Lightforce XGT to HID conversion

(v1.5 – 05/09/2k8)

Welcome!
Thankyou for purchasing these modification instructions, and also your general interest in HID technology and modifying the XGT light to fit these bulbs. Please don't have any fears at doing these mods as it really is dead simple.

If you have any questions at any stage throughout these instructions, please don't hesitate in contacting me.
The easiest way is preferably via e-mail: bushy555@gmail.com
Or by leaving a message on my mobile phone: 0429 111 017.
Please check my website for any updated information that may be available. http://lightforcehid.iscool.net

Let the HID Lightforce be with ya!
Cheers
Dave (Bushy) Maunder

Overview
The following instructions give a simple step by step approach to convert your LightForce 240 XGT lights from their original halogen bulb to use the newer HID light technology that is currently available at reasonable prices.

LightForce originally chose to use the GA series of bulbs – a bulb with two pins hanging off it. Like that of the proper H2 bulb (Hella Rallye 1000, Cibie Supar Oscar – "Thin Profile" lights), but without wings. Their official name is "JCD BI-PIN HALOGEN BULB **GY 6.35**", and made by Osram. The "GY 6.35" is what the bulb base or mount is called – that is, the distance between the middle of one pin to the other is 6.35mm. These halogen bulbs come in two voltages – 12 volts and 24 volts, with differing wattages of 35, 50, 75 and 100 watts. Lightforce sell the 12v 100w bulb for around \$15.00 each. You can pick them up at Bunnings and the like for around \$2.50 each!

The problem
What we have here are some awesome lights, but let down by early 19^{th} something century technology, ie power flowing through a wire filament to produce lightWhat we need is more light, and less heat, whilst also sucking less juice. and a great deal of heat.

The answer
Use HID technology – High Intense Discharge light. A glass bulb which has a bunch of gas in it, and when a high voltage passes through the gas, light is produced. Once lit, the voltage drops to around the 90 volt mark. When compared to older filament wire technology, 35watt HID's produce a heap more light and less heat whilst using nearly a third of power. They are around about 85% in efficiency. 50 watt HID kits are closer to 92% efficient. That is 92% of electricity going into the HID system is converted into light and around 8% is converted to heat.

High Intense Discharge bulbs utilise new technology to give up to 300% more light output (300% for a 35 watt HID kit, closer to 450% for a 50 watt HID kit) than the equivalent 100 watt halogen bulb whilst drawing much less current. The higher voltage strikes an arc through the xenon inert gas inside the bulb, and converts more power to light. Due to less heat being given off, the bulbs life is at bare minimum at least twice that of a standard halogen bulb - 3000 odd hours.

A quick example: a pair of original 12-volt Lightforce 240 XGT lights utilise the GY 6.35 100 watt bulb. The current draw is approximately 8.3 amps per bulb, give or take a bit depending on the available voltage supply. A 35 watt HID bulb will produce much more light and will do this requiring only 2.5 to 3 amps for each bulb. Compare six 100 watt halogens (600 watts – 45 to 50 amps) verses six 35 watt HID bulbs (210 watts – 15 to 17 amps) and you can easily see the power savings.

Background

The idea came about because after seeing a set of real Lightforce 240 HID lights at a 4wd winching competition back in 2002, I really really wanted a set. But I didn't really really want to pay the dollars for them. I went down the path of asking sales at LightForce for some sort of a cheap deal for a set of real HID lights, whilst giving heaps of advertising. Unfortunately Lightforce were not able to do this. So my mind went walk-a-bout and started thinking surely it is possible to convert these awesome lights. At the time HID kits were still very expensive, however these days the kits are available for a few hundred dollars. I started designing an adapter for the LightForce Blitz light and since it worked, I then started on planning (and saving) to do the same modification to the XGT light.

Why have I charged $10.00 for these instructions? Well for starters a lot of time and effort went into this document and secondly I have now successfully converted a lot of different lights to HID's, and all of those instructions are freely available for download in Microsoft Word documents on my HID site http://www.hid.isclever.com . However since I've spent sooooo much money on lights and HID kits over the past six to twelve months, I need to get a little bit of it back - I highly doubt I ever will. Most of the money has gone into research and development in order to give free information about converting other types of lights. Before this, information on such modifications were not available – believe me, I have spent months crawling google and yahoo looking for such information, and I reckon it doesn't exist. I just hope that you can understand and appreciate this.

Disclaimer

PLEASE NOTE: Attempting any type of modification on any of your Lightforce lights will void your warranty. Please make sure that you fully comprehend what you are about to do. If your lights are still in warranty Lightforce do actually have a very good warranty service. You might just want to fire off an email and find out exactly what they will cover before going ahead with these mods. (Just had to include this).

Anway, enough yabbering. Lets get into it!

The following is a list of everything that you need to do this conversion:
* At least one LightForce XGT light! Two is preferable. Four is better. Six is wild. Eight on the roof wont fit!
* One H3 bulb HID kit. Your choice of colour temp – 5000k is daylight white, 6000k is more blue-ish.

Tools required:
* Diagonal side cutters, long nose pliers or even scissors will do.
* 2.5mm Allen key
* Small round file, ie chainsaw file.
* Small flat file
* Drill press – Absolutely highly recommended.
  (If no drill press, an electric drill, vice, gloves, and band-aids will suffice)
* 6 or 8 or 10mm drill bit
* 19mm or ¾" Drill bit.
* Oil for drilling
* 17mm socket - if XGT lights are still bolted to the car.
* Knife - if XGT lights are still in original box.
* Small flat bladed screwdriver.
* 20, 22, or 24mm holesaw / drill bit. This depends on the size of the rubber grommet that comes on the bulbs.
* Inert Silicon. As noted from Peter Culley of Lightforce Australia, it is highly recommended to purchase some non-acidic 'inert' silicon, more commonly known as Neutral cure, The acidic vapours that is released whilst the silicon cures will destroy the reflective coating on the reflector lens, as well as not helping much with the inside of the clear outer protective lens. Most of the locktite range of silicons are neutral cure, whilst some white and black silicons are also neutral curing. Selley's neutral curing silicon is probably the easiest to source from Mitre 10, Bunnings, Tru Value etc.

Step 0.
So you don't have a HID kit yet? Where do I find one?
Ebay can be your friend. Jump on to http://www.ebay.com.au and if you have not already signed up, do so. In the search field, type in "HID kit". Most HID kits will always appear here – or in other words, this is your best bet at finding kits on ebay using those two words. I'd be inclined to sit back for about a week and watch what the current prices for kits go for, to give you an idea of what your maximum bid should be. Put your maximum bid in, and then wait. Try and find kits that are either listed early in the morning and very very late at night, to avoid the last minute rush of frenzy bidding. Most sellers will be reputable. At the time of writing this document, I personally have purchased eight kits from various sellers on ebay, and have yet to have a bad transaction. That is in no way of saying that it is safe. Of course there will always be the dodgy seller. Avoiding them is the trick. Always check the seller's feedback score before buying and even after saying that one of my kits I bought was from a bloke who had only signed up the previous day and had a total feedback of 2. That transaction went smooth!

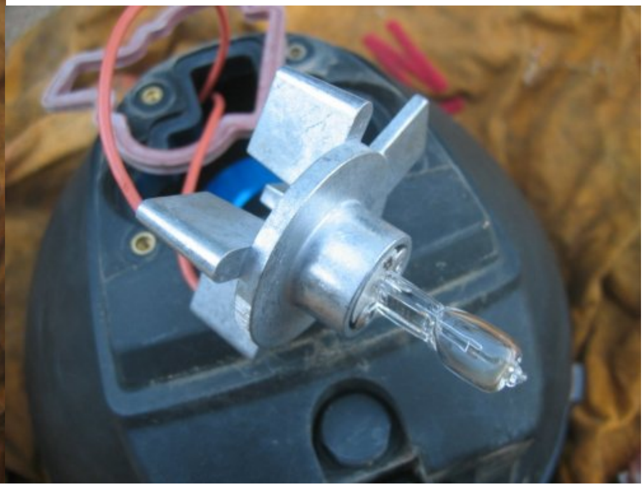
Failing eBay, you can always purchase a kit direct from importers. One company in particular that I recommed, but have no affiliation with is Paul Sinclair, in Melbourne : http://www.brightlightautoparts.com
At the time of writing this document, multi voltage 55-watt HID kits are available from him.

