Converting Porsche 928 Interior Lighting to LEDs

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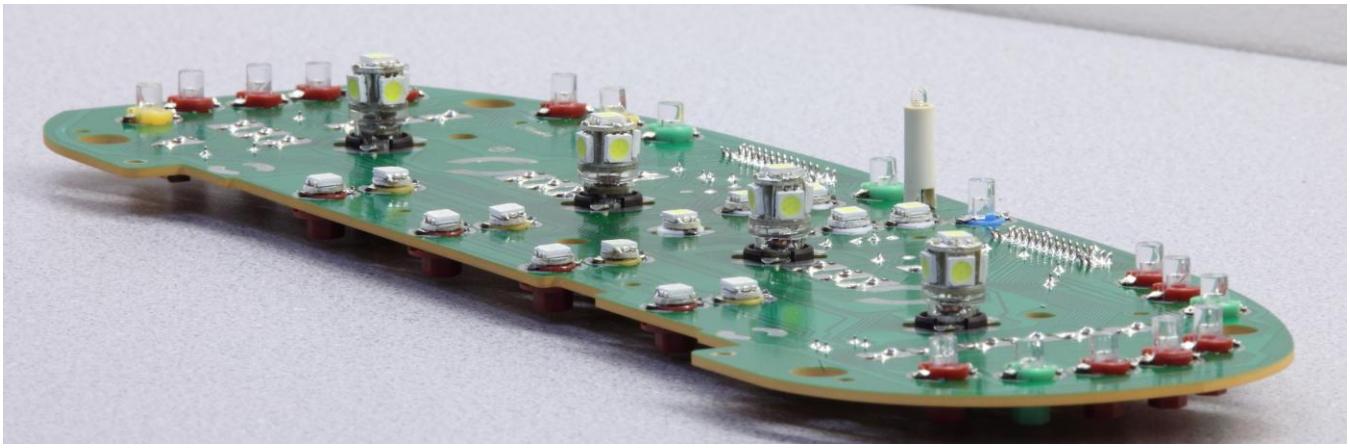
Revision 0.3 (Incomplete Early Draft)



Introduction

This document is intended to provide guidance to those who would like to upgrade their Porsche 928 to use LEDs rather than incandescent lamps for interior lighting. While some of the interior lighting (such as the courtesy lights) are quite simple to upgrade to LEDs, other items such as the instrument cluster and central console (climate control head, etc.) are quite a bit more challenging.

Scope and Limitations

This document is based on my experiences of upgrading a 1990 Porsche 928 S4. It is likely that this guide will apply to 1989 and later 928s; earlier models, however, had significantly different instrument clusters. Models prior to 1987 are even more different and even less of this guide will apply.

Requirements

As I was carrying out my interior lighting upgrades from incandescent lighting to LED lighting, I had the following requirements (or at least preferences):

- Replace *every* incandescent bulb with an LED bulb.
- Increase overall brightness of instrumentation lighting (both backlighting and indicators).
- For any socketed bulb, find replacement LED lamps with identical bases if possible (i.e., no filing or other modification of bulb base or socket).
- Attempt to achieve uniform brightness of indicators, i.e., don't have any indicators arbitrarily brighter than others (e.g., the central locking button always struck me as being *way* too bright when fully illuminated relative to the other indicators).
- Retain functionality of the instrument illumination control using the original rheostat.

Caveats

In a few cases, results were short of what I would consider ideal. These were — in my opinion — acceptable, but still noteworthy. Rather than listing those items here, I have noted them in sidebars.

Terminology

"Owner's Manual" terminology is used when appropriate. For example, the speedometer and tachometer (among many other instruments and lights) are part of the *instrument cluster*, which also contains the *park brake warning light*, the *air bag warning light*, the *high beam indicator light*, etc.

The S.I. system of units is used.

How to View Photos at Higher Resolution

If you are viewing this document using Adobe Reader (or any other PDF viewer that supports links), the photos in this document are links; if you click a photo, your viewer application should take you to a substantially higher-resolution image on Picasa Web.

Note that when viewing a photo in a web browser, many web browsers (such as Microsoft Internet Explorer) will scale the photo so it will fit within the viewable area of the browser window. You can typically click the image to re-expand it to its full resolution, and then you can scroll around in the image using the browser's horizontal and vertical scroll bars.

Warnings

- ⚠ Always disconnect the car's battery ground strap before performing significant work on the car's electrical system unless you are *absolutely* sure that the circuit you are working on is not live (e.g., you're *sure* that you've removed a fuse that provides power to the circuit). This isn't necessary for minor items (such as pulling the knob off a pod switch and replacing the bulb). But for complex devices such as the instrument cluster, there are so many signals from so many sources that it is not wise to attempt to work on it (or disconnect/connect it) "hot."

- ⚠ [more warnings TBA]

Credits

I would like to acknowledge the trailblazing work related to interior lighting of three people:

- Keith Widom (Rennlist handle "928ntslow"), whose "Interior LED Changeover (uhm...Looooong)" thread on the Rennlist 928 Forum provided the inspiration for diving into the instrument cluster and some of the other lighting. In fact, I regard my write-up as a more comprehensive and updated version of Keith's write-up.

- (Rennlist handle) "Schocki", whose "15 minute instrument pod removal update and instrument light bulbs for an OK price" thread on the Rennlist 928 Forum provided key information on how to remove the instrument cluster without removing the steering wheel. Those who doubt that you can remove the instrument cluster in fifteen minutes… well, (with the knee protector trim already removed) I timed myself and got mine out in six minutes. Once you've done it at least once, it's really easy. Getting in back in takes a little longer (at least it does for me ☺).

- "Wojtek", whose "My 1987 Porsche 928 S4, 5 speed: Instruments Illumination" provided some very good ideas about instrument illumination, particularly related to the climate control head (I wound up doing something like what he did for backlighting the fan speed control knob).

