HIGH PERFORMANCE QUICK REFERENCE GUIDE

Document #1502

THREE STEPS TO SELECTING A HIGH PERFORMANCE PLUG

When using this guide, understand that high performance sparks plugs are usually of a much colder heat range than normal automotive or street plugs. Colder heat ranges must be used in engines with increased cylinder pressures and temps and higher brake-specific power output. Also, racing engines are stressed to extreme limits and require a specially constructed spark plug to live in that environment.

The first area to investigate will be the type of shell needed. In order to gather this information you must know the thread diameter, length and seat type required by your cylinder head. Do not use a removed spark plug as a guide for determining proper shell dimensions. Failure to get accurate information can result in decreased performance and damaged engines.

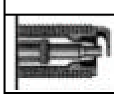
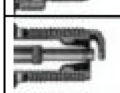
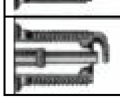
The second step is to select a gap style that will maximize your performance based on your operating environment. Champion makes numerous electrode and gap configurations to meet the needs of all racing applications.

The third step is to select the heat range that corresponds with the required shell and gap style. It's our recommendation that you start your selection of heat range on the cold side of the available plugs and work your way up to a hotter design by reading the spark plug.

Once a spark plug has been selected, it should be installed and run during practice with the motor "cut clean" to allow proper reading of the plugs. **Remember, make only one change to the engine at a time**. Do not make spark plug changes along with injection/carburetion or timing changes as this can result in misleading or inaccurate conclusions.

STEP 1 – SHELL DESIGN AND SELECTION

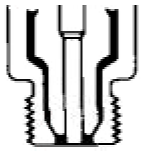
Physical inspection of the cylinder is required to determine the thread diameter, thread length or reach, and the type of seat design used by the cylinder head. The thread diameter can be 10, 12, or 14mm. The length of the threaded portion of the spark plug, as measured from the end of the threaded area to the seat, varies from .375" to .750" Either a gasket type or a tapered seat type of set design is used by the cylinder head. Failure to determine the right type of seat can result in inconsistent heat range and potential engine damage (refer to the chart below).

	SERIES	THREAD	REACH	HEX	TYPE
	G	10MM	.750"	5/8"	GASKET
	A	12MM	.750"	18MM	GASKET
	J	14MM	.375"	13/16"	GASKET
	V	14MM	.460"	5/8"	TAPERED
	L	14MM	.500"	13/16"	GASKET
	S	14MM	.708"	5/8"	TAPERED
	C	14MM	.750"	5/8"	GASKET
	N	14MM	.750"	13/16"	GASKET

STEP 2 – SELECTING ELECTRODE AND GAP DESIGNS

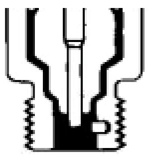
Generally speaking, the more the spark plug gap is exposed to the air/fuel mixture, the easier it is to initiate combustion. This translates into improved throttle response and more efficiency.

Surface Gap "V" Gap



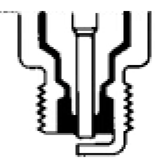
A surface gap plug provides exactly what its name describes…a gap at the surface of the combustion chamber. The gap is a .050" annular configuration. The center electrode and insulator tip operate extremely cold (no heat range rating) and are therefore, nearly impervious to pre-ignition. However, fouling deposits are always present and cannot burn away. These types have limited use in racing. A special ignition system with very high energy and a very fast rise time (CD) is required to fire the gap when fouling deposits are present. The insulator tip does not operate hot enough to allow reading of the spark plug during engine tuning. The exceptions are the G52V and G54V which have surface air gaps with sufficient insulator nose length to give some heat range. These are used in Formula 1 engines. C53VC, C55VC, and C57VC are of similar design and use a 14mm thread diameter. These are designed for small block Ford and Chevy engines used in Winston Cup type racing. There are also "S" type plugs available in this design with identical heat ranges.

Retracted "R" Gap



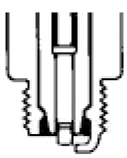
A retracted gap spark plug effectively places the spark out of the mainstream of the air/fuel flow making it difficult to initiate a good flame front. This design is necessary when valve or piston clearance is not sufficient for conventional plugs, or where boost pressures or fuel type can cause excessive combustion temperatures (i.e., turbocharged Indy engines).

Regular Gap



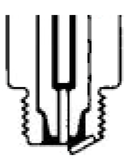
This gap style positions the spark approximately 1/16" into the combustion chamber. Many of the coldest heat ranges have a modified (shortened) ground electrode. This helps expose the spark to the mixture and protects against pre-ignition from an overheated ground electrode.

Cut-Back Ground Electrode "JC4" type



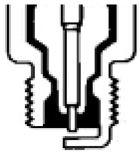
The ground electrode is cut-back from the center electrode to provide a .040" gap. The face of the ground electrode is concave to provide a constant gap to the center electrode. This plug is designed for small block Chevy and Ford engines used in Winston Cup and Trans Am type events.