Step 1.
Take your LightForce XGT light, and un bolt it from your vehicle. Or if brand new, take it out of the box. Place it upside down either on a grubby old pair of overalls that have 'Leeton Rescue Squad' written on them, or as in the second photo shows, your lounge room floor carpet which needs a bit of a vacuum. On the back of the XGT light, there is a cover which allows access to the rear of the lens – in order to change the standard halogen bulb, should it ever blow.

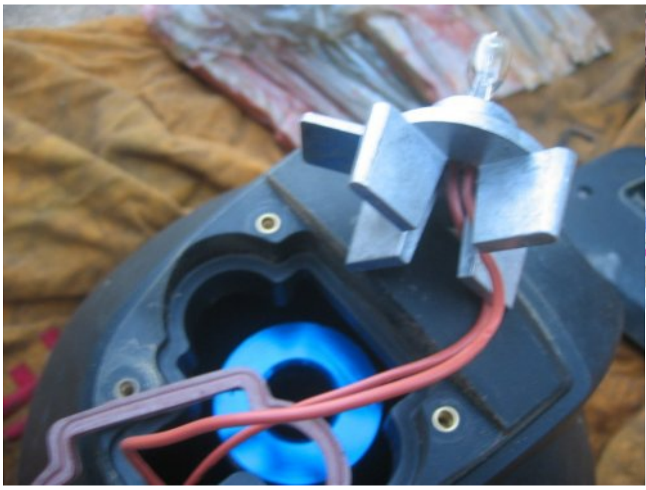
Step 2.
Grab a 2.5mm Allen key and unscrew the four bolts. Use the proper tool. Beg, borrow or steal one from a mate. Or your old man. A 25 piece metric and imperial Allen Key set from Jaycar will set you back about $9.95.


Step 3.
Put the four screws in a safe place, and lift the cover off. Don't loose the big spring that is attached to the rear cover. Pull the spring off, and put in a safe place. A safe place is usually the top shelf in the fridge.

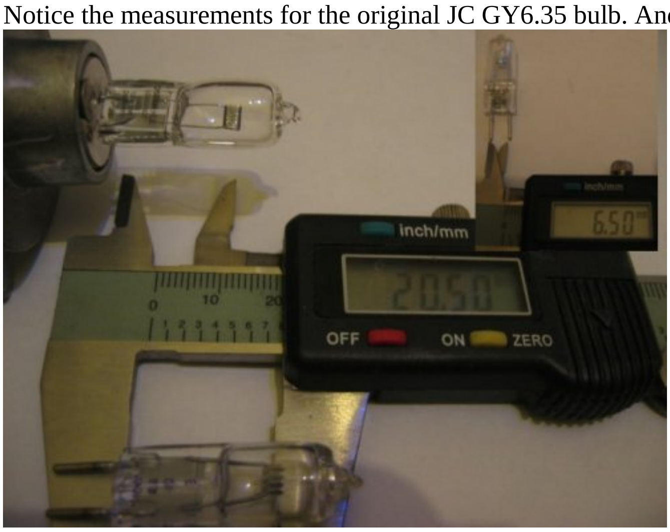
Step 4 - Say ‘oooh arrrr’.
Step 5 - Pull out the chunky bulb aluminium heatsink. It just lifts straight out.

Step 6.
Turn everything around so it looks better at a different angle.
Step 7.
Grab your pliers, long nose pliers, scissors or side cutters. Cut the two wires going to the heatsink.
Leave the light for a moment and we are now going to concentrate on the heatsink itself.



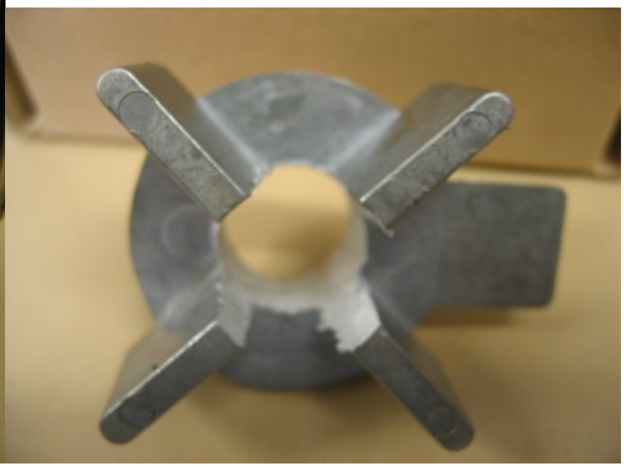

Step 8.
Notice the measurements for the original JC GY6.35 bulb. And say ‘ooooooh’. Fairly useless step.



Step 9.
With your 6 or 8 or 10mm drill bit, drill out the two rivets that are holding the ceramic bulb base within the heatsink. The ceramic base should then just be able to be pushed out with a small screwdriver from the bottom side. Once out, pull the wires completely through as well.

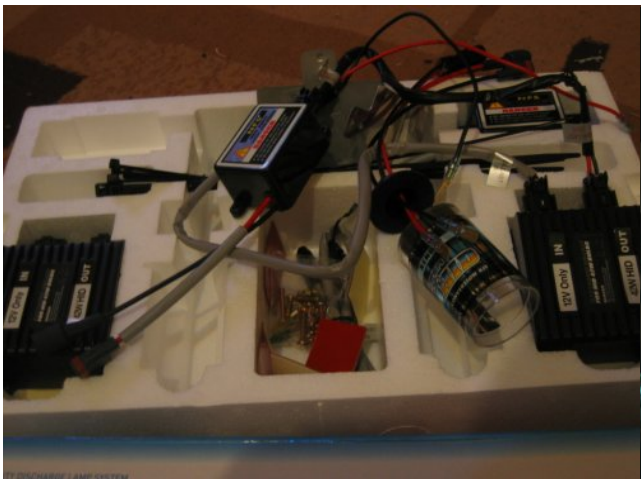
Step 10.
Using your drill press and your 19mm or ¾” drill bit, drill it out very slowly. Take extra care in this step, and use oil if you need to. The side walls will become very thin, and it is possible for the entire top section to tear off from the bottom section, and thus pretty much destroying the entire housing. Lower the drill bit very slowly. If you are using a normal handheld drill then all I can say is to HANG ON, and best of British luck to you. I will advise again for you to not use this approach. Or at least if you must use a hand drill, use a 17mm drill bit to begin with. This will not touch the sidewalls, however you may need to file a little bit out in order for a nice fit for your bulb.
Make sure the housing is sitting in the vice nice and tight. Make sure that the vice is held down nice and tight. Again, too much movement of the the vice and the entire top bit of the aluminium housing may also snap off.

Step 11.
This is what is should look like once finished. Clean up the scummy bits with a small file.



Step 12.
Finally on to the good stuff! Grab your HID kit and pull it apart. Go ‘ooooh arrrrrh’.
What? You have no kit yet? Welp – you can’t go any further until you do. Or maybe you can skip down to the below step to do the rear cover whilst you wait for your it to arrive. Jump on to ebay or some other online shop place and buy yourself a H3 HID kit. If you do have your HID kit handy, have a beer and try to read the “engrish” instructions. Make fun at the interpretations.

Step 13.
Connect up a bulb to the ballast and/or ignitor and start it up using a 12v battery or a plug pack etc.
Now is the time to test the bulbs to see if they are working. No point going any further if they don't work now, and also now is the time to send the kit back if it doesn't work. At least you can get an exchanged kit now, and not a bit later down the track.



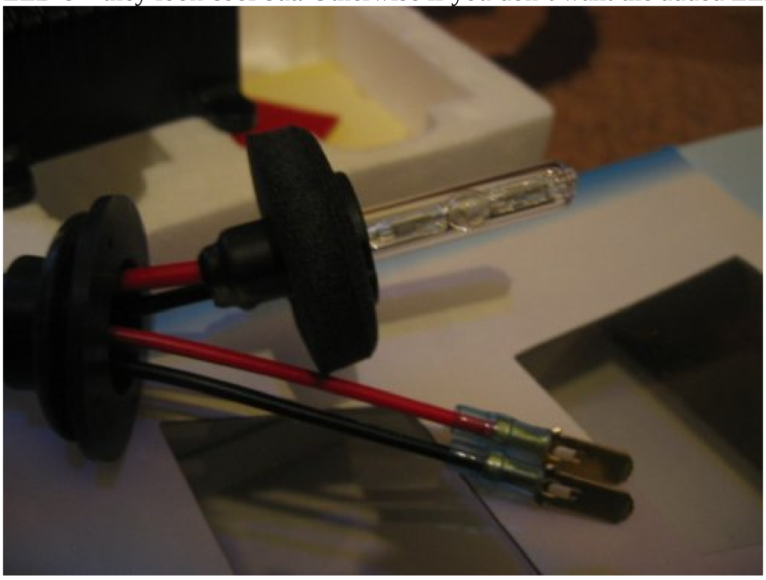
Step 14.
Note the funny looking connectors. Only pointing these out coz (1) they are new to me, and (2) you will need to drill a hole large enough for these to pass through later…
Step 15. – Second pic - Other styles of connectors that your kit may happen to have.


