RED SHIFT
PERFORMANCE CAMSHAFTS

Red Shift Cams®
Milwaukee-Eight® Cam Installation Guide

Part Number	Cam Name	Valve	Opening @ 0.050"	C/L	Closing @ 0.050"	Duration	TDC Lift @ Valve (1.6:1)	Total Lift @ Valve (1.6:1)	Bolt -In?	Recommended Valve Spring
413-810	**RS 468**	Intake	8.5	94	16.5	205	0.113	0.470	Yes	OEM Beehive
		Exhaust	35.5	98	19.5	235	0.154	0.470		
413-820	**RS 472**	Intake	7.5	98	23.5	211	0.108	0.472	Yes	OEM Beehive
		Exhaust	42	104	13	235	0.128	0.470		
413-830	**RS 548**	Intake	17	94	25	222	0.156	0.550	No	0.550 Lift (100 lbs Seat, 280 Nose)
		Exhaust	54	100	34	268	0.236	0.550		
413-840	**RS 552**	Intake	13	98	29	222	0.136	0.550	No	0.550 Lift (100 lbs Seat, 280 Nose)
		Exhaust	64	110	24	268	0.183	0.550		
413-850	**RS 558***	Intake	21	98	37	238	0.171	0.560	No	0.560 Lift* (100 lbs Seat, 280 Nose)
		Exhaust	60	106	28	268	0.204	0.550		
413-853	**RS 562***	Intake	13	106	45	238	0.131	0.560	No	0.560 Lift* (100 lbs Seat, 280 Nose)
		Exhaust	64	110	24	268	0.183	0.550		
413-860	**RS 578**	Intake	19	100	39	238	0.160	0.580	No	0.580 Lift (100 lbs Seat, 280 Nose)
		Exhaust	60	106	28	268	0.208	0.580		
413-863	**RS 582**	Intake	13	106	45	238	0.131	0.580	No	0.580 Lift (100 lbs Seat, 280 Nose)
		Exhaust	66	112	22	268	0.175	0.580		
413-866	**RS 584**	Intake	14	110	54	248	0.136	0.580	No	0.580 Lift (100 lbs Seat, 280 Nose)
		Exhaust	74	118	18	272	0.154	0.580		

*Red Shift "0.560 lift" Cams are designed to be used with higher rocker arm ratios (1.64:1), while fitting into a 0.580" Lift Spring Pack.

A Red Shift 0.580" lift Cam should not be used with a higher rocker arm ratio, unless the springs are setup for 0.600"+ lift.

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Red Shift Cams®
Milwaukee-Eight® Compression Guide

Early Torque	Horsepower	Ideal Compression Ratio	Spring Requirements
RS468	**RS472**	10-11:1	OE Beehive
RS548	**RS552**	11.0:1	0.550" Lift (100 lbs Seat, 280+ lbs Nose)
RS558	**RS562**	11.5:1	0.560" Lift (100 lbs Seat, 280+ lbs Nose)
RS578	**RS582**	11.5:1	0.580" Lift (100 lbs Seat, 280+ lbs Nose)
	RS584	12.0:1	
Torque Cams trap pressure, raise the cranking compression, and produce earlier torque with a more responsive throttle.			
Horsepower Cams produce less cranking compression, a softer early torque curve, and an easier to launch setup, with higher RPM horsepower.			
Both Torque & Horsepower cams produce very similar dyno curves, the largest difference is in the riding experience.			

Thank you for purchasing a Red Shift Performance Cam! To successfully install a new Red Shift Cam®, the following inspection procedures must be performed to ensure proper operation of your valve train. The oiling system must be operating correctly for proper valve train control, component reliability, and the final power output. If you do not have the correct factory Service Manual, obtain one before starting this installation. Be sure to follow all tear down and assembly instructions, and heed all cautions and warnings presented.

Know the total travel of your head / spring setup, before selecting a camshaft. It is very important that the correct spring is used with the correct cam.