Angled "A" Gap



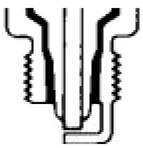
The angled ground wire is designed for V8 and V6 engines used in Winston Cup, Busch, and Trans Am type cars. The fine center electrode reduces required voltage. The angled ground electrode is shorter and provides a more exposed gap. This design may offer greater durability in some applications.

Fine wire Electrodes



Spark Plugs with small diameter center electrodes (.050”) were originally designed to improve starting and anti-fouling characteristics in small two-stroke engines such as snowmobiles, chain saws, and dirt bikes. The small fine wire center electrode reduces the voltage required to ionize the gap. These characteristics are important with low cranking speeds and borderline ignition output. The same characteristics can “Band-Aid” poor performance where fuel mixtures are either too rich or too lean. In addition, this design can aid in low speed performance in magneto or total loss ignition systems. This electrode design is available in selected plugs both in regular and projected “Y” gaps and can often provide that extra competitive edge.

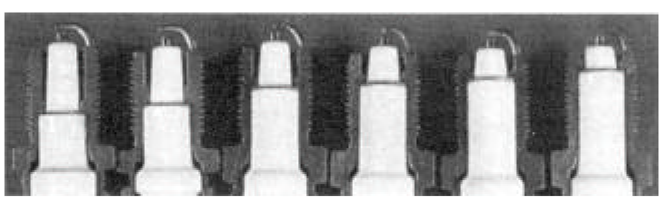
Projected Nose “Y” Gap



This gap style projects the spark an additional .060” into the combustion chamber for a total projection of .210”, and providing there is sufficient clearance to valves and pistons, provides the ultimate in performance. Initiating the flame front closer to the center of the combustion chamber has a similar effect to advancing the timing. Therefore, maximum timing may be reduced which helps reduce the chance of detonation and provides superior part throttle response. A second valuable feature of this style is a “broader” heat range. The core nose is longer, providing a “hotter” plug at low speed which helps prevent fouling. As engine speed increases, the incoming air/fuel mixture flows across the tip of the core nose, providing charge cooling which effectively reduces heat range at higher engine speeds for increased pre-ignition and detonation protection.

STEP 3 – HEAT RANGE SELECTION

The term “heat range” refers to the relative temperature of the core nose of a spark plug. The words “hot” or “cold”, when used in referencing spark plugs, are often a source of confusion and misunderstanding, since normally a hot spark plug is used in a cold engine (low horsepower) and a cold plug in a hot engine (high horsepower). The terms actually refer to the heat rating or thermal characteristics of the plug; more specifically, the plug’s ability to dissipate heat from its firing end into the engine cooling system. A cold plug, by definition, transfers heat rapidly from its firing end into the cooling system and is used to avoid core nose heat saturation where combustion chamber or cylinder head temperatures are relatively high. A hot spark plug has a much slower rate of heat transfer and is used to avoid fouling where combustion chamber or cylinder head temperatures are relatively low. The primary means of adjusting heat range are by varying the length of the core nose and the alloy material used in the electrodes. Hot plugs have a relatively long insulator nose with a long heat transfer path. Cold plugs have a much shorter insulator nose and thus, transfer heat more rapidly (see illustration).



HOT← **→COLD**

The heat range of a plug does not affect the power output of an engine. Rather, it allows the plug to function as designed for the duration of the racing event. Once the correct heat range is found that prevents fouling and does not contribute to pre-ignition or detonation, a change to a hotter or colder plug will not have a positive effect on engine performance.

HEAT RANGE FACTORS

Air/Fuel Mixture-Theoretically, ideal air/fuel mixture ratios for gasoline are 14.7 pounds of air to one pound of fuel. However, to provide a near ideal mixture, we need to provide approximately 12.2 parts of air to one part of fuel as measured at the induction system to account for losses in the system due to intake runner and cylinder wall wetting. Air/fuel ratios greater than 12.2:1 may cause the plugs to read lean. Mixtures less than 12.2:1 may cause the plugs to read rich. Rich mixtures are considered safer due to the slightly slower burn and increased charge cooling. Mixtures that cause the plugs to read lean may contribute to pre-ignition and/or detonation.

Spark Advance-Spark timing has one of the greatest effects on plug temperatures. It becomes a more critical factor as compression ratios increase. Internal environments that influence spark advance settings include combustion chamber design, compression ratio, air/fuel ratio, type of fuel and engine speed. There are also external environments that can affect timing requirements including elevation, humidity, and temperature.

Despite design differences, most engines' peak spark advance should have occurred before 3500 rpm. Additional spark advance after this point is usually unproductive.

Compression Ratio-Mechanical compression ratio is defined as the swept volume of the cylinder divided by the volume of the total combustion chamber area. Without any other alterations, increasing the mechanical compression ratio will increase the cylinder pressure and, therefore, the cylinder temperature. Any time engine modifications are made, it may also be necessary to modify the spark curve, recalibrate the fuel system and adjust spark plug heat range.

