KELFORD CAMS
POWER UNLEASHED

Sole Purpose of Degreeing Your Cams

To Achieve Correct Valve Opening & Closing Points for Your Engine

All of our new camshafts are ground to exact specification using the latest CNC machining processes but there are other factors that can cause incorrect camshaft to crankshaft phasing.

Such as:

- Cam or crank gears are incorrectly marked.
- Keyways are out of position on gears.
- Keyway in the crankshaft is miss-indexed.
- On SOHC & DOHC engines, milling the head or the block will retard the cam(s)

On SOHC rocker arm style engines, valve tip length, rocker geometry and base circle size will effect lobe separation, therefore effecting valve events.
Thus properly degreeing your cam is essential.

Before You Start To Degree Your Cam:

Assuming that you have carried out all of the preliminary static measurements and clearance checks for valve to valve, valve to piston, retainer to stem seal, cam to head casting, cam to con-rod, spring seat pressure, distance to coil bind at full lift etc, all parts are clean, and lightly oiled you are ready to start dialing in your camshaft.

Lifter Setup Instructions:

Be absolutely certain that you use the correct type of lifter for the camshaft that is being Degreed. Hydraulic lifters must never be used when degreeing cams, they can bleed down and give you false readings.

For Pushrod style engines this is easy, if your camshaft choice is hydraulic roller or hydraulic flat tappet, simply purchase a solid equivalent of your lifter. Install a pushrod that has an oil hole in it, so that the tip of the dial indicator locates properly in the end of the pushrod.

For over head cam engines that have hydraulic cam buckets, such as Nissan RB20 or Suzuki G13B or for over head cam engines with rocker arms and hydraulic lifters, such as Mitsubishi 4G63 or Nissan SR20, you will need to make a solid lifter that gives 0.1mm valve clearance when the cam is on the base circle. This is easiest done by pulling the plunger out of a hydraulic lifter and replacing it with a piece of turned silver steel (or similar) that sits properly inside the lifter body and is shaped at the valve end to clear the retainer and give a perfect flat contact to the valve tip.

(Remember to take it back out once you are done and put the proper hydraulic lifter back in)

Equipment Required:

Properly Degree Your Camshaft:

Degree Wheel


Dial Indicator

TDC FindingTool


Mounted Pointer

Equipment Rundown:

1. Degree Wheel
2. Metric or imperial dial indicator and method of mounting it to the head or block
3. Positive stop TDC finding tool (either the spark plug type or a block mounted type)
4. Rigidly mounted pointer to indicate degree wheel position

Camshaft Degree Wheel Installation Set up:

Mounting the Degree Wheel:

1. Attach the degree wheel to the flywheel or to the front pulley of the engine ensuring that you still have a method of manually rotating the engine.

2. Attach the pointer to the engine ensuring that it is rigid and won't move if you accidentally bump it.

Finding Top Dead Center (TDC):

1. Rotate the crankshaft until you get number one piston as close as possible to TDC. Next, adjust your pointer to the zero TDC position on the degree wheel.

2. It is essential at this point that you have some means of rotating the crank that will not interfere with the degree wheel. The crank can be rotated from either the front or the flywheel end. The greater the leverage, the smoother you can rotate the crank for timing checks. (Do not use the starter for turning the engine while degreeing).

3. Now that the Degree Wheel has been set at approximate TDC, and a means for turning the crank provided, you're ready to install and set the piston stop.Turn the crankshaft (in the normal direction of rotation) to lower the piston enough in the cylinder to move the degree wheel 15-20 degrees, screw in the piston stop until it contacts the piston, Turn the engine in the normal direction of rotation until the piston comes back up and touches the piston stop.

- Make a note of what degree the pointer is on the degree wheel.

- Turn the engine in the opposite direction until the piston comes back up and touches the piston stop again.

- Make a note of what degree the pointer is on the degree wheel.

- Add these two numbers together then divide them in half. For example: Let's say that the stop points are 16° in one direction and 20° in the opposite direction. The total would be 36 degrees. This figure divided in half would be 18 degrees. Therefore 18 degrees from either of your stop points is true top dead center.

- Now either move the pointer to align with the 18 degree mark on the degree wheel, or carefully loosen the degree wheel (without disturbing the position of the crankshaft) and move the degree wheel to the 18 degree mark, making sure that the piston is still against the stop.

Always double check measurements and readings. Repeat the procedure above until you get the same amount of degrees on both sides of TDC. Remove your piston stop and you are ready to properly degree your cam.