Parts, Tools, and Techniques

Necessary (or Just Useful) Items

- soldering iron suitable for use on small-gauge wires and PC boards (you might find that you'll want a flat tip for some tasks and a conical tip for other tasks)

- solder

- solder sucker and/or wick for de-soldering

- clip-on heat sink (for dissipating heat from heat-sensitive components when soldering)

- wire cutters
- needle-nose pliers
- assortment of heat-shrinkable tubing
- bench power supply
- multimeter
- test leads terminated with alligator clips, test clips (I really like the little "hook" style), banana plugs; various terminations are used for attaching to power supply, multimeter, circuit under test/being powered, etc.

Working with LEDs

LED Types

There are two main types of LEDs you will be working with in the applications covered by this document:

- *12 V LED lamps*: these are one or more discrete LEDs (see next item) packaged along with a diode and current limiting resistor wired in series such that the LED(s) are protected against reverse voltage (by the diode) and such that their drive currents are regulated by the resistor so they are operating with safe power dissipation when a +12 V voltage is applied across the lamps' terminals. These LED lamps are generally easy to work with and unlikely to be damaged as long as you don't exceed 14 V when powering them.

- *Discrete LEDs (also known as component LEDs)*: these are just "raw LEDs" that rely on external circuitry to limit their drive current. They should not be reverse biased, i.e., they should not have a higher voltage at their cathode than their anode. Discrete LEDs should be used with care, as they can be easily destroyed in two ways: reverse biasing them or exceeding their rated maximum drive current.

⚠ Applying current from a typical power supply or battery directly to a discrete LED *without* using a current-limiting resistor in series with the LED is likely to destroy the LED.

LED Polarity

- It is important that you get the polarity correct on all LED bulbs when inserting them into a circuit. LEDs have an anode ("positive side") and cathode ("negative side"). In an automotive application, the anode is typically connected to some positive voltage (usually a +12 V source or some other smaller positive voltage) and the cathode is typically connected to ground. Some LED bulbs are diode-protected so that if you insert them with reversed

polarity, it will do no harm, but *a diode-protected LED bulb inserted with inverted polarity will not light*.

- The polarity on some LED bulbs that have internal reverse voltage protection is often not marked. It is best to bench test your LED bulbs and, while you're at it, mark the polarity. I mark the cathode side (that will connect to the ground/low/negative side of the PC board) with a black marker. Likewise, the sockets for the bulbs — since they were typically intended for use with incandescent bulbs (non-polarized) — should be marked; a black mark on the ground side should suffice.

- On the most common discrete LEDs, the cylindrical/dome-shaped 3 mm or 5 mm diameter ones, the cathode is indicated by the flat side of the flange on the plastic package as well as the shorter of the two leads.

- A discrete LED will likely be destroyed almost instantaneously if you reverse bias it (i.e., apply a higher voltage to its cathode than its anode). Actually, you can get away with some reverse bias (as long as you don't exceed the LEDs *reverse bias breakdown voltage*), but it's best to just avoid *ever* applying reverse polarity when working with discrete LEDs.

Choosing Current-Limiting Resistors for Discrete LEDs

If you are using discrete LEDs to replace incandescent bulbs (i.e., in the absence of existing LED driving circuitry), you will need to add a current-limiting resistor (and optionally, a reverse polarity protection diode).

To determine the resistance needed, consult the specifications of the LED; look for the "continuous forward current" parameter. Then, given the voltage (14 V if you want to be conservative, knowing that in automotive applications, the voltage is often higher than 12 V and sometimes as high as 14 V), apply Ohm's law: V = I × R, i.e., voltage equals current times resistance. Use a resistor of *at least* the calculated value (the higher the resistance, the less current will flow through the LED, making it dimmer, but also making it run cooler and last longer).

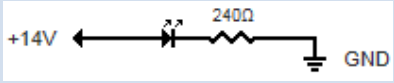
Example #1: given a LED with continuous forward current of 50 mA, then R = 14 V ÷ 0.05 A = 280 Ω. So… you would use a resistor of *at least* 280 Ω. In this case, I'd experiment with resistors certainly no less than 280 Ω, but perhaps as high as 1.5 kΩ, choosing one that provides an acceptable light intensity (remembering that a higher resistance means less current, less heat, and longer LED lifetime).

5%, ¼ W or ½ W carbon film resistors are usually acceptable for most discrete LED current limiting applications. To determine whether to use a ¼ W or ½ W resistor, you can check how much power the resistor will be dissipating using P = I × V, i.e., power equals current times voltage (actually, the LED dissipates some of the power, too, but we can be conservative and ignore that and assume that the resistor

On-Line LED Current-Limiting Resistor Calculators

There are on-line calculators that, given a few of the parameters of an LED, will provide you with the minimum acceptable current-limiting resistor.

For example, the "LED Calculator" at http://ledcalculator.net/ given the values from Example #1 (see main text on left) provides the following schematic:



dissipates all the power). Note that you can substitute a ½ W resistor where a ¼ W resistor would suffice, but not (in general) vice-versa.

Example #2: Let's assume a 14 V voltage source and a 1 kΩ resistor wired in series with an LED. The resistor would dissipate no more than $P = I \times V = (V \div R) \times V = V^2 \div R = (14\ V)^2 \div 1000\ \Omega = 0.196$ W. Since this is less than 0.25 W, a ¼ W resistor would suffice.

5%, ¼ W and 5%, ½ W carbon film resistors in a wide range of resistances are readily available from both on-line sources as well as local sources. Radio Shack carries a wide variety.

Selecting the Best LED Color

With few exceptions, it's best to choose an LED color that is well matched to whatever color filter is in front of it.

For example, the turn signal indictor was originally a "white" incandescent bulb behind a green filter to make the indicator "green". Use a green LED for this application.

