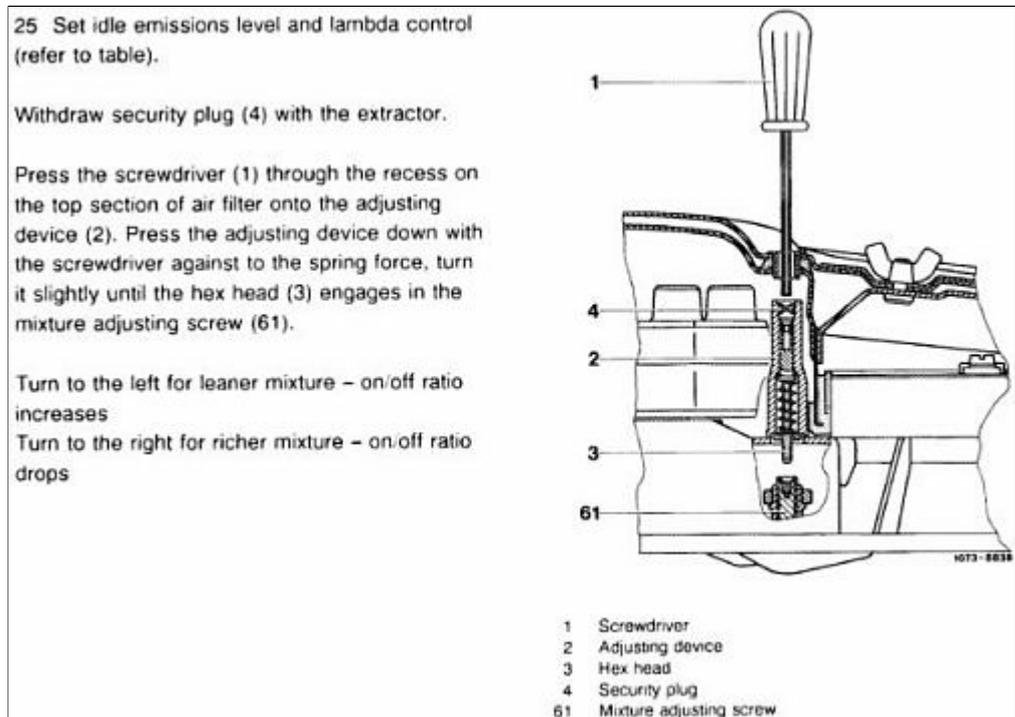


Bosch KE3-Jetronic Mixture Adjustment

Mercedes suggests that special tools are required to adjust the mixture on the Bosch KE3-Jetronic (CIS-E) fuel injection, such as is used on the 1988-91 560 series motors. The dedicated shade tree mechanic *can* do it, but needs to be well-informed first. These adjustments are intended to be followed by an actual exhaust gas CO check to ensure legality.

In order to reach the adjusting screw one must first remove the anti-tamper device required on US cars by Federal law. It is in a cast-aluminum tower just in front of the fuel distributor. Although Mercedes requires that it be removed and discarded, and after the adjustments be replaced by a new one, with care it can be re-used.



1) Procure two

5mm-0.8 x 10 or 12mm machine screws. Slotted-head screws are best because there will not be room for a socket.

2) I was able to back the old screws out by tapping them CCW with a punch instead of chiseling the heads off. This avoids looking for an extractor. The old screws were 12mm long, but 10mm is still plenty of thread length. They had blue Loctite on them.

3) Lift the tower (#2 on the drawing) and save the paper gasket. Wipe the area clean.

4) I ground away the lip of the tower until enough of the anti-tamper ball (#4) was exposed to grab it with baby vise grips and yank it out. Then I filed the remaining surface flat and chamfered the edges so I wouldn't get cut.

5) Once the ball is gone, it is clear that any old 3mm Allen key will work. It doesn't need to be long at all, even if you make the adjustment with the air cleaner in place (#1).

6) After putting a drop of blue Loctite on each screw, I replaced the tower and started the screws but did not tighten them.

7) Using the 3mm Allen key, I depressed the adjustor (#3) and engaged the bottom screw (#61). This ensured that when I tightened the mounting screws the tower would be perfectly aligned for future adjustment.

8) Although the whole assembly appears to be pretty well sealed up, I put a piece of racer's tape over

the hole keep trash out and minimize any possible air leaks.