Mounting the Dial Gauge:

- For pushrod style engines mount the dial gauge to something solid that won't flex or move.

- Install a pushrod that has an oil hole in it as this will properly locate the tip of the dial indicator.

- It is important that the indicator plunger be aligned as closely as possible with the lifter being measured, any substantial angle between the axis of the plunger and the lifter will introduce geometrical errors into the lift readings.

- With the cam on the base circle set the dial gauge to zero with enough preload that the gauge is held firmly but not so much preload that you bind the gauge on full lift.

- Rotate the engine slowly in the proper direction of rotation and make sure that the dial gauge moves freely up and over full lift and back to the zero position. If it doesn't return to zero, there are several possible causes:

1. The dial indicator may not be mounted rigidly

2. The lifter may not be contacting the base circle properly

3. The lifter could be sticking slightly in its bore.

4. Find the trouble and correct it before proceeding.

Cam Specification Card:

All the information you need for checking valve timing of your engine is provided on the specification card that you receive with your new Kelford cam. This will include the opening and closing timing points and the amount of lift at the lifter or at the valve (depending on engine type) at which the timing should be checked. It will include Cam lift, rocker ratio, Net valve lift, valve lash (tappet clearance) and more.

The Correct Method:

The method we use below is the correct method to accurately degree your cam to achieve the proper valve opening and closing events.We have split the method into two engine types to give proper examples. Pushrod engines and Over head cam engines.

Pushrod Engines

1. Using the intake opening and closing at .050″ cam lift, obtained from the information on your cam spec card, turn the engine in the normal direction of rotation. Watch the dial indicator. When it moves up .050″, stop rotating the engine.

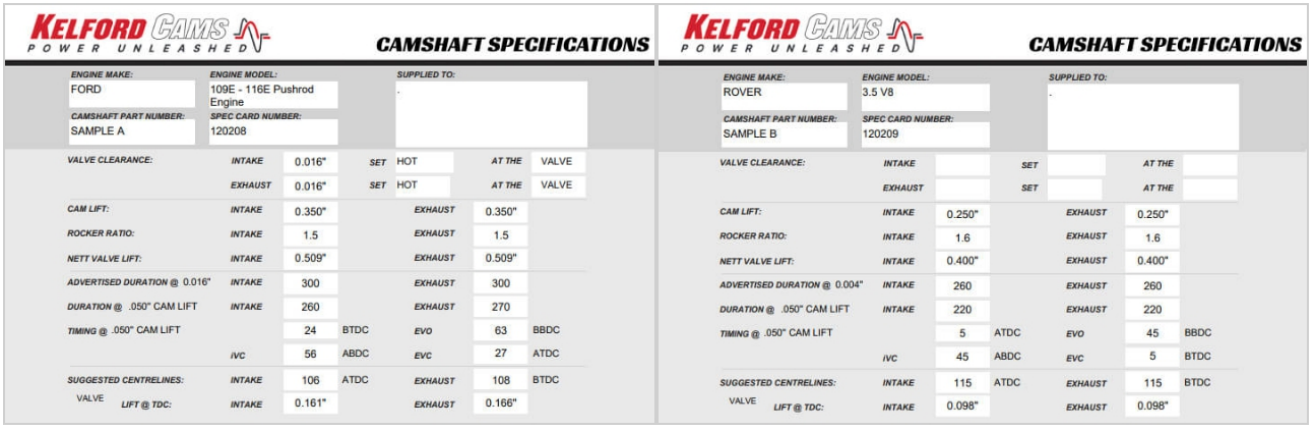
2. Record the degree wheel number that the pointer is on. (In our example spec card ‘A’ it is 24° BTDC).

3. Continue to rotate the engine in the same direction. Watch the dial indicator; it will change direction at maximum lobe lift. Record the cam lobe lift, this should match the cam lift figure on your spec card (.350″ in the example of Spec card ‘A’).

4. Continue to rotate the engine in the same direction (counting down) until you are .050″ before closing. Again record the degree wheel number that the pointer is on. (In example ‘A’ it is 56° ABDC)

5. Continue down to zero lift and verify that the dial indicator has returned to zero. The opening and closing figures should be within ±1 degree.

