



555-81621
Precision Degree Wheel Kit



Instruction Booklet

Instructions for 81621 Camshaft Degree Kit

Thank you for purchasing the Jegs Camshaft Degree Kit. Please follow these detailed instructions to properly degree your camshaft. Please note that there are instructions for degreasing your cam with the cylinder heads on and with the cylinder heads off. Please choose the appropriate instructions for your application. Please contact our tech department at 1-800-345-4545 with any questions.

Instructions for applications with the cylinder heads on

Mounting the degree wheel:

1. Install the timing set with the cam and crank gear aligned properly per the manufacturer's specifications.
2. Remove the rocker arms (This optional but will make the task easier).
3. Attach the degree wheel (using the supplied aluminum bushings if necessary to center the degree wheel) to the crank snout or balancer. (Figure 1)
4. Attach the pointer from your kit firmly to the engine block.

Finding Top Dead Center (TDC):

1. Rotate the crankshaft until you get number one piston in approximate TDC position. 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 degreasing).
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 to lower the piston enough in the cylinder to move the degree wheel 15-20 degrees. In the cylinder you are degreasing, screw in the piston stop until it contacts the piston. (Figure 2) Turn the engine in the same direction 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. Make a note of what degree the pointer is on the degree wheel. Add these two numbers together then divide them in half. 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. Now turn the engine in the opposite direction until the piston comes back up and touches the stop. The pointer should be aligned with the 18 degree mark on the other side of the TDC mark. If this is correct, then you have found true top dead center. It is best to repeat this to make sure that nothing has moved. If you didn't get 18°, as per the example, you will need to repeat the procedure 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 indicator:

1. When degreasing your cam with the heads on, the dial indicator will mount into a valve cover bolt hole. Remove any obstructions that would hinder this mounting. Be absolutely certain that you use the correct type of lifter for the camshaft that is being degreed. This means a flat tappet for a mechanical or hydraulic cam (do not use a hydraulic



FIGURE 1



FIGURE 2

lifter, as the plunger can move), or a mechanical roller tappet for a roller camshaft. You should also take particular care to clean off any excessive oil, grease, or lubricant from the cam lobe that you are degreeing. Even the slightest interference of such foreign matter can alter the readings that your dial indicator will show.

2a. If you will be degreeing your cam with the rocker arms off a pushrod with an oil hole is needed to be used as an extension of the dial indicator. The indicator will center in the oil hole of the pushrod tip. (**Figure 3**) On engines with pushrods that don't have oil holes such as FE Series Ford and Chrysler, you can follow step 2b. Install the pushrod in the intake lifter of cylinder No. 1 and mount 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.



FIGURE 3

2b. If you will be degreeing your cam with the rockers arms on. Set the valve lash for both the intake and exhaust to exactly zero (you should still be able to spin both push rods freely with your fingers). Mount the dial indicator so that the tip of the dial indicator is touching the tip of the retainer. It is important that the indicator plunger be aligned as closely as possible with the retainer being measured. Any substantial angle between the axis of the plunger and the retainer will introduce geometrical errors into the lift readings. (**Figure 4**)

CAUTION: Be sure that the indicator is mounted securely. Any looseness will introduce major errors in measurement.

3. With the Degree Wheel and its pointer accurately set, and the Dial Indicator solidly in place, rotate the crankshaft until the cam's base circle is under the lifter for the cam lobe being measured (usually starting with Number One intake). Set the dial indicator to zero at this point. Be sure the Dial Indicator is pre-loaded about .300" to insure that it will not run out of travel while on the base circle. Rotate the crankshaft to raise and lower the lifter several times to verify that the dial always returns to zero when the lifter is on the base circle. 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 solidly (3) The lifter could be sticking slightly in its bore. Find the trouble and correct it before proceeding. It may be necessary to apply slight finger pressure against the lifter when rotating the engine if you are degreeing your cam with the rocker arms off. Be careful not to bump the pushrod. Any of these camshaft checks that may be performed (base circle runout, cam timing, etc.) are also very dependent on your cam bearings being in good condition and providing the proper radial clearance for the type and size of bearing. Excessive radial clearance will distort your figures taken of tappet movement, resulting in incorrect conclusions regarding the camshaft installation and its condition.



FIGURE 4

Checking base circle runout:

This is a good time to check for runout of the cam's base circle. This is out of roundness, or wobble, during rotation. If the cam lobe is concentric with the camshaft bearing journals there shouldn't be any appreciable runout. If there is measurable base circle runout on your cam, adjust the dial indicator so the runout is divided equally on both sides of zero. This will give the minimum error for checking the cam's timing.

Cam specification card:

All the information you need for checking the timing accuracy and phasing of a camshaft should be provided on the specification card that you receive with your camshaft or can be obtained from the manufacturer.