There are a couple of steps that are supposed to precede making this adjustment. If you wish to tinker, be sure to count carefully the number of quarter-turns you make in the setting, so you can go back if necessary. Even quarter-turns may be too much, so be careful! Turning the adjusting screw clockwise makes the mixture richer, while CCW makes it leaner.

Don't leave the wrench in the adjusting device (#2, above) when you start the engine, or it may fly out. To adjust, depress the wrench just enough to engage the adjusting screw (#61) and turn it slowly. If the engine stalls, you pushed too far down! Let the hex wrench spring back up before revving the engine or the linkage could bind. If you want to do the job the Mercedes way, obey the engine service manual. First locate the X11 diagnostic connector:

The X11 diagnostic connector

On my 1991 560SEC the "X11 diagnostic connector" is mounted on the inside of the left fender, behind the ABS controller. It has a round screw-cap. On some cars (California?) there is also an "X11/4" between the two firewalls - don't get them confused.

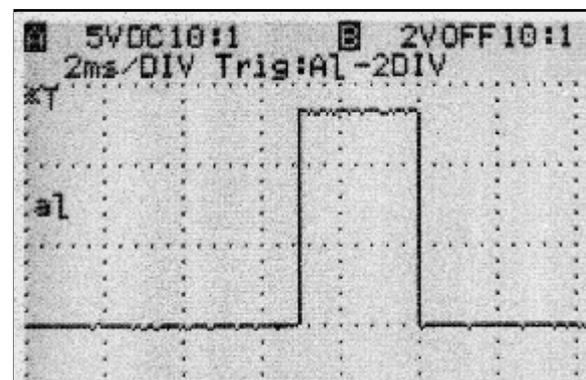
The signal provided at pin 3 of X11 is called the "lambda on/off ratio" signal. It is convenient to use pin 2 of the same connector as a ground reference.

This lambda signal is not a replica of the voltage from the oxygen sensor. Instead, it is a constant 100 Hz pulse whose duty cycle indicates the hunting of the fuel injection for an ideal mixture by switching back and forth between very slightly rich and very slightly lean.

Mercedes has chosen the less common definition of "duty cycle" in this case. They are referring to the percentage of the entire pulse period during which the voltage is **zero**, not the time when it is near battery voltage (mine was +13.6 V when the battery was +14.0 V). In other words, if the pulse rests at ground for 7 milliseconds and then rises to +13.6 V for 3 ms, the duty cycle is considered to be 70% (see oscilloscope trace at right).

If you have an oscilloscope to measure this timing, fine. If not, it can still be estimated with a voltmeter. Since continuous "0 volts" would be considered 100% and continuous 13.6 V would count as 0%, just measure the voltage between pins 2 and 3 of X11 and divide that by 13.6. Next subtract that ratio from one, and convert the result to percent.

For example, if the meter reads 4.0 V, first divide $4.0/13.6 = 0.294$. Subtract $1.0 - 0.294 = 0.706$, or



71%. In equation form:

$$\text{Duty Cycle} = [1 - (V_{\text{pin 3}}/V_{\text{max}})] \times 100\%$$

Remember that if the oxygen sensor is doing its job and the system is operating closed-loop, the reading will jump around, so you might see readings from 5 V to 7 V and have guess at an average.

The other signals available at X11 are:

Pin	Function
1	RPM signal, 0 to 12 V, 4 pulses per revolution. A frequency of 43.3 pulses per second corresponds to the desired idle speed of 650 RPM. (To check your tachometer you could measure the frequency at this pin and multiply by 15 to get RPM.) This signal is derived from the ignition amplifier and is synchronized with the low side of the ignition coil.
2	GROUND
3	Lambda on/off ratio, 0 to 13.6 V, 100 Hz. This is not a replica of the output of the oxygen sensor. The "duty cycle" in Mercedes literature refers to the percentage of time this signal is <i>low</i> . Longer duty cycle (lower average voltage) = lean, shorter = rich.
4	Low (negative) side of the ignition coil. This is where to monitor the dwell angle of the electronic ignition amplifier, and is also a good place to view a reflected and attenuated image of the spark. This is about 50 VPP, safe for an ordinary oscilloscope.
5	Hot (battery voltage) in Run or Start, NOT FUSED! This is actually the positive side of the ignition coil.
6	Hot at all times, through fuse 2
7	Shielded cable from TDC sensor. This is not the same sensor which triggers the spark control unit, but it could be used in a clever circuit with pin 1 to measure spark advance.
8	Shielded cable from TDC sensor.
9	Shield for pins 7 and 8.