6. At this point we check the duration and centerline by adding the Intake Opening (IO) point before TDC plus 180 degrees of crank rotation to get us to BDC plus the Intake Closing (IC) point in degrees ABDC so using the figures on spec card ‘A’ we calculate as follows, 24+180+56 = 260 degrees of intake duration at .050″ cam lift. This figure should match the duration figure on your spec card, 260 degrees divided by two less the intake opening gives you the centerline number that should match your spec card e.g.; 260/2-24=106degrees ATDC.



KELFORD CAMS POWER UNLEASHED — CAMSHAFT SPECIFICATIONS

ENGINE MAKE:	ENGINE MODEL:	SUPPLIED TO:
FORD	109E - 116E Pushrod Engine	.
CAMSHAFT PART NUMBER:	SPEC CARD NUMBER:	
SAMPLE A	120208	

VALVE CLEARANCE:	INTAKE	0.016"	SET	HOT	AT THE	VALVE		
	EXHAUST	0.016"	SET	HOT	AT THE	VALVE		
CAM LIFT:	INTAKE	0.350"			EXHAUST	0.350"		
ROCKER RATIO:	INTAKE	1.5			EXHAUST	1.5		
NETT VALVE LIFT:	INTAKE	0.509"			EXHAUST	0.509"		
ADVERTISED DURATION @ 0.016"	INTAKE	300			EXHAUST	300		
DURATION @ .050" CAM LIFT	INTAKE	260			EXHAUST	270		
TIMING @ .050" CAM LIFT		24	BTDC		EVO	63	BBDC	
	IVC	56	ABDC		EVC	27	ATDC	
SUGGESTED CENTRELINES:	INTAKE	106	ATDC		EXHAUST	108	BTDC	
VALVE LIFT @ TDC:	INTAKE	0.161"			EXHAUST	0.166"		

KELFORD CAMS POWER UNLEASHED — CAMSHAFT SPECIFICATIONS

ENGINE MAKE:	ENGINE MODEL:	SUPPLIED TO:
ROVER	3.5 V8	.
CAMSHAFT PART NUMBER:	SPEC CARD NUMBER:	
SAMPLE B	120209	

VALVE CLEARANCE:	INTAKE		SET		AT THE			
	EXHAUST		SET		AT THE			
CAM LIFT:	INTAKE	0.250"			EXHAUST	0.250"		
ROCKER RATIO:	INTAKE	1.6			EXHAUST	1.6		
NETT VALVE LIFT:	INTAKE	0.400"			EXHAUST	0.400"		
ADVERTISED DURATION @ 0.004"	INTAKE	260			EXHAUST	260		
DURATION @ .050" CAM LIFT	INTAKE	220			EXHAUST	220		
TIMING @ .050" CAM LIFT		5	ATDC		EVO	45	BBDC	
	IVC	45	ABDC		EVC	5	BTDC	
SUGGESTED CENTRELINES:	INTAKE	115	ATDC		EXHAUST	115	BTDC	
VALVE LIFT @ TDC:	INTAKE	0.098"			EXHAUST	0.098"		

Full Size Spec Card Example Reference Attached to End of Article

7. If the camshaft has a short duration and / or late valve events like the one in the example spec card ‘B”, the Intake Opening point could be ATDC in which case the equation to find duration is: 180 degrees from TDC to BDC, less the Intake Opening point in degrees ATDC plus the Intake Closing point in degrees ABDC. For example ‘B’ Inlet Opens 5 degrees ATDC,

Inlet Closes 45 degrees ABDC the equation is 180-5+45=220 degrees of cam duration at .050″ cam lift.

8. To find the centerline figure the equation is: Duration divided by two, plus the Inlet Opening point example 'B' would then be: 220/2+5= 115 degrees ATDC centerline. If the duration matches but the centerline figure and open and close events do not, you will need to advance or retard the cam to achieve the correct result.

9. Go through the procedure again until you are within one degree of where you want to be (preferably on the advanced side if anything to allow for chain / belt stretch during operation).

10. Depending on the engine being used, there are usually offset bushings, offset keys, or multi-indexed gears to accomplish this movement.

11. Once you are happy, move to the exhaust and repeat the process. Using spec card A we have an Exhaust Opening (EO) of 63 degrees BBDC and an Exhaust Closing (EC) of 27 degrees ATDC, the equation is 63+27+180 = 270 degrees of exhaust duration at .050″ cam lift, to find the centerline as a double check, the formula is duration divided by two less exhaust opening; 270/2-27 = 108 degrees BTDC. If your intake is set correctly the exhaust should match the spec card as well unless there is a variation in the separation.