Additional Requirements for using a Red Shift 500 lift and greater Camshafts:

1.) Spring Setup

a. The valve springs used with all Red Shift 0.500" Lift and higher cams must have a seat pressure of 100 lbs minimum, and 250+ lbs at the nose, with 280 lbs recommended. <u>These specifications cannot be achieved with the OEM or SE #18100080 valve springs</u>.

b. **RS548 & RS552 -** To achieve this, we recommend the following:

i. AV&V Valve springs (Zipper's #**515-800**) using 0.120" of shim to set the install height. This will leave enough travel with clearance to coilbind to run a 0.560" lift cam. Shims are available under Zipper's # **572-060**, and they are 0.060" thick. Two shims per spring are required to set the install height to produce a seat pressure of 100 lbs. 16 shims are required per engine.

ii. KPMI Valve Spring (Zipper's #526-800 (Ti) or #526-805 (Steel)), installed with one 0.060" Shim (Zipper's # **572-060)**. One shim per spring, 8 shims per engine.

c. **RS558 & RS562** – These cams were designed to be used with 1.64:1 rocker ratio with a conventional 0.580" lift Performance Valve Spring. These cams keep the total lift within the safe zone of 0.575-0.580" lift at the valve, and reduce stress on the valve spring.

d. **RS578, RS582 & RS584 -** To achieve this, we recommend using a set of KPMI Valve springs (Zipper's **#526-800** or **#526-805**), and using 0.060" of shim to set the install height. This will leave enough travel with clearance to coilbind to run a 0.580" lift cam. Shims are available under Zipper's # **572-060**, and they are 0.060" thick. One shim per spring is required to set the install height to produce a seat pressure of 100 lbs. 8 shims are required per engine.

2.) Lifter Travel

a. The OEM anti-rotation devices only allow for travel up to 0.520" lift, and can be reused with a 468 / 472 camshaft. They do not allow enough travel for 0.550" lift or larger cams. These need to be replaced with aftermarket tappet cuffs that were designed for higher lift, to allow the lifter full travel.

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3.) **Compression Advisory (Based on pump gasoline)**

a. **10.8 to 11.2:1 Static Compression -** The **RS 548 / RS 552** cams are designed with unique and special timing, they do not need excessive compression to generate great torque and horsepower. Static compression above 11.2:1 may result in excessive cranking compression.

b. **11.5:1 Static Compression** – The **RS 558, 562, 578, & 582** Cams are designed to work with Stage 4 cylinder heads, a larger throttle body, and a performance exhaust system. This package works best at 11.5:1, and produces 220 to 240 lbs of cranking compression in a 128ci engine. The Torque cams will produce the higher cranking compression number.

c. **12:1 Static Compression -** The **RS 584** Cam is also designed to work with Stage 4 cylinder heads, a larger throttle body, and a performance exhaust system. This package works best at 12:1, and produces 220 lbs of cranking compression in a 128ci engine.

Additional parts to consider while installing a Red Shift Cam:

1.) **Higher Ratio Rocker Arms –** Although the Red Shift Cams® lineup will work with a higher rocker arm ratio, special care needs to be noted on the cam & spring setup, and how much room you have left to coilbind. The current products offered by Red Shift are all designed to extract the most amounts of torque and horsepower out of the components readily available on the market. The new RS558 and RS562 are designed to work with 1.64:1 roller rockers, and a typical 0.580" lift spring.

If you plan on using a higher ratio (1.64:1) over the factory rocker ratio (1.6:1), then you need to state this upfront to your cylinder head expert. In many cases a simple change of spring or cam will allow you to run a higher ratio rocker arm, but stay within the safe operating range of the components. If you have any questions about this, please contact ProductSupport@zippersperformance.com for assistance in setting up your cam / spring / rocker arm ratio.

2.) **Aftermarket Rocker Arm Shafts & Studs** – When building a high compression, large displacement performance engine, please consider upgrading the rocker arm hardware with higher quality items. Zipper's stocks both aftermarket rocker shafts and studs.

3.) **Oil Pump** – All Milwaukee-Eight® engines built prior to 2020, need to have the oil pump assembly replaced with the latest factory oil pump. The changes made to the 2020 oil pump are significant, and eliminate most, if not all, wet sumping scenarios. It is essential to the longevity of your engine that you use an oil pump that properly lubricates the engine, and evacuates the crankcase & cam chest of oil properly. The latest revision from the factory is a great, and inexpensive solution.

4.) **Lifters** – We recommend using the highest quality lifters when you install a new camshaft. Never reuse a factory lifter on a performance camshaft.

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5.) **Exhaust System** – Although not part of the valvetrain, the exhaust system you choose directly impacts the shape of the torque curve, and the throttle response you feel while riding. It's not just about the looks & sound, an exhaust should be a harmonically tuned part of your performance engine package. There are many excellent aftermarket choices that produce good torque and horsepower. However there are some exhaust systems that are designed for looks, and are not made to be harmonically tuned for engine power. If you install a Red Shift Cam and find a very big torque dip in your power curve, please contact for ProductSupport@zippersperformance.com advice. The best camshaft in the world cannot solve a massive torque loss caused by an incorrectly designed exhaust system.