Whereas incandescent bulbs emit light with a fairly wide range of frequencies in the color spectrum (generally rather "yellowish white"), LEDs emit light at a very specific frequency; they emit a more "pure" color, e.g., "pure green." Using a white LED behind a colored filter generally won't give results as appealing (the color won't be as saturated) as putting the same color LED behind the filter as the filter color.

In a few cases (such as the automatic-transmission-equipped car's "selector lever position indicator"), a compromise must be made, as the same lamp shines through multiple filter colors (white and red or white and green); a white LED is appropriate in such a case, but the result will appear somewhat washed out.

Instrument Cluster Anomalies

The following minor imperfections were noted with the instrument cluster after performing the LED upgrades as described in this document:

- The air bag warning light illuminates *very* briefly (probably just a few milliseconds; barely noticeable) at regular intervals approximately every three seconds when the system is operating normally.
- After shutting off the ignition, the park brake warning light (if the park brake is applied) and the ABS warning light are illuminated very dimly as long as the information system display.

Further tweaks (like loading resistors in parallel with the corresponding LEDs) might eliminate these anomalies; I didn't believe that it was worth the additional circuitry.

Instrument Cluster

Overview

[TBA]

Removal

⚠ As the instrument cluster has four connectors with numerous signals, I'd strongly recommend disconnecting the battery (and not just trying to pull a fuse or two) when removing the instrument cluster.

To remove the instrument cluster, follow the instructions at "15 minute instrument pod removal update and instrument light bulbs for an OK price" (http://forums.rennlist.com/rennforums/928-forum/372301-15-minute-instrument-pod-removal-update-and-instrument-light-bulbs-for-an-ok-price.html).

To remove the instrument pod, you will first need to remove (using a 5 mm Allen wrench) five socket head cap screws:

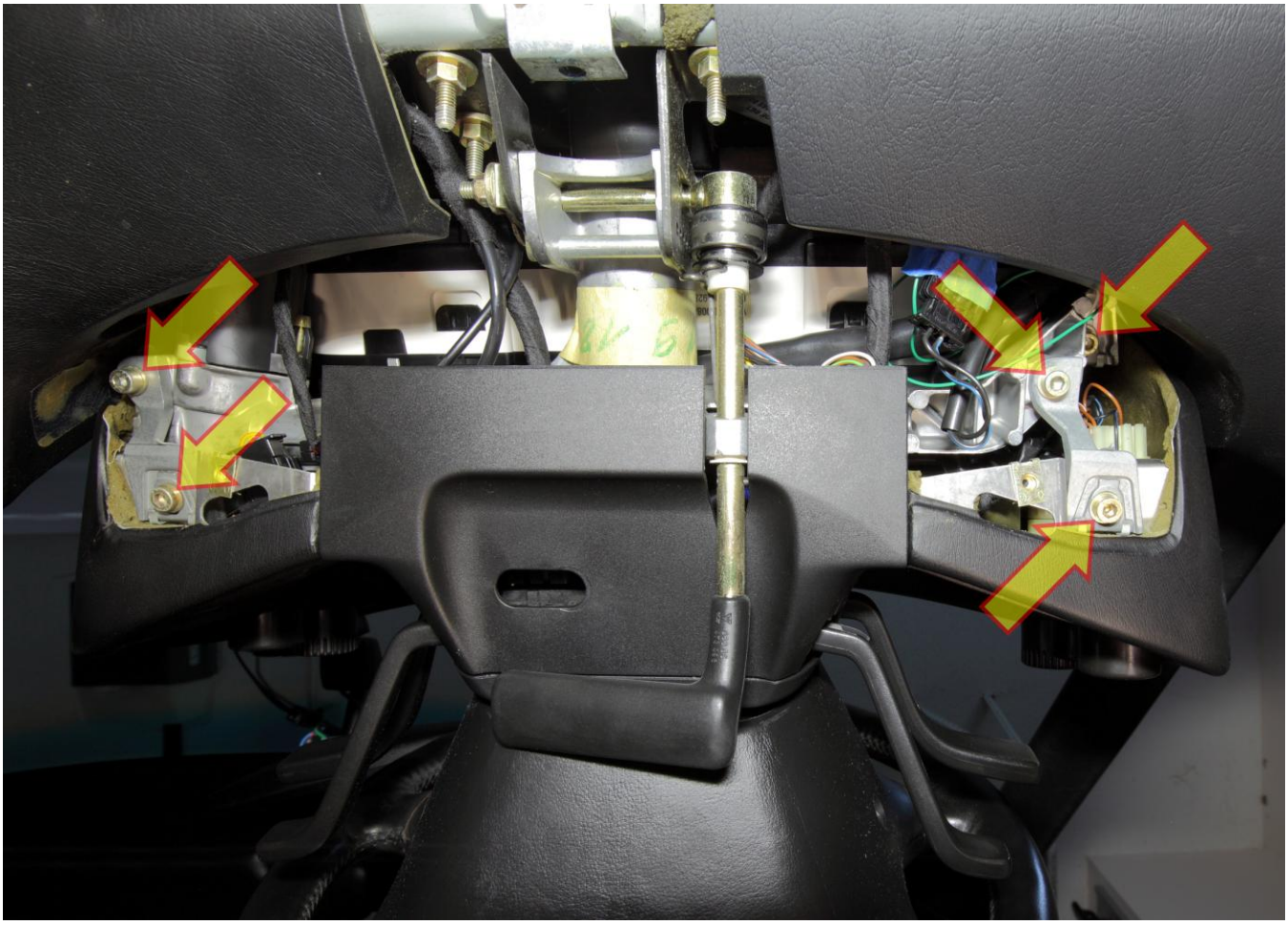
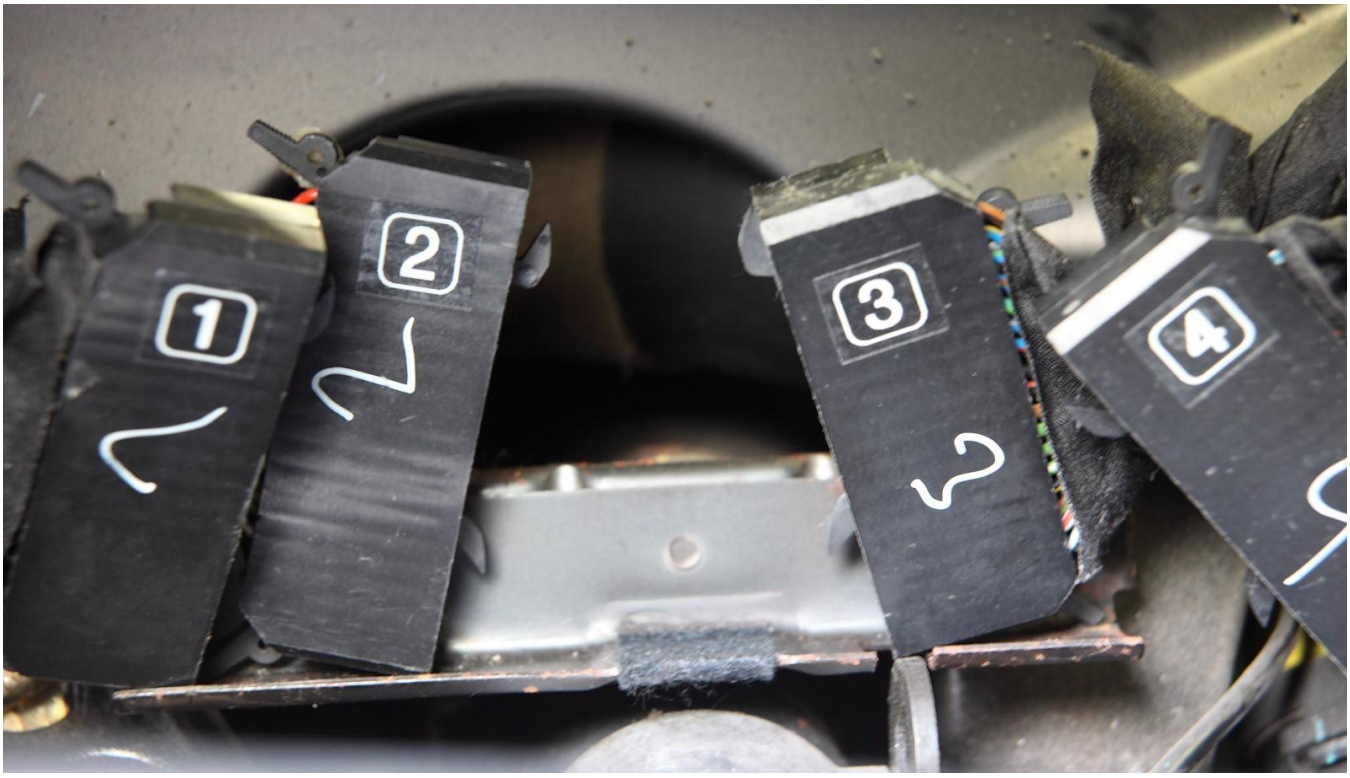