FUEL TYPES

Pump Gas-Pump gas has a relatively low octane rating and is suitable for street and strip in limited classes of racing only. Many brands of pump fuel use additives that will cause a discoloration of the core nose of the spark plug. These colors could be pink, purple, or blue. Do not consider this coloration as an indication of heat range when reading the spark plugs.

It Appears that the increased use of oxygenated fuels (up to 10%) does not directly affect the core nose temperature of the spark plug. However, the addition of the oxygenates will tend to lean out the air/fuel mixture and, since these alcohol's require more energy to vaporize, may tend to actually cool down the spark plug and combustion chamber.

Nitrous Oxide-Nitrous oxide (N_2O) is 36% oxygen by mass compared to 21% oxygen in the atmosphere. N_2O is a means of getting more oxygen into the combustion chamber. Additionally, N_2O injection will cool the incoming charge due to the energy required to vaporize the tiny liquid droplets in the vapor fog. If the N_2O is injected close to the cylinder, some of the fog enters the cylinder in liquid form and does not vaporize until after the intake valve is closed providing even more oxygen to the cylinder. When the appropriate amount of fuel is added, this mixture will result in substantially higher power output.

The use of N_2O increases cylinder temperatures and may require a plug on to two heat ranges colder. Lower output street systems may be able to use the standard plug recommendations if the nitrous oxide is used only for a very short burst (less than 10 seconds).

Supercharging and Turbocharging-Supercharging is the use of a mechanically driven "air pump" to increase the mass airflow through an engine. Turbocharging does the same job by utilizing exhaust gases to drive a turbine-type compressor.

Both of these methods provide increased mass airflow through an engine with substantial increases in specific output (horsepower/displacement). With increased pressure and temperature in the combustion chamber, a colder heat range plug is required. In some cases, especially where durability is essential, a surface "V" type gap may be required.

POPULAR HIGH PERFORMANCE TYPES

Stock Number	Plug Type	Application
256 255	C59A C57A	For Ford and Chevrolet 18^0 cylinder heads with compression heads with compression ratios 14:1 and higher. Generally for asphalt oval track racing.
297 296 295 294 293	C61CX C59CX C57CX C55CX C53CX	Chrysler, Ford, Chevrolet V6 and V8 with aluminum aftermarket cylinder heads Circle Track, Drag and Off-Road racing. For compression ratios from 11:1 to 16:1. Also for use on big block cast-iron heads using ¾" reach plugs. Used where piston dome and cylinder head modifications cause clearance problems between plug and piston top.
284 796 794 792 791	C65YC C63YC C61YC C59YC C57YC	Chrysler, Ford, Chevrolet V6 and V8 with aluminum aftermarket cylinder heads Circle Track, Drag and Off-Road racing. For compression ratios from 11:1 to 14:1. For use on big block cast iron heads using ¾" reach plugs.
283 688 687 277 686 276 693 692	C63 C61 C59 C59Y C57 C57Y C55 C53	Magneto-fired engines such as Sprint cars. Popular in highly modified Karting engines such as Yamaha and Suzuki powered. Also for modified motorcycles such as Harley-Davison, Yamaha, Suzuki and snowmobiles.
930 942	RV92YC RV91MC	Street rods with spark plug to header clearance problems 9:1 to 10.5:1.
802 265 263 670 672 671	V63C V63Y V61 V59C V59YC V57YC	Ford and GM iron head big and small block. Also V6 and some aftermarket aluminum replacements for O.E. designed cylinder heads. For compression ratios ranging from 11:1 to 15:1.

POPULAR HIGH PERFORMANCE TYPES - Cont'd

Stock Number	Plug Type	Application
280 683 685 682 684 681 697	S61YC S59C S59YC S57C S57YC S55C S53C	Some Ford and Chevrolet NASCAR style cylinder heads. Also some pro stock drag race Chevrolet, Oldsmobile and Ford applications requiring a long reach; tapered seat plug.
673 723	N59DR N57DR	Drag racing, Top alcohol, and other supercharged alcohol-burning such as competition eliminator.
291 290	N61YDR N59YDR	Nitromethane burning drag race. Top fuel, etc.

GENERAL GUIDELINES FOR HEAT RANGE SELECTION
NORMALLY ASPIRATED, GASOLINE FUELED

COMPRESSION RATION	RECOMMENDED HEAT RANGE
9:1 – 10:1	**63 – 65**
10.5:1 – 12.5:1	**61 – 63**
13.0:1 – 14.5:1	**59 – 61**
15:1 – 16:1	**55 – 57**
16:1 AND HIGHER	**53 – 55**

FOR ALCOHOL FUELS, MILD TURBO OR SUPERCHARGED, AND FOR OVAL TRACK RACING (1/2 MILE TRACK OR LONGER) DROP 1 HEAT RANGE COOLER.

FOR NITROUS OXIDE FUEL, SEVERE TURBO OR SUPERCHARGING, DROP 2 OR MORE HEAT RANGES COOOLER.