Teardown Procedure:

1.) Read the factory Service Manual's Cam Compartment Service procedure; and the associated section on Stripping the Motorcycle for Service.
2.) Following the factory Service Manual's procedure, remove all components from the motorcycle that will interfere with the cam chest disassembly. This includes the exhaust system and the floorboard, for example.
3.) Remove one spark plug per cylinder head, the pushrod cover clips, and rotate the engine over (rotate by the rear wheel, wheel off the ground, transmission in top gear), and cut each pushrod with a pair of bolt cutters. Only cut the pushrod when it is off of the spring pressure (cylinder at TDC on compression stroke).
4.) Remove the tappet covers, lifter anti-rotation guides, and lifters.
5.) Remove the Cam Cover, Cam Support Plate subassembly & associated parts, including the oil pump.
6.) Disassemble the Cam Support Plate subassembly; removing the camshaft, tensioner, and oil pump from the support plate.

Inspection Guide:

1.) Crankshaft Run-out – The first thing to check is the run out of the crankshaft pinion shaft. If the crankshaft run-out is deemed excessive, further disassembly and repairs will be required. It is highly recommended that anytime the camshaft cover is removed, crankshaft run-out is checked & recorded.
2.) Oil Pump - Disassemble the oil pump, and draw a line across the inner / outer gerotors with a permanent marker, so they can be reinstalled exactly as they were removed. Inspect the gerotors and pump body for damage due to foreign material being pumped through the system. Follow the factory Service Manual for gerotor tip clearances and the overall stack height tolerance. Replace or repair as needed. If excessive material has gone through the scavenge side of your pump, the oil tank and oil lines must be cleaned out now as well.
3.) Cam Chain - Check the outside the cam chain for any burrs or inconsistencies. Some wear may be present, but any physical damage to the chain will transfer directly into the cam chain tensioner.
4.) Cam Chain Tensioner – Check the cam chain tensioner for damage to the shoe, debris inside the hydraulic body, and free movement of the tensioner shoe prior to reinstalling.
5.) Cam Support Plate – Oil Pressure Relief Valve – Check the Oil Pressure relief valve, which is now a part of the oil pump, for debris. Remove the plunger and spring and clean, if debris is found.
6.) Take-Out Camshaft - Although this is the key item being replaced, it's the right time to take a moment to inspect the wear on the lobes and bearing journals. Finding issues on the parts that are being removed will aide you in setting up your new Red Shift Cam for a long reliable lifespan.

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7.) Lifters - Inspect the lifters' roller surfaces, the bearing condition, and the outer diameter of the lifter bodies. We recommend that higher quality lifters be installed when upgrading your camshafts, but studying the condition of the take-out parts will help you identify previous oiling and control issues. The latest factory lifters should be removed regardless of mileage, and replaced with a higher quality aftermarket replacement.

Assembly Instructions:

Red Shift Cams® produces a wide range of performance camshafts, from bolt-in cams for factory engines, to high-lift cams for dedicated racing engines. It is important to know that as the performance level increases, the number of steps increase accordingly to ensure that your installation is successful. Red Shift bolt-in cams are extensively tested in factory-built engines to ensure proper valve-to-valve and valve-to-piston clearancing on unmodified engines.

If you're purchasing a pre-engineered kit from Zipper's or another reliable source, these clearances will be pre-determined & setup for you. However, if you're building a custom performance engine, the task is up to the engine builder to determine if the desired cam will physically work or not. Changing the pistons, decking the head gasket surface, and altering the valve sizes significantly alter the available clearances. It is critical to know that the cam has enough clearance before installing it and finding out that there's interference the hard way.

1.) Read the re-assembly procedure in your factory service manual, and mark the page with the hardware torque values.
2.) Thoroughly wash and clean all of the parts that you're about to reinstall in your engine.
3.) Re-assemble the oil pump, and install it on the crankshaft. Pay careful attention to the installation, if the o-ring on the end of the pump is damaged, the engine will be unable to scavenge properly, and will wet-sump.
4.) Coat the camshaft lobes, bearing journals, and chain sprockets with assembly lubricant.
5.) Insert the cam into the cam support plate.
6.) Install the cam support plate assembly into the engine, and torque the assembly in place. Always keep the crankshaft rotating when you tighten and torque the 4 oil pump bolts. A second person will be required for this step.
7.) Reinstall the factory spacer on the rear cylinder's camshaft for a mock up.
8.) Mock up the drive sprockets first, leaving the chain on your workbench. Check the alignment of the two drive sprockets, as the factory service manual describes. A different spacer may need to be sourced to correct any misalignments between the rear camshaft and the crankshaft. Factory spacers are available in 0.010" thickness increments.
9.) Once the sprocket alignment has been set, install the outer drive chain onto the two sprockets, lining up the timing marks. Always use blue thread locker on the threads, and torque the bolts in place. The special sprocket locking tool makes torqueing these bolts a cinch.
10.) Install the Cam Chain Tensioner.
11.) Install the outer Cam cover, following the factory torque spec and torque pattern.
12.) Adjust the pushrods, using the adjustment procedure in the next section of these instructions.
13.) Reinstall the remaining parts removed, the exhaust, floorboard, and spark plugs.