Step 16.
Grab the bulb, and pull the cover off. Some bulbs will have a plastic base, others will have a foam base. Pull it off as well

Step 17.
Your bulbs may or may not have a rubber grommet such as this, and they may or may not have additional wires such as those in the pic.

Step 18.

If your bulbs do kind of look like this, you now have the option to later fit some white LED’s into the lens. If you choose to do this, then leave the wires here. I haven’t and wont go into the instructions required to add little fancy LED’s – they look cool but. Otherwise if you don’t want the added LED’s, pull the wires out and through the grommet.



Step 19.

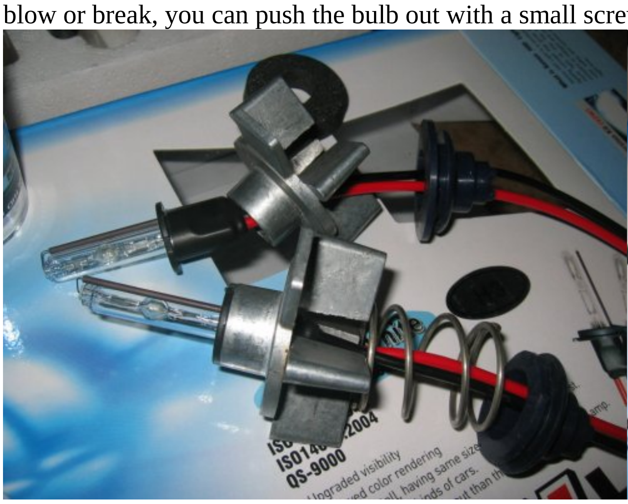
Pass the connector plug ends through the chunky aluminium heatsink.

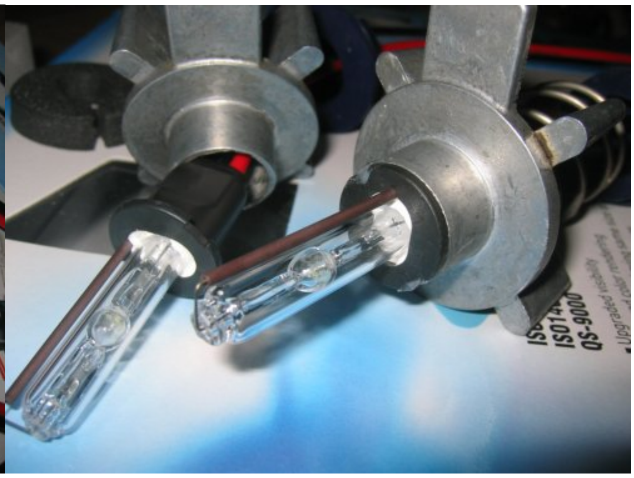
Time for a decision on your part. And it will have a bit to do with if your bulbs do have a grommet as in these pics. Most kits will have grommets, however some wont. Your decision will also depend a little on the amount of space there is behind your LightForce lights and the closest object. Ie, if your XGT lights are to be mounted on the front of a GQ with a factory alloy bullbar, clearance is going to be at a very bare minimum. You may need to drill a hole to the side or below of that of the position that I have shown. Or you might get away with it by redrilling the holes in the bullbar, and moving the light forward by say 20mm. On a GU with a factory steel bull bar, they will fit fine.

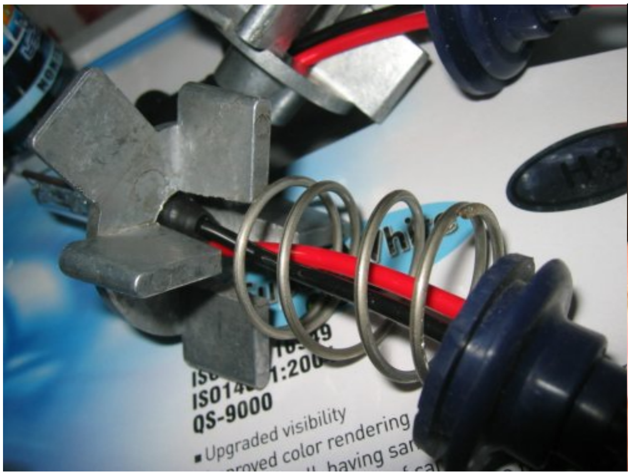
Ultimately you will need to measure things up for enough space for the wires to be run at the rear of the light. I don’t have much of an access to the likes of a Cruiser, Zuke, Rangie, Landie, Jeep etc, so unfortunately my knowledge of clearance tolerances is very limited. So, I hereby warrant that the following is what I have done and what has worked for me.

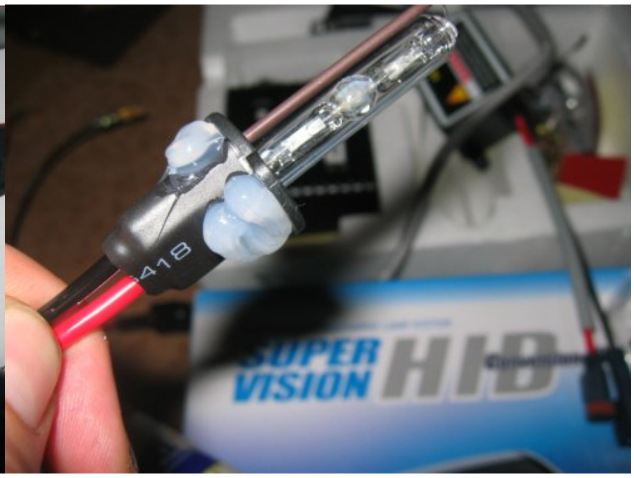
Step 20.

Add a good nice dollop of silicon to both sides underneath the base of the H3 bulb. Use either clear roof gutter, black or white silicon. The silicon will definitely be enough to hold the bulb in the base forever and a day. If the bulb ever does blow or break, you can push the bulb out with a small screwdriver from the bottom.



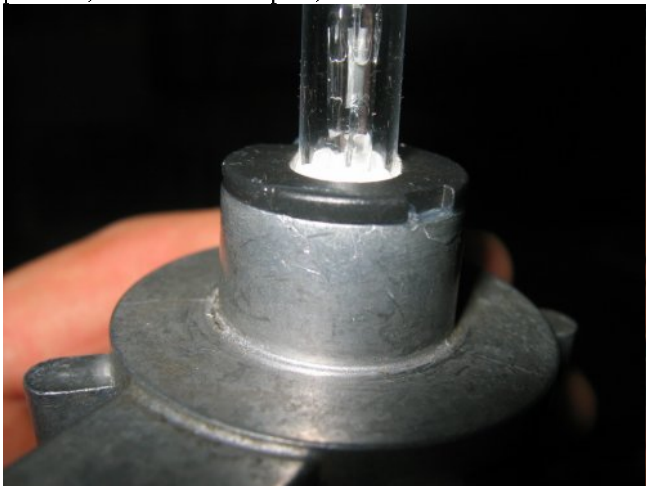


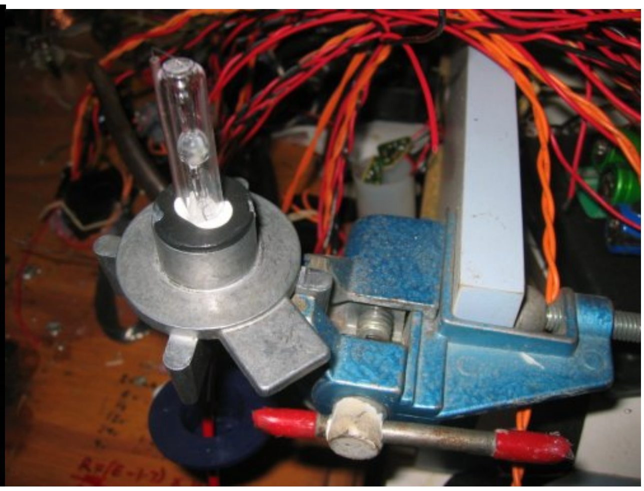




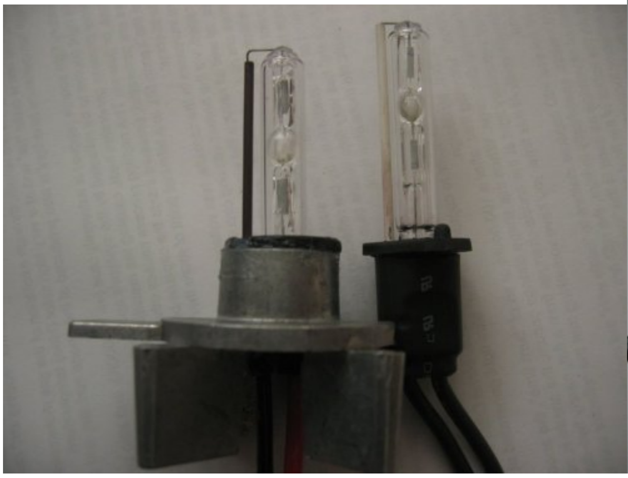
Step 21.
And push down gently but firmly. May need a rubber band around the heatsink and base of the bulb to keep it down whilst you sit the lot somewhere overnight for the silicon to dry thoroughly. Wipe excess silicon off and away from the alloy base – make it nice and clean.

