

Adblue emulator: illegal and legal



(Source: AdobeStock)

In most European countries, the use of Adblue emulators is forbidden or restricted. In other ones, they are allowed. An Adblue emulator simulates the Selective Catalytic Reduction (SCR) system behavior and truck owners can save a lot of money.

The SCR system reduces the quantity of Mono-Nitrogen Oxides (NOx) in engine exhaust gasses. The SCR catalytic converter core is usually made from ceramic (titanium oxide). It is coated with oxides of such metals as tungsten, vanadium, molybdenum, and other precious or rare metals. The reduction reaction is achieved by adding a solution of anhydrous ammonia, aqueous ammonia, or urea. This additive is called Diesel Exhaust Fluid (DEF). The most popular DEF solution on the market is Adblue; this is a registered trademark of the German Association of the Automotive Industry (VDA). DEF is the reducing agent that reacts with NOx to convert the pollutants into nitrogen, water, and tiny amounts of CO₂. The DEF can be rapidly broken down to produce the oxidizing ammonia in the exhaust stream. SCR technology alone can achieve NOx reductions up to 90 percent. Most of the SCR systems available on the market use CAN communication based on the J1939 higher-layer protocol and associated Parameter Groups.

The SCR catalytic converter works by injecting Adblue to the exhaust system. DEF is injected before the catalytic converter chamber, where its vapor is mixed with exhaust gasses. It is important that the temperature will

reach 360°C to 450 °C otherwise SCR effectiveness is relatively small. It means that it needs some time after the cold engine starts to arrive at the required temperature to start the NOx reduction process effectively. The SCR system has an exhaust temperature sensor, which sends temperature data to the SCR electronic control unit (ECU).

All Euro-V and Euro-IV type diesel engines are equipped with SCR systems. European regulation mandates this. All Euro-VI type engines provide a Diesel Particulate Filter (DPF). This device removes any possible diesel particulate matter (solid particles) or soot from the exhaust gasses before they are

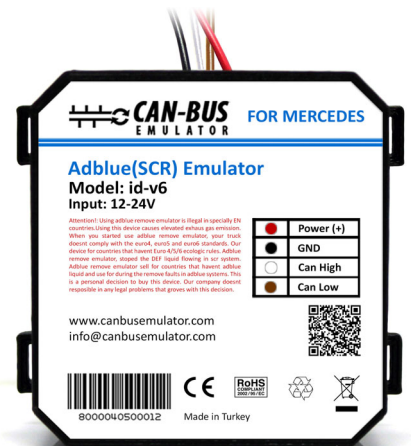


Figure 1: Typical Adblue emulator (Source: Sail Technology Software)

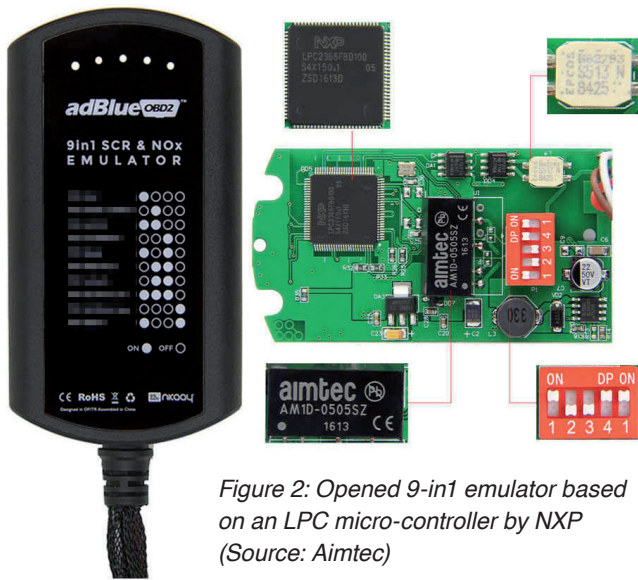


Figure 2: Opened 9-in1 emulator based on an LPC micro-controller by NXP (Source: Aimtec)

exhausted to the atmosphere. Particulate matter is a result of incomplete or improper diesel combustion cycle. There are several reasons, why particles could be produced: Cold engine starts, especially in the ultra low-temperature environment; lack of intake air pressure or flow due to damaged turbo charger or clogged intake channels; reduced compression in cylinders due to damaged engine parts; high engine load or sudden power demand on rapid acceleration; clogged exhaust gas recirculation (EGR) system; or poor fuel quality, engine oil in the combustion chamber of cylinders and other factors.