Figure 1 Looking up at the bottom of the instrument pod and the five screws that secure it

You might find that disconnecting the four cables to the instrument cluster is a little challenging if you haven't done it before. Be very careful when unlocking the four connectors. The two little locking levers on each connector are fairly strong, but you can break them if you don't understand how they work. Study the next photo to assist in your understanding of how the locking levers function.

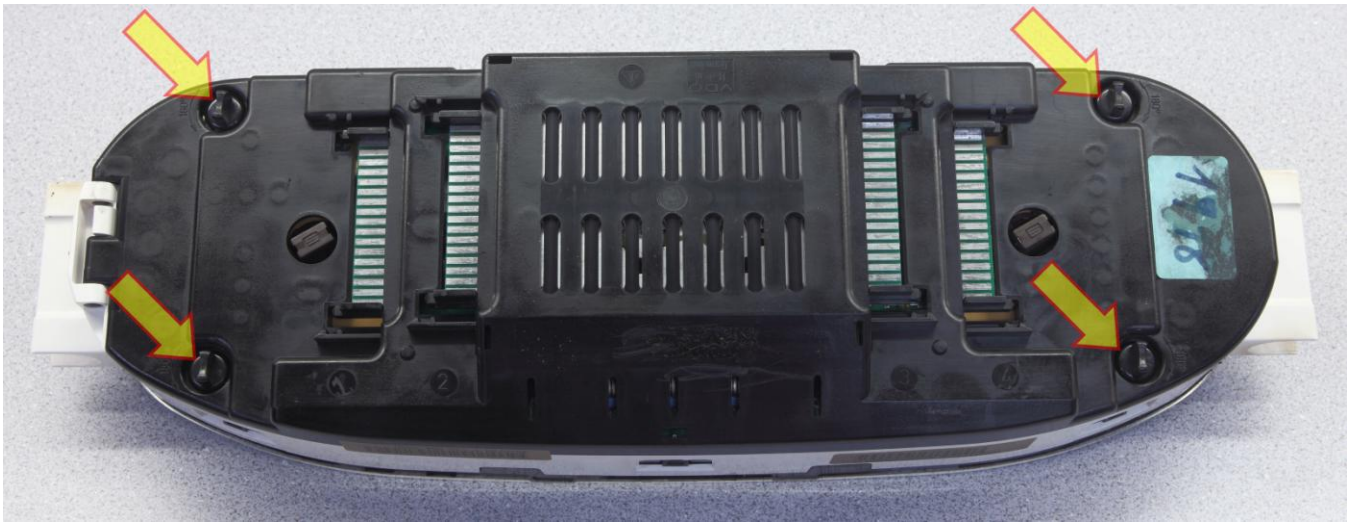
When working with these connectors:

- Move the locking levers slightly away (perpendicular from what appears to be their main direction of travel) from the connector (bend them a little) to allow them to move. This is necessary because the there are little slots on the connector and little "pins" on the locking levers that lock them into position either fully closed or fully open.
- Operate both of the levers at the same time if you can; you probably cannot fully unlock one lever while the other one is still locked (this is because as you move the levers to unlock, it also pushes the connector away from the PC board, but it can't do this if the other lever is still locked and if you're not careful and try to force it, you'll likely break the locking lever).
- Consider improving the labeling, since it is likely you'll be plugging/unplugging them more than once and you'll want to be confident you're working with the right connectors (mine had hand-written labels on the connector, but the corresponding labels on the cluster itself were black-on-black and very hard to see). See photos below for improved labeling.

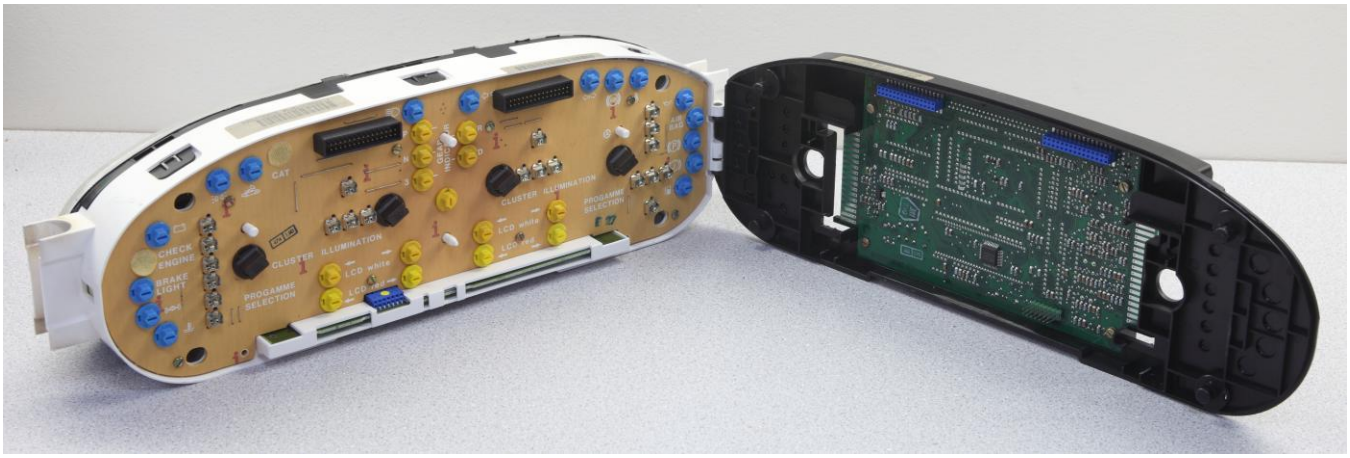


Instrument Cluster Disassembly

To get to the instrument backlighting bulbs, information display backlighting bulbs, and various indicator and warning bulbs, you will first need to separate the rear-most black part of the cluster from the white intermediate part. To do this, rotate each of the four black knobs (see arrows in photo below) on the back of the cluster 180° counter-(anti-)clockwise. You can see the “180°” label near each one of those knobs if you look carefully. Note that these knobs may be difficult to turn if they haven’t been operated for some time; mine were, so I lubricated them with some light, general-purpose oil after I got the back off so they’d subsequently be easier to operate.



This unlocks the black rear part; you can then open it up like a door:



If you open them up all the way (about 90°) as shown in the above photo, the two pieces will completely separate at the hinge when you move the white half up and the black half down.

At this point, you can familiarize yourself with the main PC board for the instrument backlighting and indicator/warning lamps.

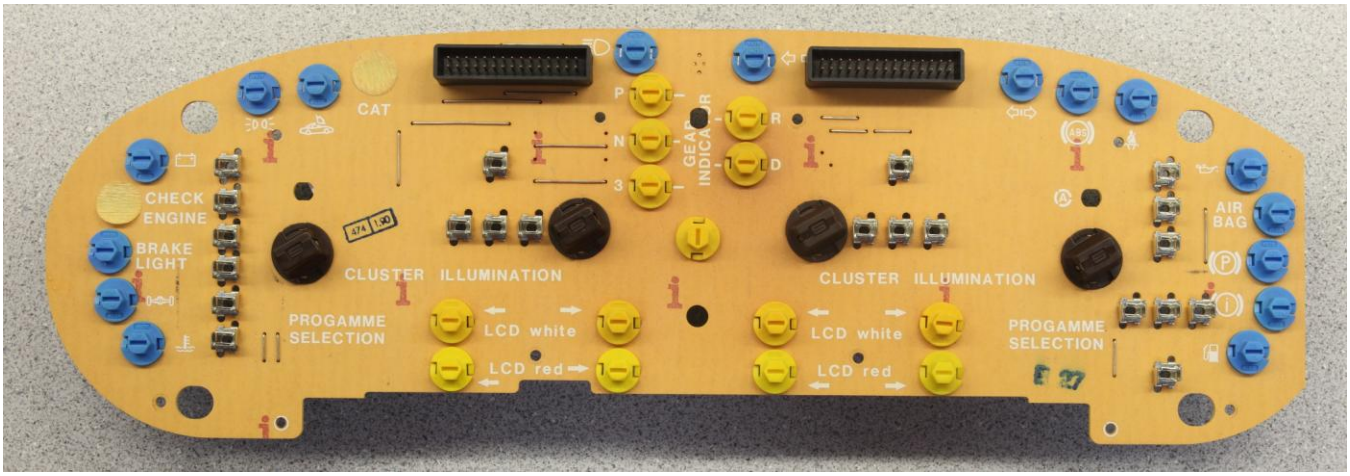
What you'll see (mostly nicely labeled):