Which cam degreeing method to use?:

There are two popular methods for degreeing a cam: (1) using the opening and closing figures at .050" tappet lift off the base circle of the cam; (2) using the intake centerline method. We recommend degreeing the cam using the opening and closing at .050" lift when possible as it is more accurate. When checking, always turn the engine in the normal direction of rotation because of possible slack in the timing chain or gear drive. If the cam card you are using

does not state what the intake centerline is, don't assume that any number on that spec card is the intake centerline. In most cases the lobe separation (lobe centerline) is not the same as the intake centerline. Most cam cards note this information.

Degreeing your cam:

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. Record the degree wheel number that the pointer is on. Then 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. Continue to rotate the engine in the same direction until you reach .050" before closing. (In our example it is 42° ABDC). If you go past either of the .050" marks, back up at least .100" and rotate the engine in the normal direction again until you reach the .050" mark on the indicator. Again record the degree wheel number that the pointer is on. Continue on to zero lift and verify that the dial indicator has returned to zero. The opening and closing figures should be within ±1 degree. If your figures are not within ±1 degree, go through the procedure again to check for possible error. If your opening and closing figures are still not correct you will need to move the cam in relation to the crankshaft in order to correct your opening and closing figures. If the cam is opening early, the cam is too far advanced, and will need to be moved in the opposite direction of the cam rotation. If the cam is opening late, the cam is too far retarded, and will need to be moved in the direction of cam rotation. Depending on the engine being used, there are usually offset bushings, offset keys, or multi-indexed gears to accomplish this movement. If your opening and closing figures at .050" are not the same as your cam card they should be "off" the same amount of opening as closing, and the intake and exhaust should all be "off" the same amount. If this is the case, the correct bushing or key will bring everything in place. Always recheck your opening and closing figures when moving the cam. If the opening and closing figures are not off the same amount or the intake and exhaust are not off the same, this would mean that the duration, and/or lobe separation is different than your specification card. If you have this type of problem contact your cam manufacturer for more information. Do not remove the degree wheel if you are going to check piston to valve clearance at this time. Reference the piston to valve section of these instructions.

If your cam card does not show the opening and closing at .050" lift then you must use the intake centerline method to degree your cam. To understand cam timing specifications, you must first understand the difference between intake and exhaust centerline and lobe centerline (which should be more understandably stated as lobe separation). Lobe centerline (or separation) is the distance in cam degrees between the maximum lift point (centerline) of the intake lobe and the maximum lift point (centerline) of the exhaust lobe. This separation is ground in the cam and can't be changed unless the cam is reground. Intake and exhaust centerline relates to the phasing (timing) of the cam to the crankshaft.

To locate the intake or exhaust centerline you must find maximum lift of that lobe. As in finding TDC, you must begin by using an arbitrary figure, such as thousandths of an inch instead of degrees, say .050". With the dial indicator on the intake lifter, rotate the engine in the normal direction until you reach maximum lift. This is where the dial indicator changes direction. At this point set the dial indicator at zero. Back the engine up until the dial indicator reads .100". Turn the engine back in the normal direction of rotation until the dial indicator reads .050". At this point, record the degree number that the pointer is on. Continue to rotate in the normal direction of rotation until the dial indicator goes past zero to .050" on the other side of maximum lift. Record the degree number that the pointer is on. Add the two degree numbers together and divide by two. That number will be the location of the maximum lift point of the intake lobe in relation to the crankshaft.

Once the cam is phased with the crank, per the manufacturer specs, then a baseline can be established. From that baseline of performance you can dial the cam exactly to your combination. The cam can be advanced or retarded from the card specs up to 6 degrees. Advancing the cam will move the power band down in the RPM range. (Increased low-rpm torque). Whatever you gain on the bottom end you will lose on the top. Retarding the cam will move the power band up in the RPM range. If 6 degrees is not enough, a different camshaft profile would be needed. Be aware that when you advance the cam you will lose intake piston to valve clearance, and when retarding the cam you will lose exhaust piston to valve clearance. Now would be a good time to check the cam advanced and retarded and with the highest ratio rockers you will use.

Instructions for applications with the cylinder heads off



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Mounting the degree wheel:

1. Install the timing set with the cam and crank gear aligned properly per the manufacturer's specifications.
2. Attach the degree wheel (using the supplied aluminum bushings if necessary to center the degree wheel) to the crank snout or balancer.
3. Attach the pointer from your kit firmly to the engine block.

