but saw no change in lambda up top despite increased targets. I didn't think too much of it at the time, but it seems to confirm that the injectors must be maxed out by that point. I did see a few HP gain lifting it towards 13, but decided to keep it safer as I use this M3 on track.

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Cheers Sli! Yeah, that totally makes sense, cheers. I had read that mid range is where correct EOI timing can really help, so I will give this a shot next. How is your own build running?

Did you adjust the knock factors for lower sensitivity or something else ?
I have a fresh revised head/valves with new valve springs, new rockers and new cams, euro header / euro cat.
Sure your knock detection is working ?
The S54 tends for knocking compared with a M54 or so.
I think caused by its high compression rate combined with high filling rates caused by optimized airflow with low turbulences.
I have a clear line on my ignition advance setup - below no knock, 1 degree increase knocking.
Even with EU 101 Oktan - no way going to 29 degrees or above.

My high rpm vanos targets, optimized by airflow - because I had not been on the dyno until now - are within your range +-3 degrees so three persons end up independent from each other with the same target values...

What are your full load relativ filing targets in the full load RF tabel ?
I'm at 1,30 @6400...1,34@ 8000 providing a flat lamda curve of 12.00.

nickpiper12 Mon, Oct-17-2016, 05:57:31 PM

Regarding TB's (Dinan) with the 288/280's, there was a 5whp peak difference on my car with no other changes besides optimizing the tune.

Anywhere from 0-8whp difference throughout the powerband. Losses were 6k and upwards. I was happy to see they didn't effect low/midrange power, but that was effected.

Graph is posted in my journal somewhere.

Obioban Mon, Oct-17-2016, 05:58:57 PM

In preparation for the end of the season here the next 2 weekends at Road America and Autobahn, I decided to hop on the dyno and make sure all was well, considering I've have a lot of random issues pop up in the last few weeks (TPS sensor, ICV, coils). Probably because I don't daily it anymore :taser:

Also, there is now some real data on what exactly the Dinan TB's bring to the table in a N/A build like this. I don't believe I've seen any graphs comparing the two with an otherwise same setup.

I removed them back in January and the car has been running great, albeit a tad rich, which makes sense. I wanted to optimize the current setup and overlap the graphs.

Here are the results... Blue is Dinan TB's, Red is Stock.

https://c5.staticflickr.com/9/8139/29486153124_0ee6ca3060_c.jpg

:thumbsup2:

paulclaude Tue, Oct-18-2016, 11:48:02 AM

Did you adjust the knock factors for lower sensitivity or something else ?
I have a fresh revised head/valves with new valve springs, new rockers and new cams, euro header / euro cat.
Sure your knock detection is working ?
The S54 tends for knocking compared with a M54 or so.
I think caused by its high compression rate combined with high filling rates caused by optimized airflow with low turbulences.
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Comp, I have decreased the KF sensitivity tables slightly. At the end of the day, 1 degree ignition accounts for about 2hp, so probably not worth worrying about. I have been turning off KA and running on knock control only for ignition tuning, but left it on for this calibration. What kind of calculation do you have on that WOT table for lambda - I've got mine set for the AFR calculation, it's set somewhere around 12.1 @ 8000, but as previously mentioned, doesn't seem to want to go richer than 12.5 - likely due to injector limitation. Are you running the CSL ECU?

Also good to verify the cam/vanos timings from someone else. My 'calculated' inlet targets based on the increased camshaft duration were actually a few degrees more advanced than where I ended up, I guess there are other influences at play there.

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Graph is posted in my journal somewhere.

Interesting results with the TB's - thanks for chiming in. Certainly some mid-top end gains to be found. So, it looks like that top end +8000rpm 'level out' is more a flow limitation of the head than anything else. Effects of a ported head would be interesting to see.

I did notice your AFR's are what I would consider very lean - up to 14:1 at the top end, was this a wideband sensor issue or is this the actual AFR reading? If so, I would assume it required reduced ignition?

:thumbsup2:

Cheers Obioban :thumbsup2:

comp Tue, Oct-18-2016, 06:49:35 PM

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I'm using the old fashioned 1/128 method thinking those values representing filing rates rather than lambda targets. Using lambda target calculation posted here in this forum 1,34@8000 giving me a measured AFR of 12.00 - would be a lambda target of 11.00 @8000 compared with your target of 12.10 = 1,22. (I have a CSL like Airbox with euro headers/cat)

Sure you did enabled knock control on the dyno ? - I don't think it is a good idea to switch it off. Have been on the track lately and pushed the car hard. I did log knock control and had to retard ignition around 2 degrees compared with non track full load runs due to increased engine heat and stress from the track.
Yes, CSL ECU, map sensor with disabled KA but increased knock recovery.

exodus454 Tue, Oct-18-2016, 08:06:30 PM

How are you all logging knock? I've looked through tool32 and testo and haven't been able to find the parameter.

MartynT Tue, Oct-18-2016, 08:08:33 PM

Log individual cylinder timing advance.

nickpiper12 Tue, Oct-18-2016, 09:50:00 PM

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Yep, seems most of the graphs with 288/280's seem to level off at or around 8000rpm. Definitely seems there is room to improve on the exhaust side of the head, but not something I'm thinking about doing as of now. Seems some people have tried and have had results not favoring the work. Lots of variables to take into account.