Just something to note:
If you were to use a H1 HID bulb at this point, the actual position of the arc focal point would be approx 8mm (from memory) further out. This will in fact give a very bad wide beam of light. Sure it will work, but the light will be rather pathetic, will have dark spots, and will not be as focussed as that of a H3 bulb.





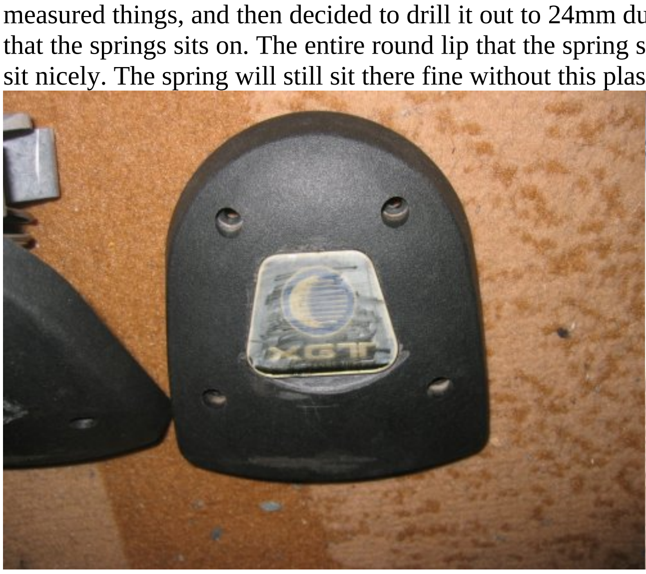
The H3 HID bulb in the XGT heatsink mount against a H1 HID bulb.

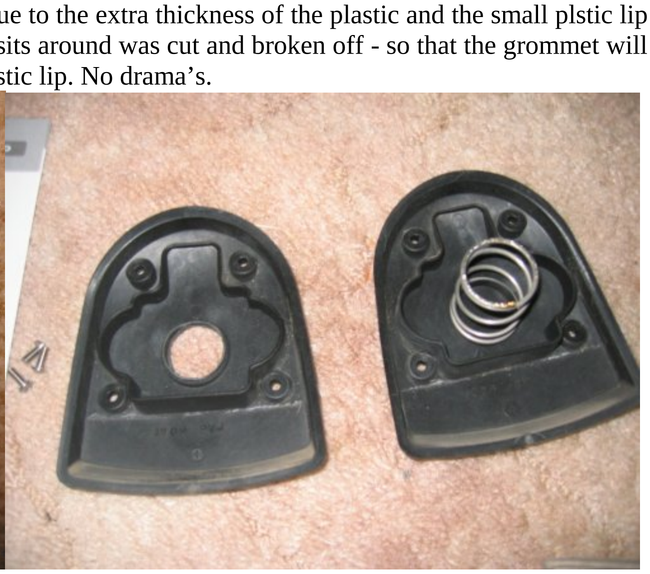


Step 22.
Check out the similar measurements of the original halogen to that of the H3 HID bulb. The origin of the arc of the HID is way bigger than that of the filament in the halogen bulb – and as they always say, bigger is usually better.

Step 23.
Grab the rear cover that you left in your safe place. While you're at your fridge, grab a beer.
With a small flat bladed screwdriver, rip off the rear XGT logo.
Polish them up a bit with a bit of toothpaste, drill a small hole, add a key ring loop, and they make a very nice key ring indeed. Give them to your Mum, your mates or just re-sell them on ebay for $5.00 each….

Step 24.
Now, depending on the size of the rubber grommet that is on your HID bulbs, find a suitable size hole saw or timber hole bit. The grommet on the Supervision 42-watt kit required a 22mm hole. So I drilled a 22 mm hole to begin with, measured things, and then decided to drill it out to 24mm due to the extra thickness of the plastic and the small plstic lip that the springs sits on. The entire round lip that the spring sits around was cut and broken off - so that the grommet will sit nicely. The spring will still sit there fine without this plastic lip. No drama's.

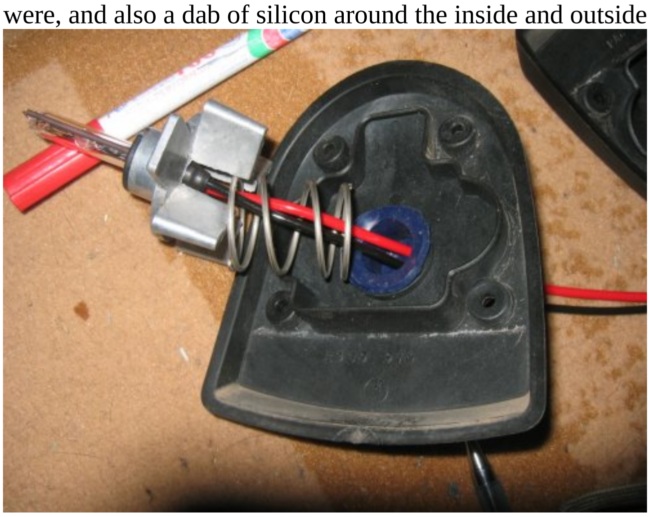




Step 25.
As shown in the below two pics, note the plastic cut away at the end of the pen. I grabbed my 100mm angle grinder with a 1mm cutting blade and ever so carefully ground away the bottom bit just enough to make the grommet sit nice and level. And also tried to make it look half reasonable. Bad photos and bad explanation - If you compare the below cover where the tip of the pen is with your cover, you should easily be able to see how much plastic to grind away.



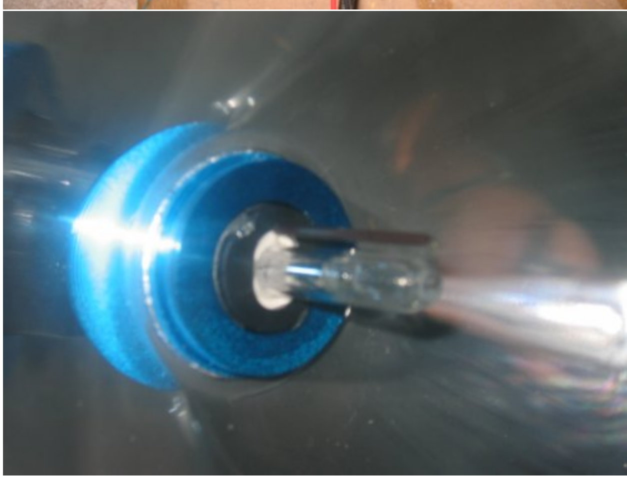
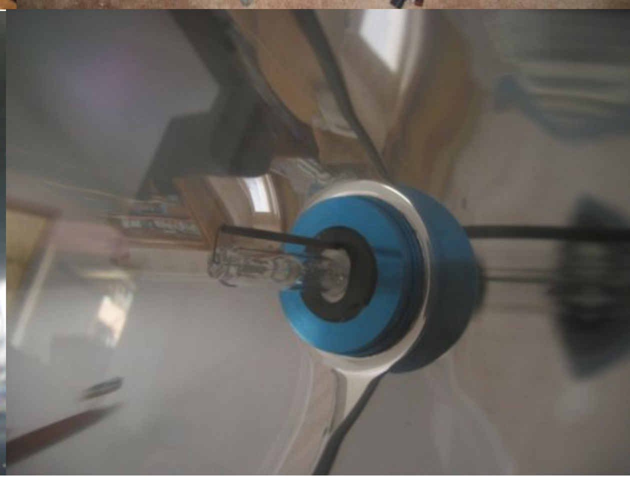

Step 26.
Grab the spring from out of the fridge and pass the end connectors through the middle of the spring. Then fold the grommet in such a way to pass it through the spring as well. Then pass the connectors and the rubber grommet through the hole and then align the rubber grommet up nicely. Position the spring on to its plastic lip on the cover. If you're worried about moisture getting into the light, add a dab of silicon to the now two blank holes where the other wires were, and also a dab of silicon around the inside and outside lips of the grommet. Let the silicon dry.

