

FORENSIC AND MANUFACTURER ASPECTS OF VIN PRODUCTION AND LOCATION ON MOTOR VEHICLES

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Summary

A vehicle identification number (VIN) is an unambiguous, globally unique vehicle identifier. The paper describes principles for its location on a vehicle, the method of its making (manufacture) and, last but not least, types of protection against negative factors to ensure that its identification value is preserved and, simultaneously, the process of identification inspection of a vehicle is clear, fast and efficient. The text analyses various views on VINs from the point of view of vehicle manufacturers, administrative bodies (that use vehicle identification in nationwide vehicle registers) and law-enforcement bodies during the investigation and gathering of evidence of car crime.

Keywords: Location, manufacture, protection, VIN, Vehicle Identification Number, vehicle originality

1. Introduction

The basic identifier of a vehicle in automotive, police, forensic as well as administrative practice (vehicle registration and its use for the purposes of state administration) is a VIN (*Vehicle Identification Number*), which is defined in international standards [1], [8], [27]. A VIN is a globally unique, unrepeatable identifier that is unique for each manufactured vehicle [7], [9].

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Fig. 1. A standard VIN position in the engine compartment of a Bentley Continental GT vehicle. The VIN is easily visually accessible (to the right from the number "2")

In order for a stolen or otherwise defective vehicle to be re-registered without being discovered during checks in a police information system and a national or international³ vehicle register, the offender has to hide (substitute) the original VIN identifier of the stolen vehicle [1], [6], [26]. Both professional thieves and manufacturers of motor vehicles know this fact. Through various technologies, by placing a VIN on various and variously accessible vehicle parts, manufacturers make the process of illegal VIN change and replacement as hard as possible [3], [4]. To ensure that their efforts are efficient, however, efficient checks on VIN originality by state and professional institutions, which involve knowing the VIN location and the method of execution of VINs for various vehicle models including securing VINs with various protective features, must also exist [5].

2. History and the present

A VIN (*Vehicle Identification Number*) identifier has actually been used compulsorily and globally in practice since 1986 [10], [28]. However, the term VIN has been known in practice since the 1920s, when it was used by German vehicle manufacturers.

Pursuant to applicable standards, a VIN shall be executed in a vehicle:

- On a part of the vehicle that is primarily inseparable from the vehicle's basic unit [11], [16]. Hence, it is the actual skeleton of the body in the case of self-supporting bodies, and a VIN should not be, e.g., marked on a part such as a panel or another replaceable component (that is replaced in the event of damage to the vehicle). In the case of frame structures of vehicles (usually in off-road vehicles – Toyota Hilux, VW Amarok, etc., lorries in general), a VIN marks the body frame (usually in the rear near the rear wheel). The basic idea of the "inseparability of a VIN identifier from the vehicle's basic

³ on an EU scale, by means of EUCARIS (*European Car and Driving Licence Information System*) technology.

unit" directly implies the technology of its making as well. A VIN identifier cannot be riveted, glued, sprayed, etc. onto metal in any way (as it would not be inseparable) but it is fabricated using a technology that immediately, volumetrically and plastically interferes with the integrity of the metal – thus, it is stamped, ground, engraved directly into the metal material, thus leaving unrepeatable identification traces behind it also in terms of the method of its creation. In other words, the technology of VIN production fixed into the metal of a vehicle is destructive [12].

- In such a way that it is readily available (accessible, visible). In terms of the availability of a VIN identifier, we differentiate direct, visual availability by mere sight or availability after simple removal of certain covering parts, components, etc., of the vehicle that can be easily turned aside, opened, bent away, moved, rotated, etc., so the VIN is then easy to visually observe without the need of any specialist knowledge or skills to make it accessible [25]. The simple covering of a VIN has aesthetic reasons (for instance, a VIN cannot be directly seen in the vehicle's interior, in the floor between the front passenger's legs), or in protecting the identifier (from fouling, damage, water access, corrosion, etc.) [19]. Other manufacturers position a VIN in a vehicle in such a way that it is first necessary to remove some parts and components of the vehicle and, to this end, it is necessary to either use specialist tools or specially trained persons (e.g. removal of windscreen wipers using special wrenches so that it is possible to take off a plastic cover under which the identifier is physically located). This is referred to as availability of the identifier by means of a professional intervention. However, such procedure denies, in a certain sense, the idea of good accessibility of the VIN that is necessary for approximate identification of the vehicle if one does not know where to look for the VIN that is hidden under parts or components of the vehicle at all [15], [17].



Fig. 2. Example of a difficult-to-access VIN in a Honda Civic vehicle. For the identifier to be visually accessible, plastic parts must be expertly dismantled