The wideband is at the tailpipe through a sniffer, which consistently reads .5 -.8 leaner at this dyno. It may even be close to 1, as the 3.5" single outlet is quite large. With that said, AFR is spot on and is a very safe tune, which was taken into account due to the abuse it takes on track.

paulclaude Wed, Oct-19-2016, 01:07:48 PM

I'm using the old fashioned 1/128 method thinking those values representing filing rates rather than lambda targets. Using lambda target calculation posted here in this forum 1,34@8000 giving me a measured AFR of 12.00 - would be a lambda target of 11.00 @8000 compared with your target of 12.10 = 1,22. (I have a CSL like Airbox with euro headers/cat)

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Yes, CSL ECU, map sensor with disabled KA but increased knock recovery.

Yep, that's correct, using the 1/128 method for calculation i'm at 1.22. I've also completely reworked the axis on the WOT table as I found the stock CSL resolution to be poor for fine tuning. I'm 100% sure Knock control was/is enabled, I have left KA and KR enabled with this tune, purely as the car is used on track - the adaptations compensate ignition for you pretty well when giving it a hard time, saving the need for ignition logging and adjustment. I've never actually run with knock control completely disabled, only with KA off.

Yep, seems most of the graphs with 288/280's seem to level off at or around 8000rpm. Definitely seems there is room to improve on the exhaust side of the head, but not something I'm thinking about doing as of now. Seems some people have tried and have had results not favoring the work. Lots of variables to take into account.

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spot on and is a very safe tune, which was taken into account due to the abuse it takes on track.

Certainly lots of variables. We don't see many Dynos with head work. I guess power beyond 8000rpm isn't too useful anyway, at least not with some kind of bottom end/crank work to support it.

BBRTuning Fri, Oct-28-2016, 06:37:08 PM

So check this out.. After the change to Euro headers and cats, I had to pretty much start over with my mapping for fueling and VANOS, but pretty early on in the tuning process I wanted to try moving the injection end angle around a bit..

Below is the result. Again, keep in mind still had a lot of cleaning up to do to smooth the curve, but the point is that moving the injection end angle only 40* retarded, across the entire RPM curve, had the effect below (up to 7-8ft/lb gain). I backed it up twice by going back to the old settings and back to new again.

You can see it has a negative effect down low but gains mostly everywhere else. Once I'm 100% done with VANOS and injection end angle etc I'll post a final graph.

The RPM sync was a bit off since I used roller speed, it was reading a bit lower than actual RPM and I didn't bother to resync it. This is on a Mustang dyno, ours reads ~15-16% lower than a Dynojet dyno. Also keep in mind this is with ID 725cc injectors, so duty cycle is low enough that I have more ability to move the injection even around freely as opposed to a stock injector that's much more close to operating static.

https://s13.postimg.org/3pqrge8d3/FI_timing_only.jpg

BBRTuning Fri, Oct-28-2016, 06:47:52 PM

Below is the injection end angle table after I combined the best end angles for low and midrange. Might still be some gains up top but I will revisit next time I'm on the dyno with more time.

These injection end-angle values are degrees BTDC, absolute (not referenced to cam angle). So you'd have to do a bit of conversion to get these into stock DME values, depending on what math you're using for that display. It's interesting to see how much the injection has to retard under load. If I held the engine steady state WOT at a mid RPM, advancing it much further lost some torque and required more fuel (likely going right through the engine during overlap) and if i retarded it much further the engine lost a lot of torque and ran quite roughly (unstable combustion).

Would not suggest that someone use these values as my injectors and setup are different etc, but posting for discussion purposes..

https://s21.postimg.org/3zpx0chaf/FI_End_Angle.png

paulclaude Fri, Oct-28-2016, 07:50:02 PM

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Very interesting results indeed BBR! In comparison to the stock DME values, you are far more retarded at the upper RPM range, and more of a flat line. At full load, ours is most retarded at the 2400-3000rpm range, after that it becomes substantially more advanced as the rpm increases.

Did you correct AFR's each time after adjustment, or was this a direct result of shifting -40deg? I had actually tested this a bit on the road recently; at a simple -50 from stock DME values are mid-upper RPM I thought it 'felt' stronger, although no real data to back up. Damn, I really need to book another session on the dyno now :smash:

daumas Fri, Oct-28-2016, 09:17:15 PM

Thanks for posting these. It would be great if we could have tables for all different car configurations. Personally I just don't have the time to tinker on a dyno and I only want a little less conservative stock tune. I'm not looking to take a 290hp tune to 291hp... no trophy to win by doing so.

BBRTuning Fri, Oct-28-2016, 11:40:57 PM

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Interesting.. Yeah I'm not convinced that the high RPM stuff is close, although it was cool to see the gains even at the top of the RPM range from that -40 shift.