- eight screws holding the PC board to the white plastic enclosure;
- twenty-one silver sockets with containing pins; these are the electrical connections for the various analog gauges (they'll come unplugged if/when the PC board is pried off);
- four backlighting bulbs for the analog gauges (brown twist-lock bases) (labeled "CLUSTER ILLUMINATION"); and
- lots of other bulbs in B8.4d twist-lock bases; the lower eight yellow ones are for the LCD information display backlighting (labeled "LCD white" and "LCD red"); the rest are for various indicator and warning lamps and are all nicely labeled.

If you were just replacing a small number of bulbs with identical incandescent bulbs, you could probably just do that now, but as you will be doing more substantial modifications, you should remove the eight screws and carefully pull/pry off the PC board. With the eight screws removed, the only things holding the PC board are the analog gauge connectors; they'll separate as you pry/lift the PC board.

Once you've separated them, you'll be left with this:

and this:



You'll probably get all excited and flip the PC board over so you can see all the bulbs:

At this point, you've got access to all the parts you'll need to replace and work on for the LED upgrade of the cluster.

Overall Guidelines for Lamp Replacement

Beveling Holes in PC Board for B8.4d Bulbs

[TBA]

Dealing with Twist-Lock Contact Shape and Unreliability

[TBA]

Marking Polarity

[TBA]

Checking Lamps after Installation

[TBA]

Anticipating and Preparing for Bulb Failures

[TBA]

Tools

[more TBA]

- A ¼ inch and/or 6 mm socket make excellent tools for removing the B8.4D twist lock bulb bases. You can use a flat-tip screwdriver in the slot, but the plastic base is rather soft and tends to deform fairly easily.

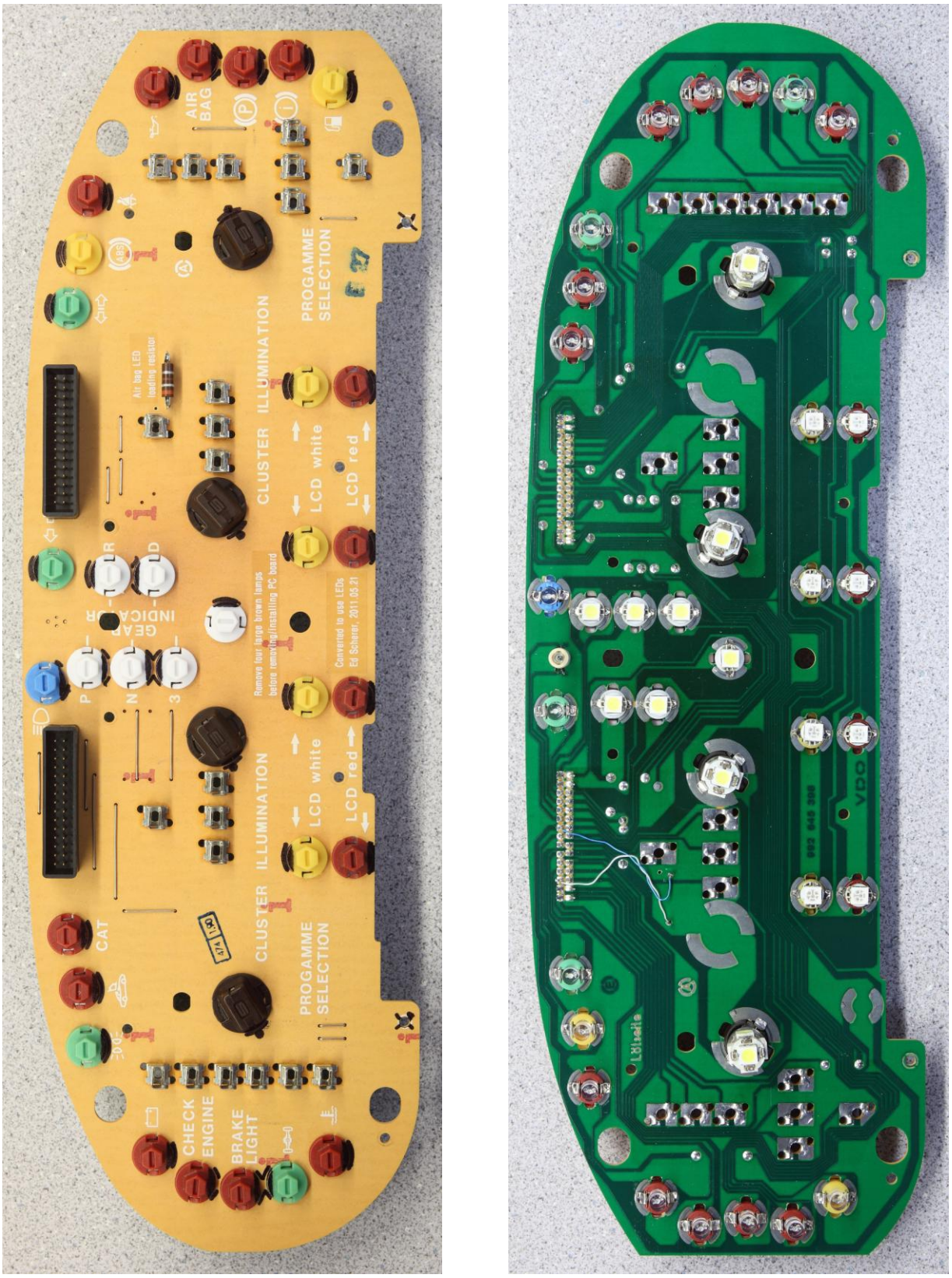


Figure 2 Back and front of PC board after LED replacement; black marks Indicate LED cathode (low/ground) side

Main Gauge Backlighting

Bulb Socket	twist-lock, with contacts for W2.1x9.5d base bulb
Original Bulb Type	W3W-12V with T3-1/4 glass with base W2.1x9.5d (10 mm diameter, 26 mm long wedge base; same base as #168 and #194)
Recommended LED Replacement Bulb Type	Super Bright LEDs WLED-WHP5
Notes	• Retain twist-lock base; just replace bulb. • Absolute maximum size bulb that will fit is 12.3 mm diameter, 30 mm long (note that a Super Bright LEDs WLED-WHP9-T *will not* fit).