12. To find separation, simply add the intake and exhaust centerline and divide by two.

13. As a triple check, measure the valve lift at TDC, and this should also match the card.

14. Once you are happy with the cam timing, you are ready to final check valve to piston clearance. (See V to P instruction)

Single and Double Over Head Cam Engines:

1. For these types of engines, Kelford Cams spec cards list duration, opening and closing events at the valve (unless otherwise stated by us)
2. The setup procedure is the same as listed above except that the dial gauge will often need a long extension to reach down beside the cam lobe to contact either the spring retainer (in the case of a rocker arm engine) or the cam bucket (in the case of a direct bucket OHC engine)
3. For mechanical lifter over head camshafts all readings are taken with the valve lash set to the proper clearance as specified by the cam card.
4. For hydraulic lifter over head camshafts, use a mechanical lifter for checking and set clearance to zero (remember to replace the checking lifter with the proper lifter once all checking is complete).
5. Turn the engine in the direction of rotation until you reach 1.00mm valve lift on the dial indicator, record the figure on the degree wheel, continue to rotate in proper direction counting up to full valve lift.
6. Record the full valve lift figure; this should match the figure on your spec card. Continue to rotate in proper direction, counting down from full lift until you are 1.00mm away from fully closed, record the degree wheel figure.

As an example spec card ‘C’ gives an Intake Valve Opening (IVO) of 4 degrees BTDC and Intake Valve Closing (IVC) of 46 degrees ABDC.

KELFORD CAMS POWER UNLEASHED — CAMSHAFT SPECIFICATIONS

ENGINE MAKE:	MITSUBISHI	ENGINE MODEL:	4G63 EVO 8	SUPPLIED TO:	.			
CAMSHAFT PART NUMBER:	SAMPLE C	SPEC CARD NUMBER:	120274					
VALVE CLEARANCE:	INTAKE		SET		AT THE			
	EXHAUST		SET		AT THE			
CAM LIFT:	INTAKE	7.10mm		EXHAUST	6.70mm			
ROCKER RATIO:	INTAKE	1.7		EXHAUST	1.7			
NETT VALVE LIFT:	INTAKE	12.07mm		EXHAUST	11.39mm			
ADVERTISED DURATION @ 0.10mm	INTAKE	270		EXHAUST	260			
DURATION @ 1.00mm VALVE LIFT	INTAKE	230		EXHAUST	216			
TIMING @ 1.00mm VALVE LIFT		4	BTDC	EVO	38	BBDC		
	IVC	46	ABDC	EVC	2	BTDC		
SUGGESTED CENTRELINES:	INTAKE	111	ATDC	EXHAUST	110	BTDC		
LIFT @ TDC:	INTAKE			EXHAUST				

KELFORD CAMS POWER UNLEASHED — CAMSHAFT SPECIFICATIONS

ENGINE MAKE:	NISSAN	ENGINE MODEL:	SR20 DET	SUPPLIED TO:				
CAMSHAFT PART NUMBER:	SAMPLE D	SPEC CARD NUMBER:	120275					
VALVE CLEARANCE:	INTAKE		SET		AT THE			
	EXHAUST		SET		AT THE			
CAM LIFT:	INTAKE	7.50mm		EXHAUST	7.50mm			
ROCKER RATIO:	INTAKE	1.55		EXHAUST	1.55			
NETT VALVE LIFT:	INTAKE	11.63mm		EXHAUST	11.63mm			
ADVERTISED DURATION @ 0.10mm	INTAKE	252		EXHAUST	260			
DURATION @ 1.00mm VALVE LIFT	INTAKE	210		EXHAUST	218			
TIMING @ 1.00mm VALVE LIFT		8	ATDC	EVO	46	BBDC		
	IVC	38	ABDC	EVC	8	BTDC		
SUGGESTED CENTRELINES:	INTAKE	113	ATDC	EXHAUST	117	BTDC		
LIFT @ TDC:	INTAKE			EXHAUST				

Full Size Spec Card Example Reference Attached to End of Article

7. To find duration, the formula is IVO of 4 degrees BTDC plus 180 degrees to get to BDC plus 46 degrees to the IVC point ABDC; 4+180+46 = 230 degrees of duration at the valve at 1.00mm checking height.