When I made that change, the AFRs were the same both runs since this ECU does full-time closed loop fueling so the AFRs are always dead on. However, much to my surprise, when the injection angle was retarded in the areas where it gained the most torque (~4000-6000 RPM) it actually wanted MORE fuel with this injection angle change, and it also made more torque. I think the theory of "adjust injection angle to achieve richest AFR(which implies that more of the fuel is actually being burned)" applies in certain situations like light load and/or minimal overlap areas, but didn't really seem to apply here.

In the lower RPM range, around 2500-3500, where peak cam overlap occurs (maximum intake advance and exhaust retard), as I mentioned earlier if the injection was advanced from "ideal", the engine would make the same torque but require more fuel, so in those areas it was pretty clearly "wasting" some of the fuel out the exhaust. This makes sense due to the large overlap and what some people refer to as "fuel short-circuiting".

Bert ///M3 Sun, Nov-27-2016, 11:40:21 AM

Hey my only comment on your cal would be this. It is usually better to not phase cams vs load at high engine speeds and this is the reasoning. If in a race the driver goes from low load to high load at constant engine speed (like a WOT stab) the cams are already at their positions and torque will be instantaneous. This also avoids transient knock at those speeds because the cams used during spark calibration will be the cams during the transient. If the cams have to move significantly with load then the cams could be in the state of transition and the spark being applied was not meant for the cams the engine is running at that instant since the cams are still catching up.

Interesting quote.

Would it be beneficial to a racecar to set the VANOS angle equal across the whole TPS range, from say 4000-5000 RPM and up?

Ie copy WOT cams to all the lower throttle plate angles.

This would eliminate the cams adjusting at a throttle stab and also it would put the cams in the right place when you upshift isn' it? It might provide for a better response after shifting :)

paulclaude Mon, Dec-05-2016, 07:39:16 AM

Interesting.. Yeah I'm not convinced that the high RPM stuff is close, although it was cool to see the gains even at the top of the RPM range from that -40 shift.

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Quick update from me - recently got round to testing injection end angle on the Dyno. Results were surprising. Over stock CSL DME values, subtracting values further resulted in a slight loss right through the curve. I then added +20deg from 4000rpm to redline at the high load points (which would be further advancing the end point as per my understanding). This resulted in a lift in the curve, all the way towards redline, where it tapered to a similar peak HP. Gain averaged 4-5hp all the way to high 7000rpm's. Interestingly, peak gain was where I had the previous 6500rpm dip in the curve, somewhere in the region of 8HP, which actually ironed it out to a more acceptable level. Advancing the IEA further had no real further gain, and going +30deg started dropping the curve. I suspect the result of this gain through IEA advance has something to do with the added duration of the 288/280 cams, so likely wouldn't see the same effect with stock cams.

BBR - exact opposite from your findings, I'd assume this is to do with injector difference, or potentially camshafts you were running on that engine? The curve on these 288/280's is looking quite good now, I still however have a significant dip at the 5-5500rpm point. I'm almost sure this can be ironed out through altered Vanos timing however. I think you previously mentioned you only had the dip at 6500rpm with the 288/280's? Are you willing to share your inlet/exhaust Vanos targets at this F.L RPM point on your tune for comparison? :)

FlyItLikeARenta Thu, Jan-12-2017, 02:19:50 PM

Chaps, any merit to set your cat warm up and normal vanos maps to exactly the same settings, seeing as there are no cats in my car?

FlyItLikeARenta Thu, Jan-12-2017, 02:33:31 PM

Another reasonably interesting thing happening with my car...

It pulls timing at around 6800-7200 like its no ones business. On the stock software the timing curve collapses so badly I don't even think its getting to 19 degrees at 8000 rpm...

So, i went and backed off the timing there, so it is getting to about 24 degrees up at redline and up about ~20 or so whp, using bmw logger and virtual dyno on EXACTLY the same piece of road every time.

Now my burning question, why would the car be more prone to knocking in the high rev range, 1500-2000 rpm past peak torque? I've changed the plugs and coils, still getting the same nasty timing pull there.

I must add I'm in Johannesburg South Africa, 5000' above sea level, with ambient temps in summer easily in the high 20's early 30's degrees celcius. One would have thought with the fact that ambient is only about 855 millibar up here the car would not have a care in the world to reach the stock timing targets?

BBRTuning, those VANOS maps you posted right in the beginning of the thread, I used SchlanD's MSS tuner and set my vanos load sites and RPM's to match yours in the AEM infinity, so got 1200,1400,1500,2000,2500 in 500 increments to redline, just interpolated for my extra 500 rpm load sites from your settings, and I whooped like an idiot the first time I revved it to 6000 rpm. That midrange is insane bud! My car is very much on par with that car, also full euro exhaust minus cats, stock cams, only difference is stock intake and airbox. Any suggestions on which way to go with the intake cam timing since I'm not on a CSL intake?

MartynT Thu, Jan-12-2017, 02:41:10 PM

Have you had a wideband on the car to see what the fuelling is like in the band where ignition advance is being pulled?

Thu, Jan-12-2017, 03:25:38 PM

Just the values in the map Martyn.