Finding Top Dead Center (TDC):

1. Rotate the crankshaft until you get number one piston in approximate TDC position. 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 to lower the piston enough in the cylinder to move the degree wheel 15-20 degrees. Install the piston stop so that it contacts the piston. (**Figure 5**) Turn the engine in the same direction 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. Make a note of what degree the pointer is on the degree wheel. Add these two numbers together then divide them in half. 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. Now turn the engine in the opposite direction until the piston comes back up and touches the stop. The pointer should be aligned with the 18 degree mark on the other side of the TDC mark. If this is correct, then you have found true top dead center. It is best to repeat this to make sure that nothing has moved. If you didn't get 18°, as per the example, you will need to repeat the procedure 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.



FIGURE 5

Mounting the dial indicator:

1. When degreeing your cam with the heads off, the dial indicator will mount into a head bolt hole. Remove any obstructions that would hinder this mounting. Be absolutely certain that you use the correct type of lifter for the camshaft that is being degreed. This means a flat tappet for a mechanical or hydraulic cam (do not use a hydraulic lifter, as the plunger can move), or a mechanical roller tappet for a roller camshaft. You should also take particular care to clean off any excessive oil, grease, or lubricant from the cam lobe that you are degreeing. Even the slightest interference of such foreign matter can alter the readings that your dial indicator will show.

CAUTION: Be sure that the indicator is mounted securely. Any looseness will introduce major errors in measurement.

2. When degreeing your cam with the cylinder heads off, use the 5" dial indicator extension. Mount the dial indicator so that the tip of the dial indicator extension is seated firmly in the lifter. It is important that the dial indicator plunger be aligned as closely as possible with the lifter being measured. Any substantial angle between the axis of the plunger and the retainer will introduce geometrical errors into the lift readings. (**Figure 6**)
3. With the Degree Wheel and its pointer accurately set, and the Dial Indicator solidly in place, rotate the crankshaft until the cam's base circle is under the lifter for the cam lobe being measured (usually starting with Number One intake). Set the dial indicator to zero at this point. Be sure the Dial Indicator is pre-loaded about .300" to insure that it will not run out of travel while on the base circle. Rotate the crankshaft to raise and lower the lifter several times



FIGURE 6

to verify that the dial always returns to zero when the lifter is on the base circle. 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 solidly (3) The lifter could be sticking slightly in its bore. Find the trouble and correct it before proceeding. It may be necessary to apply slight finger pressure against the lifter when rotating the engine. Be careful not to bump the dial indicator extension or the dial indicator mount. Any of these camshaft checks that may be performed (base circle runout, cam timing, etc.) are also very dependent on your cam bearings being in good condition and providing the proper radial clearance for the type and size of bearing. Excessive radial clearance will distort your figures taken of tappet movement, resulting in incorrect conclusions regarding the camshaft installation and its condition.

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Which cam degreing method to use?:

There are two popular methods for degreing a cam: (1) using the opening and closing figures at .050" tappet lift off the base circle of the cam; (2) using the intake centerline method. We recommend degreing the cam using the opening and closing at .050" lift when possible as it is more accurate. When checking, always turn the engine in the normal direction of rotation because of possible slack in the timing chain or gear drive. If the cam card you are using does not state what the intake centerline is, don't assume that any number on that spec card is the intake centerline. In most cases the lobe separation (lobe centerline) is not the same as the intake centerline. Most cam cards note this information.

Degreing your cam:

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. Record the degree wheel number that the pointer is on. Then 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. Continue to rotate the engine in the same direction until you reach .050" before closing. (In our example it is 42° ABDC). If you go past either of the .050" marks, back up at least .100" and rotate the engine in the normal direction again until you reach the .050" mark on the indicator. Again record the degree wheel number that the pointer is on. Continue on to zero lift and verify that the dial indicator has returned to zero. The opening and closing figures should be within ± 1 degree. If your figures are not within ± 1 degree, go through the procedure again to check for possible error. If your opening and closing figures are still not correct you will need to move the cam in relation to the crankshaft in order to correct your opening and closing figures. If the cam is opening early, the cam is too far advanced, and will need to be moved in the opposite direction of the cam rotation. If the cam is opening late, the cam is too far retarded, and will need to be moved in the direction of cam rotation. Depending on the engine being used, there are usually offset bushings, offset keys, or multi-indexed gears to accomplish this movement. If your opening and closing figures at .050" are not the same as your cam card they should be "off" the same amount of opening as closing, and the intake and exhaust should all be "off" the same amount. If this is the case, the correct bushing or key will bring everything in place. Always recheck your opening and closing figures when moving the cam. If the opening and closing figures are not off the same amount or the intake and exhaust are not off the same, this would mean that the duration, and/or lobe separation is different than your specification card. If you have this type of problem contact your cam manufacturer for more information. Do not remove the degree wheel if you are going to check piston to valve clearance at this time. Reference the piston to valve section of these instructions.