8. Use this formula to check that your measured duration matches your spec card.

9. The formula to find the centerline of the intake in example ‘C’ is, duration divided by two less IVO; 230/2-4 = 111 degrees ATDC, this should match the figure on your spec card, if it doesn’t you will need to advance or retard the cam and repeat the procedure until it is correct.
10. Once you are happy, move to the exhaust and repeat the process. Using spec card C we have an Exhaust Valve Opening (EVO) of 38 degrees BBDC and an Exhaust Valve Closing (EVC) of 2 degrees BTDC, the equation is 38+180-2 = 216 degrees of exhaust duration at 1.00mm valve lift.
11. To find the centerline as a double check, the formula is duration divided by two plus exhaust closing; 216/2+2 = 110 degrees BTDC.
12. If the camshaft has a short duration and / or late valve events like the one in the example spec card ‘D”, the Intake Opening point could be ATDC in which case the equation to find duration is: 180 degrees (from TDC to BDC), less the Intake Opening point in degrees ATDC plus the Intake Closing point in degrees ABDC.
13. For example ‘D’ Inlet Opens 8 degrees ATDC, Inlet Closes 38 degrees ABDC the equation is 180-8+38=210 degrees of duration at 1.00mm valve lift.
14. To find the centerline figure the equation is: Duration divided by two, plus the Inlet Opening point example ‘D’ would then be: 210/2+8= 113 ATDC centerline.
15. Once you are satisfied that the intake is correct move to the exhaust and repeat the process. Using spec card D we have an Exhaust Opening (EO) of 46 degrees BBDC and an Exhaust Closing (EC) of 8 degrees BTDC, the equation is 180-8+46 = 218 degrees of exhaust duration at 1.00mm valve lift, to find the centerline as a double check, the formula is duration divided by two plus exhaust opening; 218/2+8 = 117 degrees BTDC.
16. As a triple check, measure the valve lift at TDC, and this should also match the card.

Other valuable info:

Overlap at 1.00mm valve lift from Spec card ‘C’ = IVO of 4 degrees BTDC less 2 degrees BTDC = 2 degrees at 1.00mm valve lift.

To find total overlap, check valve timing at 0.1mm valve lift as a checking height, if the valve motion is symmetrical at that lift, our example spec card cam which has a intake duration of 270 degrees and an exhaust duration of 256 degrees at 0.1mm will have valve timing events of IVO 24 BTDC / IVC 66 ABDC – EVO58 BBDC / EVC 18 ATDC giving an overlap of 24+18= 42 degrees.

Because of camshaft ramp designs the valve events at a lift as low as 0.1mm are often asymmetrical this is why we specify checking valve timing at 1.00mm or .050″ (in the case of imperial engines), it is more accurate for most people.

The Incorrect Method / Myths About the Centerline

Never use the ‘centerline’ method that zeros somewhere near full lift and then splits the difference between two readings on the degree wheel either side etc, this is not accurate.

The full lift position is not relevant to the engine it is only a quick reference figure used in dialogue amongst engine builders. Incoming intake charge or outgoing exhaust does not care where the centerline is, they only respond to filling or evacuating the cylinder based on relevant valve opening and closing events.

It is not accurate to use the centerline number to determine valve events.

It is accurate to use the valve event figures to determine a centerline number.

The problem with the centerline method is it has you finding the theoretical point of peak lift in relation to crank rotation. This method makes the assumption that the lobe or valve motion you are checking is symmetrical; with its opening side being the exact same shape as the closing side of the lobe. Most modern cam lobes are asymmetrical, with the opening side of the lobe being much more aggressive and the closing side being gentler. Therefore when you attempt to locate the middle (or centerline) of the asymmetrical lobe there is an automatic error. It could be as little as 2° or as much as 6° depending on the actual lobe design. Also, the centerline method does not really indicate if your camshaft was properly produced, as no confirmation of the duration at any given point. Our method will verify correct valve opening and closing and duration.