SCR systems are also used in other countries. For example, in the USA to meet the EPA 2010 diesel engine emission standards for heavy-duty vehicles and the Tier-4 emissions standard for engines found in off-road equipment. Diesel particulate matter particles are considered as one of the most harmful pollutants. Therefore all Euro-IV type exhaust systems must have DPF systems. Some DPF filters are single use, and some of them are capable of regenerating at certain conditions (DPF regeneration). Recovery is possible by burning more fuel and rising exhaust system temperature, which makes it possible to burn out any contamination from the filter. DPF regeneration controlled by a vehicle ECU and executed when necessary conditions are reached (exhaust temperature, fuel quantity in the tank, vehicle speed, and engine speed).

Failures in SCR or DPF systems

When the SCR or DPF systems fail, the truck driver is in trouble: In both cases, the central ECU activates the limp mode of the engine. This reduces the engine power to protect the environment from possible highly polluted exhaust gasses. This is done independent, if the engine is capable to work properly. The ride to the next repair shop or garage can be time-consuming. Additionally, repair costs are high.

In some northern regions of Europe and Russia, environment temperatures can be low as -40 °C. These ultra-low temperatures are way beyond the freezing point of DEF; it freezes if its temperature falls below -11 °C. Injecting frozen Adblue to the SCR chamber is impossible. Also, it will damage the DEF pump, and the whole SCR system fails. This means, you need to switch-off the SCR system. This could be done by means of so-called Adblue ▶



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Figure 3: The award-winning Multi-Diag tool can detect Adblue emulators (Source: Actia)

emulators. They can help to drive on the regular engine mode even if the SCR system is faulty. But the main reason why so many trucks equipped with Adblue emulators is the saving of money on a diesel exhaust fluid.

Such products were available shortly after introduction of Euro-IV type diesel engines. The first of such CAN-connectable devices were designed for a dedicated truck. In the meantime, they can support multiple brands. Some of them are configurable by means of DIP-switches, while others implement an USB-to-CAN dongle. The price for such Adblue emulators has come down to 30 euros comprising a USB dongle. This leads to another question: Why generic CAN-to-USB interfaces cost often more than 300 euros? Of course, some of them provide additional features and are tailored for sophisticated diagnostic purposes.

Installing an SCR emulator is easy

In the CiA office, 9-in-1 emulators have been opened. They have been bought via Internet from a China supplier. It uses a low-cost NXP micro-controller with on-chip CAN and USB interfaces including transceivers. The product seems to be developed and manufactured by Marathon in Russia, where such devices can be legally used. The price of less than 30 euros including shipping costs is more than reasonable. Such products come with an installation guidance, which makes it very easy to apply the device into the CAN-based in-vehicle network. It is also necessary to remove the fuse for the SCR system. One of the Adblue emulator suppliers describe the installation for an Iveco Euro-VI truck as follows: The best place for the CAN connection is plug ST55A on the vehicle frame, right side of engine, above the right front wheel. Connect the yellow cable to pin 22 (CAN_H) and the green cable to pin 21 (CAN_L). Connect power to the emulator: the red cable to VCC and the black cable to GND. Do not forget to remove the fuse number 70405 from the 4th block.

Such an emulator overrides the controls of the Selective Catalytic Reduction (SCR) system. Adblue emulators are of different types, adapted to the particular truck or engine models. Such device installed on the compatible vehicle takes control over whole SCR system and its

parts. It imitates proper work of the Selective Catalytic Reduction system on the On-board diagnostic (OBD) level. When installed it keeps SCR system inactive, and at the same time, it sends necessary data to the central ECU to avoid limp mode. There are no errors on the OBD system, because it emulates all parameters. No loss of engine power, no increased smoke from the exhaust system, no Diagnostic Trouble Code (DTC) errors on OBD system and zero consumption of DEF. Latest Adblue emulator models are capable of overriding exhaust temperature and NOx sensors for complete functionality.