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Final Setup Tips:

1.) Pushrod Adjustment Procedure - *Only for Adjustable pushrods*

Red Shift Milwaukee-Eight camshafts are designed with factory base circles, meaning you can retain your factory non-adjustable pushrods if you choose. They are high quality parts that work well, but do not offer the ability to be adjusted to change the preload inside the hydraulic lifter.

There are different methods to adjusting a pushrod. Zipper's has a long-established procedure called "Bottom-up" that allows you to limit the travel of the hydraulic lifter, which can prevent excessive noise or valvetrain control issues. You are effectively finding the full travel of the lifter by bottoming it out, and then retracting the pushrod to allow a set amount of hydraulic travel. This is highly recommended if you have a valvetrain noise issue, or are building a large displacement engine with big cams & springs.

However on a bolt-in cam, the "top-down" procedure that the factory and many competitors use will work fine as well. If you are not comfortable attempting the "bottom-up" procedure, but you have experience with "top-down", please use the adjustment procedure you are comfortable with. The "top-down" approach simply means you are finding the start of the hydraulic lifter's travel, and moving it down to approximately the middle of the travel. This is fine on the 468 & 472 cams!

Zipper's "Bottom-Up" adjustment process:

a. **DRY** - Starting with a dry lifter will allow full compression of the lifter, without risk of damaging the valve. Install the pushrod, and fully extend it in place. Shorten the pushrod by 4 flats (2/3 of a turn), for proper lash. Make sure to tighten the locknut to keep the pushrod at this length.
b. **WET** – If your lifters are primed or fully pumped up, you simply have to bleed the oil out of the lifter to find the bottom. Install the pushrod and extend it fully to zero lash, with no pressure on the valve. Lower the adjuster 22 flats (3 -2/3 Full turns), and stop at this point to allow the lifter to bleed down. Once you can freely spin the pushrod, adjust the pushrod down another 20 flats (3-1/3 turns). The hydraulics should be at the bottom, but give it a few minutes to bleed down. If the pushrod turns, slowly lengthen the pushrod until the free movement is contained. At this point, shorten the pushrod by 4 flats (2/3 of a turn), and tighten the lock nut.

When complete, the pushrod should spin freely, after the lifter bleeds down in its final position. Do not proceed forward until you've verified the pushrod can spin freely in its locked down, final position. If you have any questions or concerns, please contact ProductSupport@ZippersPerformance.com before starting the engine.

IMPORTANT NOTE ABOUT PUSHROD ADJUSTMENTS

Zipper's has a unique method for adjusting pushrods, to limit the overall hydraulic travel of the lifter, without eliminating it. However this can be seen as a very different procedure than you are used to. If you are more comfortable using a different method, where you go "top-down", that's perfectly ok. Although we have reasons for our method, it is very important that the installer is comfortable with the instructions. Any experienced installer who deems their install method to be safer, should use their existing method.

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It is possible to over-travel the lifter in the “bottom-up” procedure, and then crash the valvetrain when the engine is started. No one wants to see that, so if you are having a hard time finding bottom, please use the top-down method that is safer.

If you have the rocker box covers off while installing the cam, you can very quickly see when the cam is on or off of the base circle. The rocker arm should have moveable endplay when it is bled down. If it does not, then there’s either hydraulic pressure, or you’ve gone past bottom, and you are now opening the valve manually. Just because you can physically keep turning the adjuster, does not mean that you are still seeking bottom. This is especially difficult in an M8 engine, where the valve spring pressure is far less than a typical hot-rod Twin Cam or Evo.

2.) **Fuel / Spark Tuning -** Tuning an M8 engine with a new cam and other aftermarket components is a very important task. The preferred tuning devise highly recommended by Zipper’s is the robust wide band system “ThunderMax”. Other capable tuning systems designed for professional tuners are Power Vision and TTS.

Zipper’s only tunes with TMax tuners. https://www.zippersperformance.com/all-products/performance-kits/thundermax/ Its powerful wide band tuning and simplicity in design with excellent base maps developed for Red Shift cams makes tuning as close to plug and play you can get.

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