MartynT Thu, Jan-12-2017, 03:34:00 PM

You really need to log your AFRs with a wideband prior to making changes to your vanos. Altering your vanos maps can have an effect on the fuelling.

paulclaude Thu, Jan-12-2017, 03:55:36 PM

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If you have mirrored the Vanos maps BBR has posted, then you'll have significantly increased camshaft overlap. This will have knocked your fuelling out, and the engine will be wanting more fuel for certain - this is why you are experiencing ignition knock.

As Martyn has said - the only way to setup this correctly is with proper tools, i.e. wideband lambda.

BBRTuning Thu, Mar-02-2017, 11:41:41 PM

BBR - exact opposite from your findings, I'd assume this is to do with injector difference, or potentially camshafts you were running on that engine? The curve on these 288/280's is looking quite good now, I still however have a significant dip at the 5-5500rpm point. I'm almost sure this can be ironed out through altered Vanos timing however. I think you previously mentioned you only had the dip at 6500rpm with the 288/280's? Are you willing to share your inlet/exhaust Vanos targets at this F.L RPM point on your tune for comparison? :)

Sorry it's taken me a while to update in this thread, been super busy lately and haven't had much to report on until now.

Pretty cool to hear about the gains from the injection angle! I have a feeling that the values in the factory DME don't work quite the same as they do for the AEM Infinity so it's going to be hard to properly compare the raw values until we know exactly the steps the DME takes between the values in that table and the actual ending angle relative to engine TDC. My particular example was on stock cams and stock plenum.

So I just retuned the 288/280 car that previously had the massive low end hole. I used my same injection angle map, and even with different cams and a Karbonius plenum, I wasn't able to find any gains at all by adjusting the end angle away from my values, so the cams didn't seem to have an effect on ideal injection timing, at least that I could detect.

As far as fixing that low end hole, all we changed was section 1/2/3 exhaust and nothing else

FlyItLikeARenta on the car. Previously had the BW "race" single exhaust which has a giant 3.5" merge shortly after the headers. I suspected this was causing the low end issue, so we went back to OEM Euro section 1/2, and SS Race sec 3, which was his old setup (before the 288/280 and Karbonius box). This car has always had OEM Euro headers.

The results of that exhaust change are below. This was a long 4th gear Vehicle Simulation pull, and unfortunately we had some tach pickup issues with the dyno on this dyno run. I smoothed the graph to get rid of the noise, you can still see a bit of oddness in the curve, but the overall trend here is what is significant.

As you can see the low end hole is completely fixed. However, we lost significant top end power, likely due to the restriction of the cats. The dip at 6500 is interesting too but I wasn't able to get that any better. The VE % of the engine drops about 4% at that point. The 288/280 cams really need to breathe and will be much more sensitive to exhaust backpressure. I think a stock "style" exhaust layout with either high-flow cats or cat delete in section 1 will bring back most of the top end. I spent quite a while on Vanos, and I'd say it's within 3* or less of optimal at all points. The Vanos curve had to be completely redone after this exhaust change.

https://s13.postimg.org/6m421a5pz/dyno_comparo.png

Below are the Vanos maps for the 288/280 / Karbonius car. Top is before (with BW Race exhaust and bad low-end) and bottom is after, with the more restrictive exhaust. Again remember these values are advance/retard, with 0* always being the "resting" position of the cam. You can see that the less restrictive BW exhaust wants more intake cam advance at high RPM, as we'd expect. This is surely what the cams want, but with added backpressure in the picture, the cam has to be retarded to prevent air charge "blowback". The weirdly small overlap values at low RPM were an attempt to regain some of that low-end loss from the BW setup. It did actually help (along with keeping the throttles partially closed) but this is of course a band-aid from a serious exhaust scavenging issue. This completely went away with the OEM style exhaust setup. The exhaust cam curve looked a bit funny to me, but it seemed to like being there. It was much less sensitive to exhaust cam angle change than intake cam angle.

288/280, Karbonius box, BW "Race", Vanos Intake/Exhaust:
https://s9.postimg.org/vcfq015tb/BW_Race_288_280.png

288/280, Karbonius box, Euro 1/2, + SS Race, Vanos Intake/Exhaust:
https://s21.postimg.org/b18ttgnvr/Euro_exh_288_280.png

paulclaude Fri, Mar-03-2017, 12:26:39 PM

Sorry it's taken me a while to update in this thread, been super busy lately and haven't had much to report on until now.

Pretty cool to hear about the gains from the injection angle! I have a feeling that the values in the factory DME don't work quite the same as they do for the AEM Infinity so it's going to be hard to properly compare the raw values until we know exactly the steps the DME takes between the values in that table and the actual ending angle relative to engine TDC. My particular example was on stock cams and stock plenum.

So I just retuned the 288/280 car that previously had the massive low end hole. I used my same injection angle map, and even with different cams and a Karbonius plenum, I wasn't able to find any gains at all by adjusting the end angle away from my values, so the cams didn't seem to have an effect on ideal injection timing, at least that I could detect.

As far as fixing that low end hole, all we changed was section 1/2/3 exhaust and nothing else on the car. Previously had the BW "race" single exhaust which has a giant 3.5" merge shortly after the headers. I suspected this was causing the low end issue, so we went back to OEM Euro section 1/2, and SS Race sec 3, which was his old setup (before the 288/280 and Karbonius box). This car has always had OEM Euro headers.