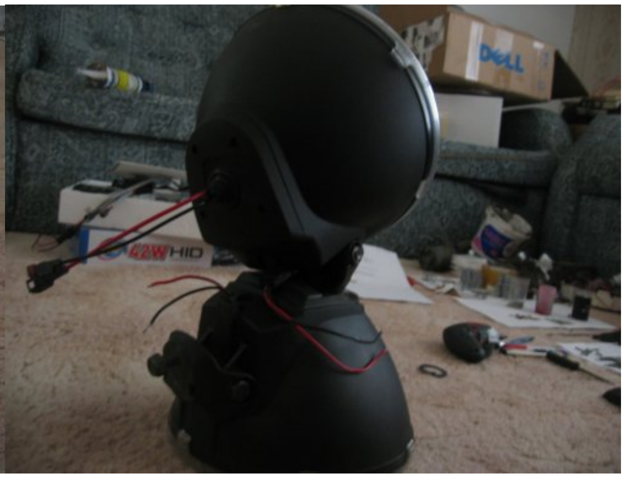


Step 27.
Grab a soft dry cotton cloth and carefully clean the bulb, because by now you would have accidentally mishandled the bulb and there possibly could be oil and dirt from your fingers/hands on the glass. If need to, dip the cloth in some metho and carefully clean the class. Allow to dry and insert the heatsink back into position. Carefully re-position the spring correctly on to the heatsink and position the cover in readiness to screw back down using the four hex screw that you oh-so carefully put away in that safe spot back in step 3. Using the 4mm Allen key screw in the four screws.

Step 28.
Observe what you have created. If clearance was to be a problem at the rear of the light, it is possible to drill your hole either to the side of the current location in the photo, or you could experiment by drilling a hole further down, either to the left or the right of the original wiring. The original 12-volt plug can be removed.



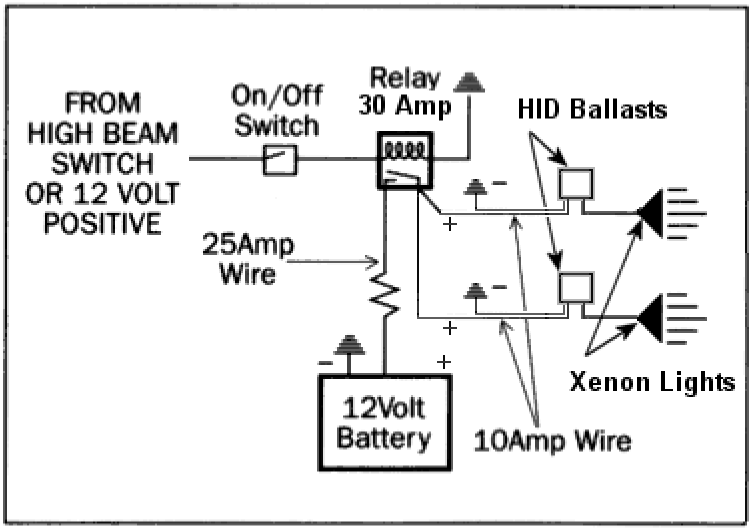


Step 29.
Now do everything above on the second XGT light.

Step 30.
Bolt the ballast (and external ignitor if your kit comes with one) somewhere close to the located where your XGT lights will be mounted. Most ballasts and ignitors will be at least IP54 rated or higher - All ballasts that I have seen are water proof to a large degree. They have had a nice big o-ring, or square-ring underneath the bottom cover. Somewhere near the radiator inside the engine bay is ideal, however due to the leads being not very long, they will still need to be fairly close to the final location of the lights. I have successfully mounted the ballast in front of the radiator to one side, however other locations can be up underneath or behind the bullbar and another hole drilled through the top of the bar for the high-tension leads. The only problem with behind the bull bar is the possibility of water/moisture.

If mounting on the roof, the ballasts and ignitor will also need to be fairly close in location. If a ute, then the roll bar of course will be ideal. If a wagon, then ideas could be along the light on the light bar, or depending on the vehicle, could be mounted inside the vehicle on the ceiling, and the wires passing through a hole in the roof. This isn't really highly recommended for your $85,000 Cruiser though – more for your old competition Rangie wagon that has yet to be turned into a ute.

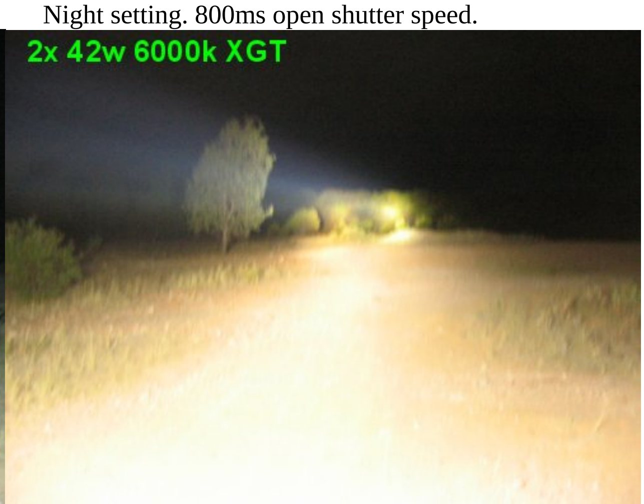
Usually there is only approximately 300mm of high-tension lead from the ballasts to the HID bulbs AND SHOULD NEVER be cut, lengthened and re-joined. Why? They are high tension silicon coated leads. Your looking at the same principle as spark plugs leads. These HID leads carry up to 25000 volts upon startup of the ballasts / ignitor to trigger the arc within the bulb. After the arc has been created, the voltage drops to 80 to 90 volts. If the leads are cut/rejoined there will always be a source for the power to try to discharge back to ground / the vehicle or yourself. Light output can diminish, voltage drop will occur and warranty will be void. Just don't be tempted to do it. Move the ballasts closer to the bulbs, don't lengthen the wire. Be aware that some ballasts are grounded to negative, and also be aware that some ballasts may need to be electrically isolated from the chassis/car body. Ie, the body of the ballast may need to be mounted on a piece of plastic isolating the ballast from ground, including the bolts/screws used to hold the ballast in place. It is also advisable to utilise at least one relay for HID ballasts, however I like a bit of redundancy in the system and have always wired up my spotlights with one relay for every light. Why? If a relay welds shut, only one will be on to blind the oncoming traffic. If a relay fails to open or the coil burns out, you will only loose one light.

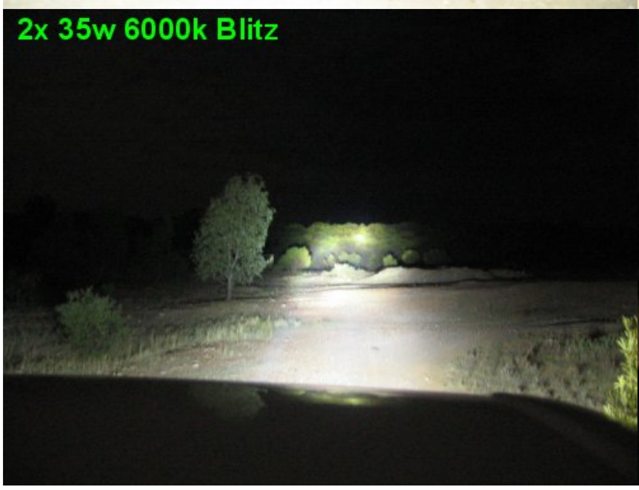


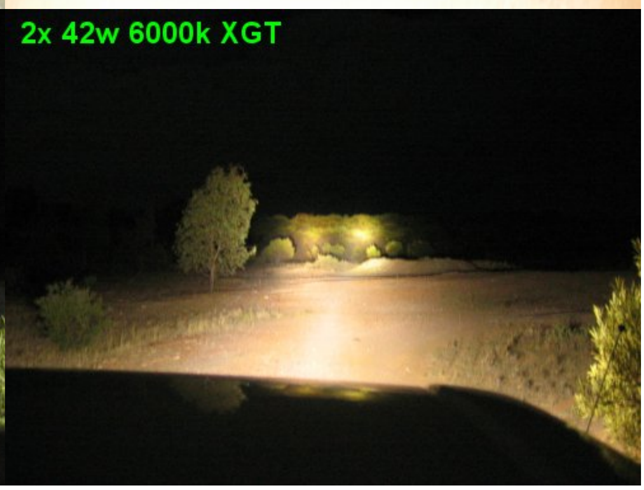
Wiring your spot light converted ballasts up like this should cause no problems at all. However it will if your normal headlight switch switches to ground or you have a positive chassis. So don't read these instructions when you are connecting up HIDs for your headlights! Most of them will be in Engrish anyway. "Don't finger the lamp, the bulb with bum out". …or you can just simply connect to your existing spotlight wiring. (Piccy from www.offroaders.com)

Night setting on digi camera. 800ms open shutter speed.