Each of the four brown twist-lock bulb sockets can be easily unscrewed (rotate 90° clockwise).

Information System Display Backlighting

Bulb Socket	twist-lock integrated with bulb (not designed to be separated)
Original Bulb Type	[TBD] with B8.4d twist base
Recommended LED Replacement Bulb Type	• Super Bright LEDs B8.4D-AHP (amber) for the upper four "LCD white" lamp positions • Super Bright LEDs B8.4D-RHP (red) for the lower four "LCD red" lamp positions
Notes	Order extra LED bulbs and bench test to obtain sets of four LED bulbs with good color and brightness match (variations can be visible).

Indicator and Warning Lights

Bulb Socket	twist-lock integrated with bulb (not designed to be separated)
Original Bulb Type	W1.5W-12V with T1-3/4 glass with base W2.1x4.9d or B8.4d twist base (all the originally yellow-base bulbs); W1.2W-12V with T1-3/4 glass with base W2.1x4.9d or B8.4d twist base (all the originally blue-base bulbs)
Recommended LED Replacement Bulb Type	[TBA]
Notes	[TBA]

The Mysterious CHECK ENGINE and CAT Warnings

Did you notice that there are two bulb positions labeled CHECK ENGINE and CAT that weren't filled in with bulbs?

It's not clear why these were unused, but I chose to put LED lamps in these positions.

And… interestingly enough, they turn on during the "lamp check" period when the ignition is first switched on.

Whether or not they'll ever actually illuminate to warn about anything, I don't yet know.

Adding Air Bag LED Loading Resistor

[TBA]

Additional Optional Tasks

Additional Labeling on PC Board

[TBA—"X"-ing out two holes that might be assumed to be screw holes, but aren't, and labels "Air bag loading resistor", "Remove four large brown lamps before removing/installing PC board", "Converted to use LEDs…"]

Cleaning

If there is any cleaning you want to do to the front side of the cluster (analog gauges, etc.) or for any other reason, you want to access that part of the cluster, [TBA]

⚠ Be careful when separating the last few pieces of the instrument cluster; if the pieces separate in an uncontrolled fashion, you might damage the fragile needles on the gauges.

[TBA]

Pod Switches

Light Switch

Fog Light Switch

Zero Button

Rear Window Defogger Switch

Emergency Flasher Switch

Intensive Windshield Cleaning Switch

Center Console Switches and Instrumentation

Automatic Climate Control

Central Door Locking Button

Clock

Cigarette Lighter / Ashtray

Courtesy Lighting

Footwell Lights in Lower Door Panels

Light in Headlining Near Front Visors

Light in Headlining Near Rear Visors

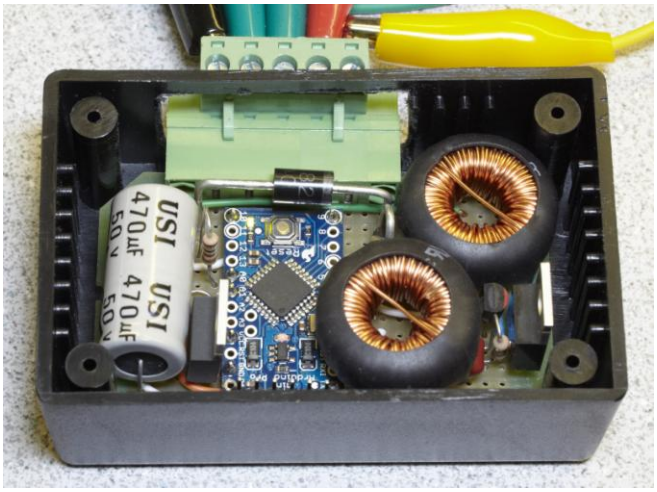
Luggage Compartment Light

Glove Box Light

Central Electric Panel Area Light

Restoring Dimming Functionality

The factory 928 instrument backlighting dimmer control (a simple rheostat that adjusts current supplied to the instrument backlighting circuit) will not function with LED lights.



[Status as of 07-Sep-2011: I've developed a PWM-based dimmer module: it has moved from a breadboard prototype to a fairly compact packaged module that is working on a test bench (I'll be installing it in the car shortly). I might create a proper PC board for this (instead of the current pad-per-hole perfboard that took lots of time to solder components to). Subsequent work on this will be based on the level of interest I get from the 928 community.]

The module has the following features:

- Installs by cutting the existing two wires to the dimmer rheostat, connecting the four wires to the module's detachable plug, and adding a ground wire.
- Is small enough to tuck under/behind the instrument pod.
- Contains a microcontroller with some "smart" programming that locks in the dimmer setting (after a delay of a second after the dimmer control is adjusted), eliminating the electrical noise / flicker that is often present due to the rheostat not providing a clean resistance. It also allows the dimming level to be reduced gradually to the desired level when the lights are first turned on and the dimmer module is activated ("slow, gentle turn-on").
- Allows the brightness of a mix of LEDs to be controlled in a uniform fashion, even if those LEDs have different intensity/voltage response.