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Hey BBR, thanks for the update! :thumbsup2:

It's very interesting to see the effect of a different exhaust setup has with these 288/280's. As you've said, massive gain in low end, but significantly detrimental to top end. I guess from your findings, it suggests the optimal setup would likely be a free flowing 3.5" system with x-merge at the same spot as stock.

On my own, I was finally able to iron out the 5500 dip through a combination of Vanos and fuel/ignition adjustment. Interestingly, my Vanos maps are very similar to where you were with the BW exhaust setup (at least mid-upper RPM). I'm running Scorpion de-cat's on mine where the Euro cats normally sit, so you could be right about the Euro Cats accounting for the loss of top end. Vanos Exhaust side, i'm just 1-2deg away at all points, and I also have that 'odd' transition to more advance at 5-5500, then back towards more retard at upper RPM. Intake side, i'm roughly +3deg more retarded from 5000 but peaking 8000 with the same value.

I've just bought some uprated injectors for it, so will be getting things dialled in once again with these. Won't be running anywhere near the duty required from them, but they will allow for future upgrades. I'll be back on the Dyno with them, so will make sure to get a copy of the latest plots and post an update :)

BBRTuning Thu, Mar-09-2017, 12:17:46 AM

Hey BBR, thanks for the update! :thumbsup2:

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Yes, I agree about the exhaust! Or, at least a stock style exhaust with no cats or high-flows. I'm working on getting an exhaust backpressure sensor fitted on my car to see how detrimental the OEM euro cats are to flow at high RPM. Planning on modifying the EGR valve for this purpose since I have that port blocked off anyway. For an engine like this we want to minimise exhaust backpressure at high RPM as much as possible, ideally less than 1 PSI although I have a feeling it's quite a bit higher than that. i'm still on stock cams, so any significant pressure I measure will only be worse with larger cams!

Very cool to hear how close the cam timings are, I suppose that's a great sign! Were you able to recover some of that dip by advancing the timing a bit in that area? I'd think in theory if BMEP is dropping at that point due to VE, that the timing can be advanced a bit more. In practise I haven't always found this to be the case though, or at least it hasn't made much of a measurable difference.

Keep forgetting we're using different injectors which explains the difference in injection angle values. Curious what injector size you end up with and what injection angle numbers you find work best! Maybe with this info we can finally know exactly how the end angle table is used by the DME.

SliM3 Thu, Mar-09-2017, 10:43:05 AM

Maybe with this info we can finally know exactly how the end angle table is used by the DME.

Not much in the function description. I really need to go back through the disassembly.

1.6 Injection

The injection end time is calculated relatively close to intake valve closing, ie. Injection end time at 200°
CA is actually 200° CA before the intake valve closes. There is one constant for each of the injection end time operating states as follows:
K_TI_ENDE_MAN
K_TI_ENDE_START
K_TI_ENDE_VL
KL_TI_ENDE_0(bis 5)
K_TI_ENDE_11

K_TIENDE_START - End of injection at start
K_TIENDE_TMOT - Engine temperature threshold for end of injection
K_TIENDE_TMOT_HYS - Engine temperature hysteresis for end of injection
K_TIENDE_TAU - Time constant tau for end of injection
K_TIENDE_TAU1 - Time constant tau1 for end of injection
K_TIENDE_N_TAU - Engine speed threshold for tau end of injection
K_TIENDE_TAU2 - Tau for end of injection

SliM3 Thu, Mar-09-2017, 02:18:10 PM

Thought I'd jump in here if you guys don't mind :thumbsup2:

Here are my current VANOS maps with values for intake = ATDC / exhaust = ABDC. No dyno yet but I'm mainly going by AFR's and throttle response, both in light and heavy loads @ low engine speeds. I idle right around 13.5, cruise at about 13:1, and accel enrichment usually averages about 11-10.5:1. My full load maps stay between 13-12.5:1.

As far as tuning the maps, I kept the CSL intake pretty much the same, up to about 6k where I roughly added about 8-9° of retard. I did take some of the overlap out at mid cruise loads by retarding about 4-5°. Since anti-bucking is disabled in the CSL tune I need to work on tip-in while in sport mode, because when I hit a bump just right, THIS:
Guy crashes zero turn mower funny - YouTube

:lolhit::lolhit:

Exhaust is pretty much the same as well, with the higher loads advanced a bit more to take advantage of scavenging while rolling catless. I also have my exhaust coated from headers to tips, so that also helps tremendously with scavenging.

So far so good, but as mentioned @ higher engine speeds the engine really screams. I really have to pay attention to rpms because I hate bouncing the engine off the limiter.

http://i45.photobucket.com/albums/f90/bmech211
/current%20vanos%20maps_3-9-17_zpskmwlybgd.jpg

Olza Thu, Mar-09-2017, 02:35:38 PM

so for non HP versions we have:
K_TIENDE_N_TAU 0 (0 rpm) - speed threshold for low pass filter TAU.
K_TIENDE_TAU 30 (0.1172) - that low pass filter TAU. 0 means quick current-to-target switch, 0.99 means slow.