Night setting. 800ms open shutter speed.







Note the so called 6000k on the left. Box said 6000k. Is actually 5000k.

Normal daylight setting. 100ms open shutter speed.   Night setting. 800ms open shutter speed.

This next two photos are a total bewdy to prove colour output. The top two lights are these XGT's with a "Supervision" 42 watt kit that was bought from Don Sing in Brisbane, who deals on Ebay "onlineautoagarage". The box said 6000k but are actually 5000k. The bottom two lights are 240 Blitz's with a cheapy Ebay-bought "Techone" 35 watt kit 6000k. Note the colour difference!

42w "Supervision" 6000k (5000k) vs 35w "Techone" 6000K

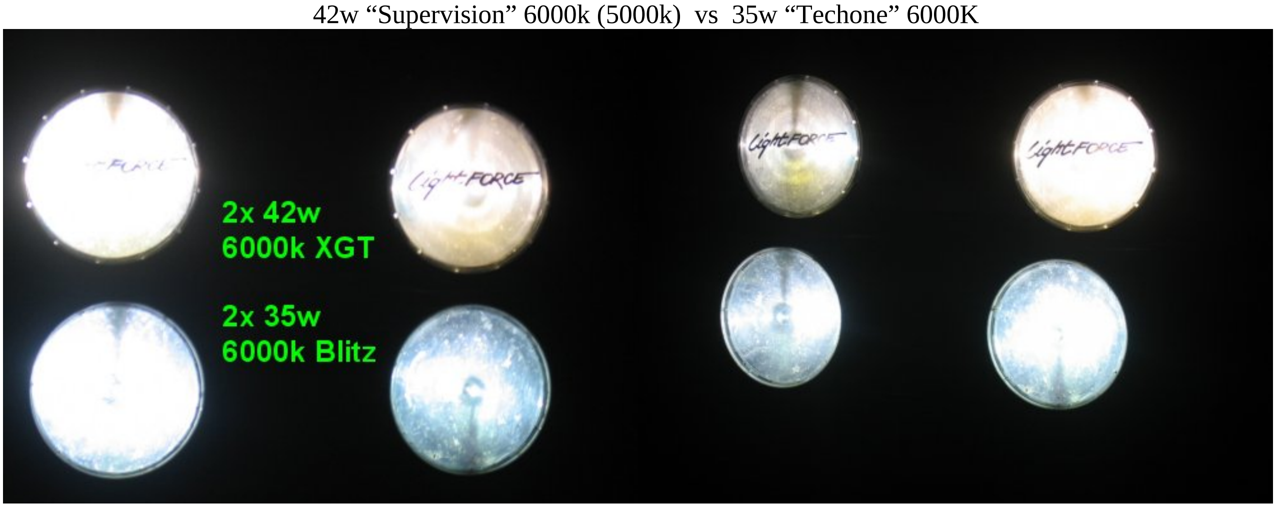


Photo taken with digital camera on normal night setting. 800ms open shutter speed.
Pics taken from bull bar level.

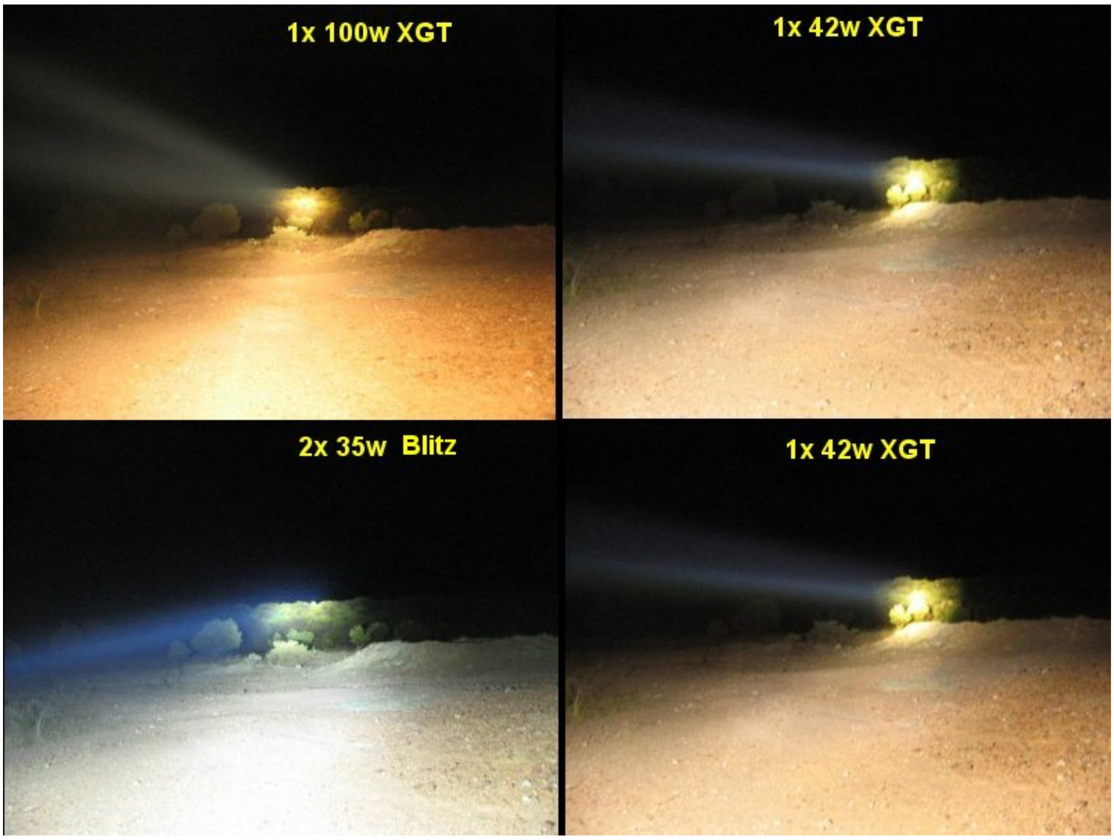


Photo taken with digital camera on normal night setting. 800ms open shutter speed.
Pics taken from roof level.

Automotive Xenon Metal Halide HID Lamps

Written by Don Klipstein (http://members.misty.com/don/d2.html)

Introduction The automotive HID (high intensity discharge) headlight lamps are often referred to as xenon lamps but they are more of a specialized metal halide lamp than anything else.

The main part numbers are:

D2S - plain

D2R - like D2S but with heat-resistant black paint on spots to control the light output pattern

D1S - like D2S, but with integral ignitor

D1R - like D2R but with integral ignitor

The above are 35 watt lamps. D2S and D1S types nominally produce 3200 lumens of light and the D2R and D1R types nominally produce 2800 lumens of light.

Description of the Lamp / Bulb This sort of lamp consists of a tubular outer bulb approx. 10 mm (.4 inch) in diameter which contains the arc tube (inner bulb). The outer bulb is made of special quartz such as cerium-doped quartz which blocks most ultraviolet, especially the more dangerous short and medium wavelengths as well as much of the 365-366 nM longwave mercury line cluster.

The arc tube or inner bulb is made of plain fused quartz and has tungsten electrodes with the distance between the tips approx. 4.2, maybe 5 millimeters (approx. or slightly under .2 inch). Its construction resembles that of a miniaturized short arc lamp, but true short arc lamps have a much more concentrated arc.

The arc tube has xenon gas in it at a couple of atmospheres to maybe a few atmospheres when cold and a few to maybe several atmospheres when hot. There is also mercury in the bulb, and when it is vaporized the mercury adds at least 20 atmospheres of pressure for a total pressure of around or maybe even over 30 atmospheres.

Metal halides - salts - are also in the arc tube. The formulation in automotive HID lamps includes sodium and scandium halides (probably iodides) and maybe traces of others such as lithium and thallium halides.