Static tests

It is suggested that before the active (engine-running) tests are attempted, some static tests should be performed to check a few of the basic components of the Bosch fuel injection controller.

With the ignition on but the engine not running, the duty cycle tells which version of controller is installed. A 70% duty cycle indicates the standard controller with the ability to read some faults by monitoring the duty cycle. 85% indicates the California controller, which ordinarily displays the faults as a blinking LED on connector X92, although it can be programmed to display the faults as an X11-pin3 duty cycle. 100% indicates the controller does not display fault codes in this manner, or is faulty.

For California cars, starting in 1988: Press the push button switch on test connector X92 (passenger side, between the two firewalls) for two to four seconds. The LED will flash once, indicating no fault

code is stored in the system. Now press the switch again for two to four seconds. The LED will be on continuously, and the injection control is switched over to an on/off ratio output.

Assuming the "standard" 49-state controller (70% duty cycle with ignition on but engine not running, or about 4 volts average), the following tests should be performed before attempting to adjust the idle mixture.

- 1) Idle Contact: Deflect the air flow sensor plate. The duty cycle should decrease to 10%. If it remains at 70% test the throttle valve switch (Job 07.3-121).
- 2) Full Load Contact: Open the throttle completely. The duty cycle should decrease to 20%. If it only decreases to 40% test the air flow sensor potentiometer (Job 07.3-121).

Testing, adjusting engine (Job 07.3-110)

- 1) Check all physical linkages including the air flow sensor plate for binding, etc. Ensure that there is no tension or pre-loading of the connecting rod which runs towards the front of the engine from the curved slot in the variable-fulcrum lever. That is the slotted lever just behind the injection distributor and to its right. The roller should rest in the curved slot lightly with no tension. If you have ever played with the lateral linkage which can adjust how sensitive the transmission is to kick-down, that adjustment may need attention. If it is too tight, fast idle will result.
- 2) Transmission in Park, air conditioner off, engine at operating temperature.
- 3) Detach the purge line at the electric switchover valve and seal. On my car, this valve is mounted on the inner wall of the left fender, adjacent to the ABS controller. The subject line is black tubing with white stripes.
- 4) **BEFORE** raising the engine speed above idle, let the spring in the adjustment tower push the hex wrench back out of the adjusting screw. If you do not, the internal parts can jam when the throttle is opened and the air flow sensor plate drops. (Starting 1988) Test lambda control (see "**X11 Connector**", above) at 2500 RPM by taking an average reading of the signal at pin 3. Compare this reading with the idle speed reading at the same pin. Adjust the average at idle speed so it is within +/- 10% of the reading at 2500 RPM. That is, if the duty cycle at 2500 RPM is 40%, at idle it should be between 30% and 50%. On 1986/87 cars the specified idle setting is between 5% and 15% greater than that at 2500 RPM. After each adjustment wait 5 or 10 seconds for the idle mixture to stabilize.

The reading should jump around a little. If it does not, the oxygen sensor may be bad. On my 1991 560SEC the duty cycle jumped between about 40% and 50% at both idle and 2500 RPM. Mercedes does not specify a target value, but experience (and **other reference books**) suggest that it should be near 50%. If throttle response just off idle seems soft, try adjusting the mixture a little leaner (about 1/4 turn of the hex wrench CCW, which gave me about 70% duty cycle). Remember: Turning the adjusting screw left (CCW) results in a leaner mixture, a longer duty cycle at X11 pin 3, and thus a lower average voltage at this pin.

- 5) If the condition of the oxygen sensor is suspect, the connection for it is located under a removable plastic panel in the passenger-side footwell. In my car this is a black wire coming from the sensor to a plug, which plugs into a socket at the end of a shielded cable with green insulation. The screws on this panel are not grounded! They attach to plastic parts, so a good ground reference must be found elsewhere. After warm-up, the sensor voltage should be seen to oscillate between approximately 0.2 and 0.8 V, with an average near 0.5 V. If the mixture is rich it will read above 0.7 V, lean below 0.3 V. See also: <http://www.flash.net/~lorint/lorin/fuel/lambda.htm> and http://www.volvoclub.org.uk/k_jetronic.htm.

Please consider this document to be a "work in progress". If you find any errors, or have additional information or explanations I should add, please let me know right away at the address below.
Thanks!

Visit [Dan@Home](#) | [More automotive links](#) | Comments to dan@landiss.com