K_TIENDE_TMOT 8 (-40 oC) - temp threshold for using "warming" TIENDE table KL_TI_ENDE_N
K_TIENDE_TAU1 127 (0.4960) - low pass filter TAU while engine cranking until that K_TIENDE_N_TAU threshold switch TAU to K_TIENDE_TAU
320, 720, 3520, 4000, 4520, 6000,10000 rpm x 400, 400, 400, 360, 339.6, 308.6, 308.6 degree. -40 oC means this table never, khm-khm, used.

main table is KF_TI_ENDE_N_RF. important, intake vanos current position (EVAN_IST) subtracted from table value = TIENDE.
range is ONLY below 720 degrees.
filtering occurs using TAU from old value to target value.
then TIENDE_x calculates:
initial base angles for final per-cylinder calculations are 0, 480, 240, 600, 120, 360.
(91.5 + (0-TIENDE), this should be in 0-720 range) * 256 / 60 = TIENDE_1
(91.5 + (480-TIENDE), this should be in 0-720 range) * 256 / 60 = TIENDE_2
(91.5 + (240-TIENDE), this should be in 0-720 range) * 256 / 60 = TIENDE_3
(91.5 + (600-TIENDE), this should be in 0-720 range) * 256 / 60 = TIENDE_4
(91.5 + (120-TIENDE), this should be in 0-720 range) * 256 / 60 = TIENDE_5
(91.5 + (360-TIENDE), this should be in 0-720 range) * 256 / 60 = TIENDE_6

also TI_ENDE_MIN calculated: 500, 800, 1200, 2000, 3000, 4000, 6000 rpm x 190, 190, 190, 190, 190, 190, 190 degree. TI_ENDE_MIN-EVAN_IST between 0 and 720 degree.

and my questions is, as i am mainly in MSS50 S50B32 now:
why end of injection values so different?
and what if i will use MSS54's ones?

http://i64.tinypic.com/2epqzap.jpg
tune related, can i just try to decrease about 10-40 degrees in some ranges?

Olza Thu, Mar-09-2017, 02:56:58 PM

SliM3, how can you use more than intake vanos 60 degrees? its limited by 0 .. 60, no?

EDIT: oops, you added 70 degrees, why?

SliM3 Thu, Mar-09-2017, 03:12:56 PM

SliM3, how can you use more than intake vanos 60 degrees? its limited by 0 .. 60, no?

EDIT: oops, you added 70 degrees, why?

Olza, just personal preference on how I like to read the values. I prefer actual peak lift/crank degrees as opposed to the VANOS spread. From there I can calculate when "true" opening and closing of the valves occurs.

Thanks for that info on the injection end angles. The US/Euro's are also different from the CSL, but from my understanding the maps are set conservatively for emissions purposes. You stand the chance of increasing hydrocarbons the more fuel you fire into an open valve as opposed to firing on a closed one.

paulclaude Fri, Mar-10-2017, 06:06:00 AM

Yes, I agree about the exhaust! Or, at least a stock style exhaust with no cats or high-flows. I'm working on getting an exhaust backpressure sensor fitted on my car to see how detrimental the OEM euro cats are to flow at high RPM. Planning on modifying the EGR valve for this purpose since I have that port blocked off anyway. For an engine like this we want to minimise exhaust backpressure at high RPM as much as possible, ideally less than 1 PSI although I have a feeling it's quite a bit higher than that. i'm still on stock cams, so any significant pressure I measure will only be worse with larger cams!

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Keep forgetting we're using different injectors which explains the difference in injection angle values. Curious what injector size you end up with and what injection angle numbers you find work best! Maybe with this info we can finally know exactly how the end angle table is used by the DME.

The back pressure sensor should yield some interesting data BBR, sounds good.

Regarding the dip, I was able to visualise it in the power curve by logging airflow on the road. A combination of increased vanos advance both exhaust and intake side, along with a little more and fuel and ignition did the trick and pulled it out. I'll verify it next Dyno - certainly logs now look much flatter and the slight flat spot I could feel before at that rpm is now gone, so it's definitely improved, at least :thumbsup2:

Injector wise, i've gone for EV14's rated 550cc @ 3bar - which is around 700cc @ 5bar. Way above requirements for this setup, but should allow plenty of head room for future modifications.

Thought I'd jump in here if you guys don't mind :thumbsup2:

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So far so good, but as mentioned @ higher engine speeds the engine really screams. I really have to pay attention to rpms because I hate bouncing the engine off the limiter.

Brian - interesting approach Vanos target wise. In comparison, i've taken the exact opposite with the 288/280's mid-top end (increased intake advance, and exhaust retard). I assume this is with your stock cams? Look forward to seeing your Dyno results :)

SliM3 Fri, Mar-10-2017, 09:22:52 PM

Paul, this is for the 288/280's.