The first generation of Adblue emulators just removed errors from OBD system, if the SCR failed. The second generation was able to override SCR system controls and to delete OBD errors caused by faulty or disconnected SCR systems. Nowadays emulators can also override NOx and temperature sensors of the exhaust system.

Illegal use of SCR emulators

There are a lot of countries outside the EU, which do not require Euro-VI, Euro-V, or even Euro-IV compliance of diesel engines. In those countries, Adblue emulators can be used legally. However, in the EU they are forbidden with the exceptions when the environment temperatures are ultra low or you are approaching a repair station in case of a mal-functioning SCR system. There is no evidence, how many trucks are using permanently Adblue emulators. Because they are very tiny, it is not easy for the enforcers to detect them. Especially, when they are installed in the wiring harness. Clever cheaters hide them in the semi-trailer. There are some tools, for example, the awarded Multi-Diag by Actia (France), which supports the detection of such emulators. But not all enforcers working with the German Federal Office of Goods (BAG), a kind of police, have such tools. They need to check the Adblue bills provided by the truck driver, when available. If a cheating driver is catch, the BAG officer needs to find an appropriate garage, to remove the Adblue emulator and to re-acti- ▶

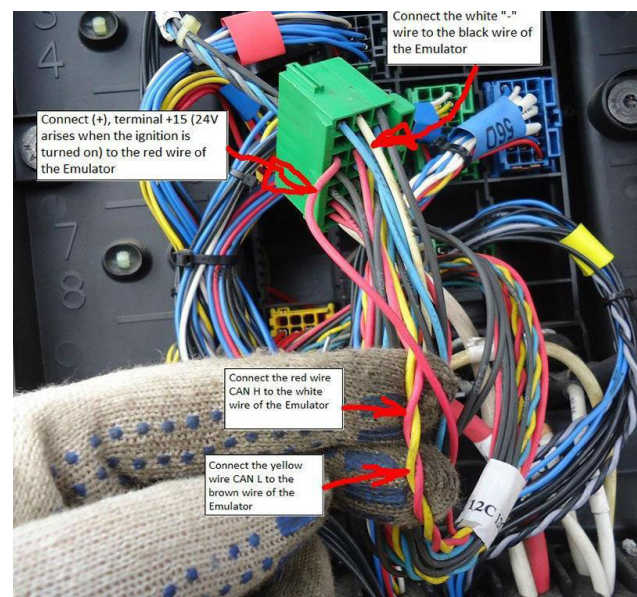


Figure 4: Detailed installation guides are provided by the Adblue emulator suppliers (Source: Aimtec)

vate the SCR system. This can take some time for the truck driver, but also for the enforcers.

Already in 2017, European truck OEM (original equipment manufacturer) requested actions to prevent aftermarket manipulation of emissions controls. "The European Automobile Manufacturers' Association (ACEA) strongly condemns the advertising, sale, and use of any aftermarket device that can be used by truck operators to turn-off emission control systems," stated ACEA Secretary General Erik Jonnaert two years ago. The association already raised its concerns in 2012 with the European Commission and the member states, but no action was taken. The issue of aftermarket devices was also raised by Denmark several years earlier, but the general view at that time up to now was and is that this should be a matter for national enforcement. In 2017, the German Ministry of Traffic responded a question regarding the manipulation of emissions controls that it would appreciate banning of Adblue emulators. But nothing has happened: you can still buy them and advertise for them. It is not that the manipulated trucks causes a higher pollution of NOx, but there is also a lost of income regarding the toll on trucks. Trucks without SCR systems pay more money.

It is possible, that due to political reasons it is not that easy to forbid selling of Adblue emulators in Germany. Another option would be to make the integration of such devices more complicated by means of authentication. The J1939 communication regarding emission control between several ECUs could be protected by means

of authentication of messages. Even a simple authentication mechanism is better than nothing. If the automotive industry, heavy-duty truck OEMs, and related associations, would really like to support the EU emission regulation, there are several options to do so.

To summarize: for just a few euros a truck owner can save annually about 6000 euros and more said some sources. The achievable profit depends on the driven kilometers and the consumed Adblue. This does not consider possible repair costs for the SCR system. What is not used, does not need to be repaired. ◀



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