If your cam card does not show the opening and closing at .050" lift then you must use the intake centerline method to degree your cam. To understand cam timing specifications, you must first understand the difference between intake and exhaust centerline and lobe centerline (which should be more understandably stated as lobe separation). Lobe centerline (or separation) is the distance in cam degrees between the maximum lift point (centerline) of the intake lobe and the maximum lift point (centerline) of the exhaust lobe. This separation is ground in the cam and can't be changed unless the cam is reground. Intake and exhaust centerline relates to the phasing (timing) of the cam to the crankshaft.



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To locate the intake or exhaust centerline you must find maximum lift of that lobe. As in finding TDC, you must begin by using an arbitrary figure, such as thousandths of an inch instead of degrees, say .050". With the dial indicator on the intake lifter, rotate the engine in the normal direction until you reach maximum lift. This is where the dial indicator changes direction. At this point set the dial indicator at zero. Back the engine up until the dial indicator reads .100". Turn the engine back in the normal direction of rotation until the dial indicator reads .050". At this point, record the degree number that the pointer is on. Continue to rotate in the normal direction of rotation until the dial indicator goes past zero to .050" on the other side of maximum lift. Record the degree number that the pointer is on. Add the two degree numbers together and divide by two. That number will be the location of the maximum lift point of the intake lobe in relation to the crankshaft.

Checking piston to valve clearance:

When you install a high performance cam, it is possible that there may not be sufficient clearance between valves and pistons when near TDC on overlap. Even if they don't touch when you rotate the crankshaft slowly by hand, they may hit and damage the engine at high revs due to slight "Floating" of the valves, stretch in the rods, deflection in the valve train, and other causes.

We recommend at least .080" clearance between intake valves and pistons at all times, and at least .100" for exhaust valves, which expand more with heat. Add .030" to these figures if you have aluminum rods in the engine to allow for their expansion and stretch.

If you are using aftermarket heads, many of them have modified valve positions and/or valve angles. This may cause valve to piston valve relief alignment problems. If your engine is equipped with an aftermarket head of this type, we recommend checking piston to valve over a broader range.

The easiest way of checking piston to valve clearance in an engine, with the cylinder heads installed, is to install a pair of light checking springs in place of the valve springs. These light checking springs (supplied in the Crane Tune-A-Cam kit) will allow you to depress the valve easily at any time during the entire rotation of the engine, enabling you to measure the piston to valve clearance.

If you are going to use rocker arms with a higher than stock rocker ratio now or in the future, you will need to check piston to valve clearance with the higher ratio rocker at this time. (Higher ratio rockers increase gross valve lift).

After the light checking springs are installed in place of the standard valve springs, install the rocker arms and then adjust valve lash to zero, zero lash will work best to give you flexibility if at any time you want to tighten or loosen lash to change performance characteristics, you'll know that you have sufficient clearance. Be absolutely certain that you use the correct type of lifter for the camshaft that is being checked. This means a flat tappet for a mechanical or hydraulic cam (do not use a hydraulic lifter, as the plunger can move), or a mechanical roller tappet for a roller camshaft. Remember; always use a flat tappet lifter on a flat tappet cam and a roller lifter on a roller cam.

As a general rule, the closest point of piston to valve clearance during the rotation of an engine, is between 15 degrees and 5 degrees before top dead center overlap for the exhaust valve, and between 5 degrees and 15 degrees after top dead center overlap for the intake valve. This sequence takes place during the overlap cycle when both valves are open, 360 degrees from the top dead center compression stroke.

1. With your degree wheel still mounted to the engine in correct TDC position, and the valves adjusted to zero lash, turn the engine in its normal direction of rotation until you come to 15 degrees before top dead center overlap on your degree wheel, then set the tip of the dial indicator on the exhaust valve spring retainer, in line with the movement of the valve. Preload the dial indicator to about the mid-point of travel, and set to zero. Depress the valve with your finger by pressing on the valve end of the rocker arm until the exhaust valve contacts the piston, make a note of the reading on the dial indicator, and record the clearance. Now, continue turning the engine in its normal direction two degrees at a time, checking and recording the clearance every two degrees until you reach top dead center, on your degree wheel. Remember, since the valve will be moving, the dial indicator will not return to zero. You can either subtract the difference or reset the dial indicator back to zero each time before you make your clearance check.
2. Move the dial indicator to the intake retainer and start checking the intake piston to valve clearance the same way you checked the exhaust, except begin at top dead center and continue to 15 degrees after top dead center, turning the engine in its normal direction of rotation. The actual position of closest piston to valve clearance will depend on how far advanced or retarded your cam is. Remember, as you advance your cam you will lose intake piston to valve clearance and as you retard your cam you will lose exhaust piston to valve clearance.



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