My rationale for setting the intake retard is based (loosely) on mach index numbers. The best way it was explained was like this:

Picture holding a ball attached to a rubber band, the ball representing the intake charge, rubber band representing differential pressure & your hand representing the piston. When you raise your hand slowly the ball will pretty much follow the rubber band at the same rate of speed. This is representative of engine speeds around 2000-3500 where cylinder filling follows closely behind the piston, thus early closing is ideal so you don't push the charge back into the intake. Of course you get the benefit of increasing dynamic compression.

Now, if you were to "snatch" your hand upwards, the rubber band will stretch before the ball begins to move. But, once it starts moving it'll travel at a much faster rate and build-up a lot of inertia. This would be representative of 7000+ rpm and late valve opening, taking advantage of the inertia once the intake charge really starts moving.

As far as exhaust, I'm trying to guesstimate the point at which the piston outruns expansion, since there's really no more power to extract.

Of course all theory, but I'll definitely get a dyno REAL SOON. Looking forward to comparing our numbers.

paulclaude Sat, Mar-11-2017, 12:02:33 PM

The theory of course makes perfect sense Brian :) I can't say i've tried this approach myself with these cams, so look forward to seeing your Dyno results!

Another benefit of pushing the cams towards increased inlet retard/exhaust advance at upper rpm, is the ability to run more ignition timing and less tendency to knock. With the opposite approach, increased intake advance at upper rpm tends to make the motor have more tendency to knock, along with increased exhaust retard demanding more fuel.

SliM3 Sun, Mar-19-2017, 02:34:56 PM

Hey guys refresh my memory, what are your cruise, accel enrichment & full load afr's?

I've got mine down to about 13.5 in cruise, hard accel will net about 11:1 then taper down to 12-12.3:1. @ full load. The engine seems to really like running rich compared to maintaining stock values with these cams. I've yet to get any detonation with aggressive timing, so I do think the ceramic coating is helping in that regard.

I also notice that the cams/engine like to run @ 3500-4000. Been doing a lot of cruising in 4th @ highway speed, around 3500-3800 rpm. It just hums along until I stab it!

Got with the guys up at Technica Motorsports and they're going to let me throw the car on the dyno for some power runs this Thursday, so I'll have some numbers, good or bad, to share.

Also guys, what about your clearances? I know Cat/Schrick say .25mm (.010" thereabouts) but I set mine on the tighter side this time, around .008". Seems a little more "peppier" compared to the last set of 280/272's @ .010". I was trying to chase down that racket in the video (I believe it's the JE's rocking and slapping), but you can hear the valves at .008", quiet IMO. Do you guys think it's OK to maintain such tight clearance if I'm not having any issues?

https://youtu.be/QU49mK_BfJU

ZiMMie Sun, Mar-19-2017, 03:25:00 PM

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https://youtu.be/QU49mK_BfJU
Is that during cold start up?

My JE have a slight slap when cold but goes away after a min of running..

Do you have a light weight flywheel?

Sent from my Robin using Tapatalk

SliM3 Sun, Mar-19-2017, 03:40:27 PM

Is that during cold start up?

My JE have a slight slap when cold but goes away after a min of running..

Do you have a light weight flywheel?

Sent from my Robin using Tapatalk

Actually that's a little after warm-up and extended idle. Oil temps were still relatively low, as well as coolant temp. It goes away once i get some heat into them, but will still linger around 1500-1800. Stock DMF!

On first cold start, it does sound like a tractor for a quick second!

Forgot to mention but I had my cylinders bored based on coated piston measurements. Prolly should've waited to coat till after, as I'm sure some of it has burnished away. Been able to go a full 500 miles on this rebuild so far, believe or not.

Sent from my iPhone using Tapatalk

ZiMMie Sun, Mar-19-2017, 05:27:46 PM

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Sent from my iPhone using Tapatalk
Ahhh.. Its a little more slappy compared to mine. The cams and call tune may have something to do with it tho.

I have the exact same setup minus the cams, and running stock Euro tune.. I'll try to get u a video on the weekend.

Can't wait to throw in cams and airbox again.

SliM3 Sun, Mar-19-2017, 05:50:20 PM

Another question: does low compression affect afr's? Mine are consistent between both banks, just curious if that could be a telltale sign in general.

Sent from my iPhone using Tapatalk

comp Tue, Mar-21-2017, 06:31:42 PM

Hey guys refresh my memory, what are your cruise, accel enrichment & full load afr's?

I've got mine down to about 13.5 in cruise, hard accel will net about 11:1 then taper down to 12-12.3:1. @ full load. The engine seems to really like running rich compared to maintaining stock values with these cams. I've yet to get any detonation with aggressive timing, so I do think the ceramic coating is helping in that regard.

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I got my AFR to 14.7 in closed loop and open loop for cruise and 12.5....12.0 at full load.
But I had to rework accelleration enrichment, part load tabel, moment manger, etc for getting a propper setup with those cam's.
After fixing part load, accel enrichment needed to be adjust because at some rpm AFR went to

below 10.0 causing stuttering.
For ignition timing I can achive 25...27 ign. advance between 6000 and 8000 rpm but need to get down to ~24 at 6700 due to knock detection.
I needed to do cylinder specific full trim to achiev that values.