More ordinary metal halide lamps do not have high pressure xenon but have low pressure argon instead. The high pressure xenon is used to obtain some usable light output during warmup before the other ingredients have vaporized.

Safety and Reliability Requirements Please note that D1 and D2 type bulbs operate at high temperature with great pressure probably near or over 30 atmospheres. The internal quartz arc tube temperature is probably typically around 800 degrees C (1400-1500 degrees F or so). The outer bulb is not this hot, but it is definitely burning hot. The arc tube always has at least some miniscule risk of exploding and should only be operated in a headlight housing or other suitable container. Improper operation increases the risk of bulb explosion. The bulb must be clean and free of dirt, grease, organic matter, ash, salt, or alkali. Salts, ash, and alkalis have a tendency to slowly leach into red-hot and nearly red hot quartz which will result in strains, weak spots, and maybe cracks. A metal halide lamp does not like frequent starting. D1 and D2 types can be blinked, but this should only be done for a limited amount of time. Starting causes wear on the electrodes. Excessive evaporation of electrode material will deposit it onto the inner surface of the arc tube which results in darkening and overheating of the arc tube. In D1 and D2 and some other metal halide lamps, there is a halogen cycle which cleans deposited tungsten electrode material from the inner surface of the arc tube. Prolonged continuous operation at proper internal temperatures is required for the halogen cycle to work.

Legality of Auxiliary Headlights ADR 77 covers everything about Gas Discahrge Headlamps. We're not interested at all in headlamps, but what the ADR call "auxiliary driving lamps", or commonly known to the rest of us as "spotties". All my searches so far on the exact wording of this matter have ended up with very little information. Lightforce 240HID's and Hella Predators are legal within Australia. Lightforce XGT has the exact same lens as that of the Lightforce 240HID. Hella Rallye 4000 has the exact same lens as that of the Hella Predator.

Electrical Requirements The electrical requirements of D2 type lamps are nasty. They require ballasts which are more difficult to homebrew than other ballasts. I strongly encourage hobbyists, do-it-yourselfers, and hackers to *NOT* try this. Try homebrewing a D2 ballast only if you have the patience of two saints, lots of electrical and electronic project skills including high voltage skills and skill in homebrewing high voltage transformers with the combined difficulties of flyback transformers and xenon trigger transformers, and a budget for replacing lots of blown parts before you get it working. You are better off buying ballasts from Osram, Bosch, or Aromat (a division of Matsushita) or others. For one thing, these lamps require special sockets made by few manufacturers and mostly sold only to ballast manufacturers.

The D2 types require a starting pulse. 7 kilovolts may on an average spark through these bulbs, but for reliability you need more, maybe 10 or possibly 12 kilovolts. Automotive use requires ability to restart a hot bulb with the mercury vapor pressure high, and this requires even more voltage - 12 to 15 kilovolts and maybe even more for good reliability. The usual ballasts supposedly produce starting pulse voltages like 18 kilovolts minimum, 20 kilovolts typical.

D1 types have an integral ignitor which the ballast has to work with.

Starting pulses must be repeated frequently until the arc is established. The ballast must supply an open circuit output voltage - other than the starting pulses - of over 300 volts, preferably 400 or maybe preferably 450 volts - to force the arc to establish. D1 and D2 type lamps are 35 watt lamps. Once the arc is established, the ballast must supply limited current or else the arc will draw extreme current and this will be bad for the bulb and/or other parts. The voltage across the lamp is normally around 80-90 volts when it is warmed up, but will be less during warmup. The ballast must handle a lamp voltage possibly as low as 16 volts early in warmup, although this voltage usually bottoms out higher - probably at least in the 20's of volts. The ballast must deliver 35 watts to the lamp when the voltage across the lamp is between 70 and 110 volts. When this voltage is lower, the ballast must deliver at least .5 amp but generally no more than 2 amps and preferably as close to 35 watts as possible. Higher currents are preferred - a partially warmed up metal halide lamp sometimes has an unstable arc at lower current. An automotive grade ballast often delivers boosted power (above 35 watts) at some times during warmup to give near-full light output. Note that a xenon arc or a mercury vapor arc does not produce visible light as efficiently as a metal halide arc does. Automotive grade ballasts with boosted power at some points of warmup have circuitry that models the thermal characteristics of the bulb. The maximum safe current for the bulb's electrodes must not be exceeded during a power boost during warmup. A voltage across the bulb higher than 110 volts only occurs in the early stage of establishing the arc or if the bulb is failing. The ballast should deliver enough power to heat up the electrode tips enough for the arc to establish - more is better and over 35 watts is OK as long as the current is not excessive. But excessive power delivered to an aging bulb can cause the bulb to explode.

D1 and D2 lamps and most other metal halide lamps require AC. DC is tolerable briefly, and then preferably only if the bulb is cold. A DC electric field, hot quartz or hot glass, and salts or alkalis is not a good combination - electrolysis effects can occur which can create weak spots or cracks in the arc tube. The AC delivered to a D1 or D2 type bulb usually has a frequency of a couple hundred to a few hundred Hz. Higher frequencies are probably OK with D2 types but the ignitors in D1 types may only work correctly or even be adequately conductive in a certain range of frequencies. The AC current waveform in a D1 or D2 type lamp is traditionally a squarewave or close to a squarewave. Other waveforms have higher peak current for a given average current or RMS current, and the higher peak current is harder on the electrodes and may shorten the life or cause problems with the use of higher currents during warmup.

Metal halide lamps should not be overpowered, except where permissible for accelerated warmup and near-full light output during warmup. Overpowering one will shorten its life and increase the risk of the lamp exploding.

Underpowering a metal halide lamp is also bad. If the electrodes are not hot enough, they do not do a good job of conducting electrons into the arc and voltage drop in this process (known as the "cathode fall") is excessive. Excessive cathode fall causes positive ions in the arc to hit the electrode at excessive speed which "sputters" electrode material onto the inner surface of the arc tube. It is not recommended to experimentally operate metal halide lamps at reduced power. Besides the bad effects of high cathode fall on hot electrodes, an unusual temperature pattern can have the chemicals in the arc tube condense in locations that can block some of the light. And if the electrode cathode falls are excessive and unequally so, a DC electric field can result, which can cause destructive electrolysis effects on hot salts on hot quartz. This can cause the arc tube to crack. Metal halide lamps should have power input within 10 percent of their rated wattage.

Why some HID lights stay "blue" after warm-up - by Ekooke

1) To capture the blue light produced at the arc terminators on a continuous basis, some OEM manufacturers design (deliberately point) a small portion of the reflector to capture the "flat" blue light generated at the anode, and incorporate it as part of the total light output, by design.

2) Other OEMs will just "leave it alone", knowing that, after a 100 hours or so of "burn time", the anode will change shape, because of the constant electrical discharge. When this shape change occurs, the anode is no longer ground flat, and the shape of the blue secondary light at the anode changes from a flat, nearly two-dimensional, shape, to something that is three-dimensional. At this time you have something that the reflector can use, and, you've got blue-tinted light, all the time.

3) A trend for "blue" lights has caused several HID capsule makers to "fiddle with" the metallic salt mix just for the aftermarket. By incorporating different metals, specifically Indium, the HID arc can continuously fluoresce at higher color temperatures with the same amount of voltage as used in the "lower color temperature" HID capsules. Results have been mixed, depending on the optics of the final applications. This is due to the "stratified light" nature of the stabilized HID arc, and how the reflector focuses on the total arc "layers". Also, the use of different metallic salts may also decrease the useful life of the HID capsule, through quicker metal deposition on the capsule walls. Note: Indium is a material also used to plate mirrors, via a cathode/anode process.

Info on HID lights. – blue light output

Without going into the physics of electron orbits, photon pumps, valences, and other arcane stuff, it has to do with;

The ballast/igniter, the nature of the arc terminators (cathode -, and anode +), the ignition (startup) current, the vaporizing metallic salts, and the constant Xenon gas fill.