Part Summary

Order Extras!

Save yourself the trouble of having to place additional orders for replacement LED bulbs in case any fail or don't match in intensity or color with others. This is especially recommended for the information display backlighting LED bulbs and the analog gauge backlighting bulbs, which are most prone to failure as well as color and intensity matching issues.

Instrument Cluster

Qty	Part	Used For	Available From
11	B8.4d LED bulb, red	• brake fluid warning light • park brake warning light • air bag warning light • oil pressure warning light • safety belt warning light • catalytic converter warning light (optional) • tire pressure warning light • voltmeter warning light • check engine light (optional) • stop lamp warning light • coolant temperature warning light	Super Bright LEDs B8.4D-R
4	B8.4d LED bulb, green	• trailer turn signal indicator light • turn signal indicator light • parking light indicator • PSD warning light	Super Bright LEDs B8.4D-G
1	B8.4d LED bulb, blue	• high beam indicator light	Super Bright LEDs B8.4D-B
2	B8.4d LED bulb, amber	• fuel level warning light • ABS warning light	Super Bright LEDs B8.4D-A
6	B8.4d LED bulb, white, high-intensity	• selector lever position indicator (automatic transmission only)	Super Bright LEDs B8.4D-WHP
4	B8.4d LED bulb, amber, high-intensity	• information display backlighting (normal display)	Super Bright LEDs B8.4D-AHP
4	B8.4d LED bulb, red, high-intensity	• information display backlighting (fault display)	Super Bright LEDs B8.4D-RHP
4	#168/#194-style LED bulb with W2.1x9.5d base, white	• analog gauge backlighting	Super Bright LEDs WLED-WHP5

Qty	Part	Used For	Available From
1	330 Ω, ½ W carbon film resistor	• loading resistor for air bag warning light	numerous sources (e.g., Radio Shack)

Pod Switches

Note that there are many #74 style bulbs available from various sources; the ones recommended below were chosen because (of various ones tested), they were appropriately bright, cool running, and had bases that didn't need to be filed to fit into the sockets in the pod switches (quite the contrary—it might take a little tape around the bases to keep them from popping out).

Qty	Part	Used For	Available From
2	#74-style LED bulb, green	• light switch backlighting • fog light switch backlighting	Autolumination "#74 Super High Power 1 Watt Super-Charged LED Bulb", green
1	#74-style LED bulb, white	• zero button backlighting	Autolumination "#74 Super High Power 1 Watt Super-Charged LED Bulb", super white
1	#74-style LED bulb, amber	• rear window defogger switch backlighting	Autolumination "#74 Super High Power 1 Watt Super-Charged LED Bulb", amber
1	#74-style LED bulb, red	• emergency flasher switch backlighting	Autolumination "#74 Super High Power 1 Watt Super-Charged LED Bulb", red
1	3 mm, 45° discrete LED, white	• intensive washer switch backlighting (optional: if was originally yellow LED and you want to replace it with white)	Super Bright LEDs RL3-W6045
4	1.8 kΩ, ½ W (or ¼ W) carbon film resistor	• current limiter to dim fog light switch backlighting when switched "off" • current limiter to dim hazard light switch backlighting when switched "off" • current limiter to dim zero switch backlighting at all times (it's too bright otherwise) • current limiter to dim emergency flasher switch backlighting when switched "off"	numerous sources (e.g., Radio Shack)
1	1 kΩ, ½ W (or ¼ W) carbon film resistor	• current limiter to dim rear window defogger switch backlighting when heating element is switched off	numerous sources (e.g., Radio Shack)

Center Console Switches and Instrumentation

Qty	Part	Used For	Available From
1	5 mm, 15° discrete LED, white	• climate control fan speed switch backlighting	Super Bright LEDs RL5-W18015
1	1 kΩ, ½ W carbon film resistor	• current limiting resistor for climate control fan speed switch backlighting LED	numerous sources (e.g., Radio Shack)
1	1N4148 or 1N914 diode	• reverse voltage protection for climate control fan speed switch backlighting LED (optional)	numerous sources (e.g., Radio Shack)
1	#74-style top-and-side firing 5-SMD LED bulb	• climate control head (including sliders) backlighting	Autolumination "#74 Matrix II, 5 LED 5x brighter", super white
1	#74-style LED bulb, high intensity	• rectangular A/C button backlighting	Super Bright LEDs 74-WHP
1	5 mm, 60° discrete LED, red	• central door locking button backlighting	Super Bright LEDs RL5-RD1560
1	1.8 kΩ, ½ W (or ¼ W) carbon film resistor	• current limiting resistor for central door locking button backlighting when indicating "unlocked" (dim)	numerous sources (e.g., Radio Shack)
1	680 Ω, ½ W (or ¼ W) carbon film resistor	• current limiting resistor for central door locking button backlighting when indicating "locked" (bright)	numerous sources (e.g., Radio Shack)
1	B8.5d LED bulb, white, high-intensity	• clock backlighting	Super Bright LEDs B8.5D-WHP
1	BA7s LED bulb, white	• lighter backlighting	Super Bright LEDs BA7S-W

Courtesy Lighting

Qty	Part	Used For	Available From
3	42 mm festoon-style LED bulb, front-firing, wide, white	• footwell light in left door panel • footwell light in right door panel • overhead light in headlining near front visors	Super Bright LEDs 4210-CWHP6
3	42 mm festoon-style LED bulb, front-firing, narrow, white	• overhead light in headlining near rear visors • luggage compartment/hatch light • central electric panel area light	Super Bright LEDs 4210-CWHP3

Qty	Part	Used For	Available From
1	30 mm festoon-style LED bulb, front-firing, white	• glove box light	Super Bright LEDs 3022-W9

[TBA: seat position memory switch backlighting]