I don't have that rattling sound at Idel, but some vanos rattling in a dedicated mid rev band.

FlyItLikeARenta Sat, Apr-01-2017, 03:35:05 PM

Sli, I also have the tractor noises when my motor is cold... Same, JE 87.5mm bore, sounds horrible, but mine quietens down after about a minute of idling.

paulclaude Wed, Sep-06-2017, 12:08:53 PM

Update - I finally found the time to get down to the Dyno to dial in my new AEM Infinity Standalone ECU. This really is a fantastic piece of kit - I spent a few hours setting up the Fuel/Ignition and Vanos at all load points, using the dyno to it's full potential. Real time adjustments make this a joy!

Drive-ability with the AEM after setup is just excellent, and the power is so consistent. I'm very pleased with the result! Engine spec and result is as follows;

Schrick 288/280 Camshafts
BW Street/Track 3.5" Single Exhaust
Scorpion Decat Section 1
Karbonius CSL Intake
Bosch EV14 550cc Injectors

https://i.imgur.com/5h42EwV.jpg

https://imgur.com/5h42EwV

As you can see, it really holds onto that torque up to max RPM and you can most certainly feel it on the road. Limiter was set at 8100rpm, although it is still climbing so there is another few HP there. I wanted to keep it in the safe zone at the moment until I get round to changing the rod bearings. MBT ignition value with the AEM was found at 22deg which is much lower than the targets on the stock DME. I assume this is due to how the ECU translates the actual ignition values. My intake and exhaust Vanos values ended up fairly close to where I was previously on the stock DME, 18deg of advance on the intake cam and 27deg of retard exhaust side @ max RPM target. AFR wise, the AEM uses dual wideband lambdas and after setting the main VE map, I targeted 12.6:1 at upper RPM which was where it wanted to be for best output.

Thanks to Beau (BBRTuning) for helping me out with the base map, and also Dave at SOS motorsport (Scotland) for running the dyno while I got it all dialed in :thumbsup2:

Bert ///M3 Wed, Sep-06-2017, 05:29:25 PM

Nice work, the graph looks really good, flat torque curve.

Just a question about the results. What is this 372 HP measured in? Fly or WHP?

It seems very high for a whp figure but very low for a fly figure with the mods you have listed.

Ie 372 fly on Schrick cams, we run them on stock cams and get around 370 HP in most cases, bit dependant on the exhaust setup.

On the other side 372 WHP would equate to roughly 440 HP fly which is kind of high. (390-400 is what you would be looking at with your supporting mods)

I wonder about this 22 degrees ignition advance. Usually when you advance intake vanos you need to back off a bit on the ign because you are closing the intake valves earlier increasing dynamic compression. But usually they sit around 26ish degrees. This is on stock cams though, not sure on how Schrick cams alter this precisely. But I wonder if additional power can be found if retard your inlet vanos a bit and try running more ignition advance.

paulclaude Thu, Sep-07-2017, 07:10:56 AM

Nice work, the graph looks really good, flat torque curve.

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Ie 372 fly on Schrick cams, we run them on stock cams and get around 370 HP in most cases, bit dependant on the exhaust setup.

On the other side 372 WHP would equate to roughly 440 HP fly which is kind of high. (390-400 is what you would be looking at with your supporting mods)

I wonder about this 22 degrees ignition advance. Usually when you advance intake vanos you need to back off a bit on the ign because you are closing the intake valves earlier increasing dynamic compression. But usually they sit around 26ish degrees. This is on stock cams though, not sure on how Schrick cams alter this precisely. But I wonder if additional power can be found if retard your inlet vanos a bit and try running more ignition advance.

Thanks :)

This is a UK Dyno Dynamics dyno, so the result is flywheel corrected. WHP figure was around 320. As I always say, you can't directly compare figures from dyno to dyno due to different calibrations, so it's the delta that matters. For example, there is a Dynojet readout of a 288/280 cam'd S54 earlier in this thread making 371 'WHP' (Nickpipers).

As a comparison however, I've tuned several S54's on this same dyno and standard euro spec engines usually put out 310-320 corrected. Engines with CSL intake and stock cams usually make around 340-350 after tuning, although I did have one recently only doing 331 with a 3" single exit system. This result of 372 is actually the highest figure for an S54 we've had on there. This particular engine did 315 bone stock on this same dyno, so it's come a long way!

With regards to the timing, I believe the ignition sync differences on the infinity ECU results in the ignition targets being different to the stock DME, so again you can't directly compare. My previous result on the stock DME with the cams was 362HP (earlier in this thread) and I was targeting a much higher ignition value.

FWIW, any significant camshaft retard at upper RPM resulted in a fair drop in peak HP that couldn't be regained through ignition timing advance. The 288 inlet cam demands a fairly advanced vanos target at peak for best power output/optimum intake closing point.

Bert ///M3 Thu, Sep-07-2017, 06:43:04 PM

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That is clear :)

Actually funny to see that it makes 10HP more on the Infinity ECU rather than using the stock DME. Is that just the result of more finetuning or a physical difference in the way the ECU operates? I imagine there is a lot less correction parameters in trhat ECU that make extracting more power easier.