When a cold (room temperature) automotive HID is first turned on, the startup voltage produced by the igniter (sometimes separate, sometimes integrated into the ballast) is in the neighborhood of 20,000-25,000 volts. This high voltage potential forces the current at the arc generating point (cathode -) to leap the gap to the arc receiving point (anode +), identical to what happens with an arc welder. As the "leaping arc" contacts the anode, a number of interesting things start to happen;

1) Light is produced along the arc length, through excitation of the gas molecules of the (constant) Xenon-fill gas. At this point, the arc is quite "fat" and at a very high color (blue) temperature.
2) Robust high temperature blue light is also produced at the anode surface, and (to a lesser extent) at the cathode**.**
3) This secondary light source (above) is extremely blue (+/- 10,000K), and also semi-spherical in nature, which allows this light source to be reflected by the system's optics.
4) The arc welder process generates heat, causing the metallic salts also contained in the capsules to begin to vaporize into gas, or gasses. This heating process causes other changes:
5) As the gasses are generated, pressure inside the capsule begins to rise, from a static pressure of 5 atmospheres (from the Xenon fill), to a terminal point of more than 30 atmospheres. Total pressurization takes (typical) 30 seconds to occur.
6) As the pressure increases in the capsule, less voltage is required to sustain the arc (electron flow), and the ignition current is dropped, via the ballast sensing circuitry, in a tapering fashion. This causes the arc to shrink in diameter and stabilize, as well as reduce the electrode surface sources of "blue" light. Note: The electrode (secondary) light sources are now very flat, like an LED, making them difficult to be captured by the reflector

surface, because the reflector is designed to reflect axially produced light. What happens at this point is that the blue light (apparently) goes away. This is because; the arc is shrunken and stabilized, the voltage has been reduced to "arc sustaining", the fluorescing gasses are running at a lower color temperature, and most of the usable (i.e., by the reflector) light is being generated just along the arc's axial length. This "sustaining arc" has very little visible blue light, and the flat electrode-generated light is "invisible" to the reflector. Result: No more blue light.

The following was grabbed from http://www.offroaders.com

High-intensity discharge (HID) lamps include these types of electrical lamps: mercury vapor, metal halide (also HQI), high-pressure sodium, low-pressure sodium and less common, xenon short-arc lamps. The light-producing element of these lamp types is a well-stabilized arc discharge contained within a refractory envelope (arc tube) with wall loading in excess of 3 W/cm² (19.4 W/in.²). Compared to fluorescent and incandescent lamps, HID lamps produce a much larger quantity of light in a relatively small package.

Construction

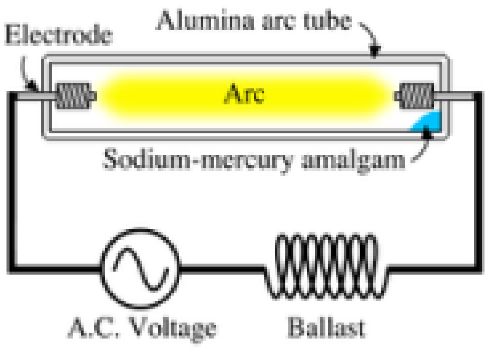


Diagram of a high pressure sodium lamp.

HID lamps produce light by striking an electrical arc across tungsten electrodes housed inside a specially designed inner fused quartz or fused alumina tube. This tube is filled with both gas and metals. The gas aids in the starting of the lamps. Then, the metals produce the light once they are heated to a point of evaporation.

Types of HID lamps include:

Mercury vapor (CRI range 15-55) Metal halide (CRI range 65-80, ceramic MH can go to 90's)
Low-pressure sodium (CRI 0 owing to their monochromatic light) High-pressure sodium (CRI range 22-75).

Mercury vapor lamps, which originally produced a bluish-green light, were the first commercially available HID lamps. Today, they are also available in a colour corrected, whiter light. But they are still often being replaced by the newer, more efficient high-pressure sodium and metal halide lamps. Standard low-pressure sodium lamps have the highest efficiency of all HID lamps, but they produce a yellowish light. High-pressure sodium lamps that produce a whiter light are now available, but efficiency is somewhat sacrificed. Metal halide lamps are less efficient but produce an even whiter, more natural light. Coloured metal halide lamps are also available

Auxiliary devices Like fluorescent lamps, HID lamps require a ballast to start and maintain their arcs. The method used to initially strike the arc varies: mercury vapor lamps and some metal halide lamps are usually started using a third electrode near one of the main electrodes while other lamp styles are usually started using pulses of high voltage.

Applications HID lamps are typically used when high levels of light over large areas are required, and when energy efficiency and/or light intensity are desired. These areas include gymnasiums, large public areas, warehouses, outdoor activity areas, roadways, parking lots, and pathways. More recently, HID lamps, especially metal halide, have been used in small retail and residential environments. HID lamps have made indoor gardening practical, especially for plants that require a good deal of high intensity sunlight, like vegetables and flowers. They are also used to reproduce tropical intensity sunlight for indoor aquaria. Some HID lamps such as Mercury Vapor Discharge produce large amounts of UV radiation and therefore need diffusers to block that radiation. In the last few years there have been several cases of faulty diffusers, causing people to suffer severe sunburn and Arc eye. Regulations may now require guarded lamps or lamps which will quickly burn out if their outer envelope is broken. Recently, HID lamps have gained use in motor-vehicle headlamps. This application has met with mixed responses from motorists, mainly in response to the amount of glare that HID lights can cause. However, many motorists still prefer these lights as they emit a clearer, brighter, more natural appearing light than normal headlamps. They almost always have an automatic self-leveling system to minimize this issue and as such are usually an expensive optional extra on most cars. HID lamps are also being used for all external lights on the Airbus A380 superjumbo airliner and on many other general aviation aircraft for landing and taxi lights.

Watts Watts is a measurement of the current draw. A watt is the unit of electrical power equal to 1 ampere (amp) under a pressure of 1 volt. (Its also equal to 1/746 horsepower for what it's worth). Amperes are the rate at which electricity flows through a wire or piece of machinery. A good analogy is water through plumbing. When you open a faucet on a sink, water flows out at a certain rate. The same thing occurs when you turn on an auxiliary light. Electricity flows at a certain rate. This is amperes. Watts are the amount of energy a device uses in performing its function. To get watts, you multiply volts x amps. For example, a typical set of offroad auxiliary lights might draw about 4.6 amps. 12 volts x 4.6 amps = 55.2 watts. To get amperes, divide watts by volts. Examples: 55 watt auxiliary lights would calculate like this: 55 watts / 12 volts = 4.58 amps. In the home a 100 watt light bulb would calculate this way: 100 watts / 240 volts= 0.416 amps.

Candlepower One candlepower is the radiating power of a light with the intensity of one candle. This unit is considered obsolete as it was replaced by the candela in 1948, though it is still in common use. 1 candlepower is equal to about 0.981 candela. *

Candela The standard unit for measuring the intensity of light. The candela is defined to be the luminous intensity of a light source producing single-frequency light at a frequency of 540 terahertz (THz) with a power of 1/683 watt per steradian, or 18.3988 milliwatts over a complete sphere centered at the light source. *

Lumen The standard unit for measuring the flux of a light being produced by a light source. One lumen represents the total flux of light emitted, equal to the intensity in candelas multiplied by the solid angle in steradians (1/(4.pi) of a sphere) into which the light is emitted. * * source: Russ Rowlett at unc.edu

With Offroad lights different light sources could have the same power requirements, but vastly different light output. The primary factor of candlepower are the bulb itself. The light itself is then influenced by the reflector placed behind the bulb, reflecting the light outward towards the target area. The brighter and more efficient the bulb is the more light it will produce using less energy. When a bulb produces light, some of the energy is wasted by producing heat. The more efficient a bulb is at creating light, the less heat it will produce. An LED light (light emitting diode) are a prime examples of efficiently generating light with very little energy wasted as heat. Therefore LED lights consume a less amount of energy then incandescent bulbs. However LEDs are not high light producers when compared to other bulbs typically used in offroad lights. Typically Quartz Xenon bulbs and standard halogen bulbs are used.

The reflector's role is to "reflect" the light generated by the bulb. Most of the light projected from an offroad auxiliary light is actually from the back and sides of the bulb and not projected directly from the bulb itself. Therefore the better the design of the reflector the more light will be reflected outward towards the target area. With the reflector size matters. The larger the reflective area of a light, the more light will be reflected out towards the target area. The shape of the reflector is also important. A well engineered reflector will produce a desirable spread of light on the area in front of it. The shape of the area can differ from manufacturer to manufacturer. Some manufacturers design into the light reflector the means to change the focal length so you can change the spread of light from a more point point to a flood of light. Because light from a bulb emits in all directions, the more efficient design of a light is a broad, somewhat deep circle shaped reflector. The least efficient is the small egg shape or rectangle lights that reflect less light. With the reflector, the reflective surface should reflect as much light as possible with a mirror like finish and deteriorated reflectors will obviously have a negative effect on the light emitted.

A good set of offroad lights will have a combination of the best factors, a highly efficient, very bright bulb and a large, broad, weather tight reflector. Reviews can be good sources of information to get opinions on popular offroad lights as well as new lights as they become available on the market.