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CAMSHAFT SPECIFICATIONS

ENGINE MAKE:	FORD	ENGINE MODEL:	109E - 116E Pushrod Engine		SUPPLIED TO:	.	
CAMSHAFT PART NUMBER:	SAMPLE A	SPEC CARD NUMBER:	120208				
VALVE CLEARANCE:	INTAKE	0.016"	SET	HOT	AT THE	VALVE	
	EXHAUST	0.016"	SET	HOT	AT THE	VALVE	
CAM LIFT:	INTAKE	0.350"		EXHAUST	0.350"		
ROCKER RATIO:	INTAKE	1.5		EXHAUST	1.5		
NETT VALVE LIFT:	INTAKE	0.509"		EXHAUST	0.509"		
ADVERTISED DURATION @ 0.016"	INTAKE	300		EXHAUST	300		
DURATION @ .050" CAM LIFT	INTAKE	260		EXHAUST	270		
TIMING @ .050" CAM LIFT		24	BTDC	EVO	63	BBDC	
	IVC	56	ABDC	EVC	27	ATDC	
SUGGESTED CENTRELINES:	INTAKE	106	ATDC	EXHAUST	108	BTDC	
VALVE LIFT @ TDC:	INTAKE	0.161"		EXHAUST	0.166"		

KELFORD CAMS
POWER UNLEASHED

CAMSHAFT SPECIFICATIONS

ENGINE MAKE:	ROVER	ENGINE MODEL:	3.5 V8		SUPPLIED TO:	.	
CAMSHAFT PART NUMBER:	SAMPLE B	SPEC CARD NUMBER:	120209				
VALVE CLEARANCE:	INTAKE		SET		AT THE		
	EXHAUST		SET		AT THE		
CAM LIFT:	INTAKE	0.250"		EXHAUST	0.250"		
ROCKER RATIO:	INTAKE	1.6		EXHAUST	1.6		
NETT VALVE LIFT:	INTAKE	0.400"		EXHAUST	0.400"		
ADVERTISED DURATION @ 0.004"	INTAKE	260		EXHAUST	260		
DURATION @ .050" CAM LIFT	INTAKE	220		EXHAUST	220		
TIMING @ .050" CAM LIFT		5	ATDC	EVO	45	BBDC	
	IVC	45	ABDC	EVC	5	BTDC	
SUGGESTED CENTRELINES:	INTAKE	115	ATDC	EXHAUST	115	BTDC	
VALVE LIFT @ TDC:	INTAKE	0.098"		EXHAUST	0.098"		

KELFORD CAMS
POWER UNLEASHED

CAMSHAFT SPECIFICATIONS

ENGINE MAKE:	MITSUBISHI	ENGINE MODEL:	4G63 EVO 8	SUPPLIED TO:	.		
CAMSHAFT PART NUMBER:	SAMPLE C	SPEC CARD NUMBER:	120274				
VALVE CLEARANCE:	INTAKE		SET		AT THE		
	EXHAUST		SET		AT THE		
CAM LIFT:	INTAKE	7.10mm		EXHAUST	6.70mm		
ROCKER RATIO:	INTAKE	1.7		EXHAUST	1.7		
NETT VALVE LIFT:	INTAKE	12.07mm		EXHAUST	11.39mm		
ADVERTISED DURATION @ 0.10mm	INTAKE	270		EXHAUST	260		
DURATION @ 1.00mm VALVE LIFT	INTAKE	230		EXHAUST	216		
TIMING @ 1.00mm VALVE LIFT		4	BTDC	EVO	38	BBDC	
	iVC	46	ABDC	EVC	2	BTDC	
SUGGESTED CENTRELINES:	INTAKE	111	ATDC	EXHAUST	110	BTDC	
LIFT @ TDC:	INTAKE			EXHAUST			

KELFORD CAMS
POWER UNLEASHED

CAMSHAFT SPECIFICATIONS

ENGINE MAKE:	NISSAN	ENGINE MODEL:	SR20 DET	SUPPLIED TO:			
CAMSHAFT PART NUMBER:	SAMPLE D	SPEC CARD NUMBER:	120275				
VALVE CLEARANCE:	INTAKE		SET		AT THE		
	EXHAUST		SET		AT THE		
CAM LIFT:	INTAKE	7.50mm		EXHAUST	7.50mm		
ROCKER RATIO:	INTAKE	1.55		EXHAUST	1.55		
NETT VALVE LIFT:	INTAKE	11.63mm		EXHAUST	11.63mm		
ADVERTISED DURATION @ 0.10mm	INTAKE	252		EXHAUST	260		
DURATION @ 1.00mm VALVE LIFT	INTAKE	210		EXHAUST	218		
TIMING @ 1.00mm VALVE LIFT		8	ATDC	EVO	46	BBDC	
	iVC	38	ABDC	EVC	8	BTDC	
SUGGESTED CENTRELINES:	INTAKE	113	ATDC	EXHAUST	117	BTDC	
LIFT @ TDC:	INTAKE			EXHAUST			