- In such a way that it is clearly legible. For this reason and pursuant to applicable standards, the font of VIN lettering must be at least 6 mm high so that it can be read using human sight without the use of optical devices. A relatively problematic issue is good legibility of the identifier over time. The point is not only that the identifier must be legible immediately after the vehicle has been manufactured, but also throughout its life cycle, i.e., until physical destruction of the vehicle, its scrapping, including the identification features – so that it is certain that it was this very vehicle and not another that has been scrapped. Otherwise, there is a risk of "surviving" identifiers being misused to create a new, altered (fake) identity of another vehicle. The legibility of a VIN recorded into metal changes over the course of time for many reasons – owing to damage to the VIN, fouling of the VIN (oil, dust, washing agents and other service fluids) and, in particular, corrosion. A manufacturer that is aware of this threat has multiple options how to protect the identifier [1], [22], [23].
- In such a way that it is safely legible. This principle relates to the safety of persons who work with the identifier, that is check it, especially directly in road traffic. For this reason, reasonable manufacturers place VINs in vehicles intended for the European market (i.e. driving on the right side of the road) to the right side of the vehicle. A policeman checking identifiers in normal traffic then stands nearer the edge of the road and cannot be threatened by the traffic of the other vehicles, mainly under debilitating light conditions. It is useful to apply this rule both to VIN identifiers stamped into body metal and to so-called homologation stickers that also carry a VIN identifier (as a rule, they are currently printed on a self-adhesive sticker).
- In such a way that it is unmistakable. Both locally and to a larger extent of environs. A VIN must be created in such a way that its possible illegal change aiming to change the content of the identifier and thus the overall identity of the vehicle is made as difficult as possible [21]. Therefore, a VIN is stamped using various technologies and with various lettering fonts [25]. Special separator characters (delimiters), which determine the spacing (length) of the VIN for each vehicle model, are used at the beginning and at the end of the VIN. This length is constant [1], [27].



Fig. 3. Demonstration of a dismantled plastic cover in the space in front of the windscreen wipers



Fig. 4. Overall, the identifier is visually inaccessible even following this dismantlement. Reading the VIN is very uncomfortable, and the inclined surface plays a role as well

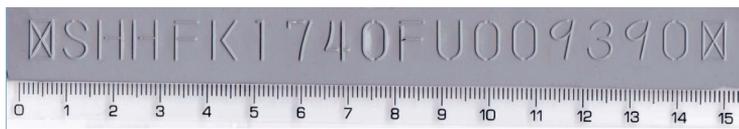


Fig. 5. In forensic practice, plastic prints by means of a special compound (ISOMARK in this case) are used in such cases for documentation purposes. They are very sensitive and make it possible to observe the print in detail in its detailed form afterwards

3. Protecting a VIN against damage, fouling and corrosion

The basic protection of a *Vehicle Identification Number* (VIN), which the manufacturer must provide, is protection to maintain a good legible condition [18]. A VIN becomes illegible in some of its parts or in whole owing to service fluids, dust, damage and the action of corrosion and, therefore, unusable in practice. The following has an impact on the protection of a VIN against the aforesaid factors [24], [25]:

- location;
- protective mechanical covering;
- protective paints and coats.

In practice, we can encounter a combination of the aforementioned factors.

4. Location of the VIN identifier

A VIN identifier can be positioned in the interior of a car or in its exterior. The term interior generally refers to the internal part of the vehicle space that is intended for passengers. As a rule, a VIN is placed in the floor under the front passenger's seat, on the inner bottom side of the body "frame", behind the rear support between the rear seats, etc. In the interior of a vehicle, identifiers are best protected from any external influences and, therefore, this

location has been very frequent for positioning identifiers in recent years (e.g., in Hyundai vehicles) also because of the fact that in most cases the VIN is very easily accessible (for instance, it is not necessary to take items out of the luggage compartment where it is usually hidden under a removable bottom).



Fig. 6. A VIN located in a non-standard way in a Mercedes – Benz "S" class vehicle in the space behind the elbow rest of the rear seats. It occurs to hardly anyone to look for the identifier there. On the other hand, this space is clean, dust-free so the identifier is not exposed to the negative effects of ambient phenomena

A transitional zone can be defined between the interior and the exterior, which is comprised of the engine and luggage compartment of a vehicle. In passenger cars (unless they are utility type vehicles), the luggage compartment is also protected against external, primarily weather effects. In this area, the VIN may only be fouled by dirt from transported material. However, the accessibility of the VIN is limited in a vehicle loaded with luggage. To gain access to the VIN identifier, the load has to be first unloaded, which is not entirely comfortable during an operational check by security forces, especially under unfavourable weather conditions "in the street".

Aside from certain exceptions, a VIN identifier located in the engine compartment usually tends to be well-placed, so it is visible at first sight after the engine compartment lid is opened. VINs have been placed there plentifully in the past, particularly along the upper sides of the body; in the front top part of the dividing partition between the cabin and the engine compartment [20]. A VIN is then rather placed on the left (when one faces an open engine compartment of the vehicle in its front part, opposite the windscreen), or symmetrically based on an imaginary rear-front longitudinal axis of the vehicle. In other cases, the VIN can be found in the left and right top section of the body to which vehicle wings are attached. Vehicles of the BMW make tend to have their VINs located on shock absorbers.

VINs in the engine compartment of older vehicles may be more fouled than in the interior or luggage compartment of the vehicle: there is greater moisture, dust levels, and the possibility of corrosion there as the engine is never entirely covered from its lower section, usually not at all. For the sake of protection against these types of physical and chemical effects, a protective transparent film is stuck over the VIN, having a double role: protection against the said external physical and chemical effects and against wilful interference by a person having an illegal reason to alter the VIN.



Fig. 7. The VIN of a Lexus CT 200h vehicle standardly placed below the front passenger's seat. The VIN is protected by a plastic guard against damage and soiling

The extent of potential physical and chemical damage resulting from the operation of the vehicle and the external environs of the vehicle (e.g. climatic conditions) is also decided by the selection of a horizontal or vertical position of the VIN identifier as well as of other similar identifiers: water and service fluids better flow down vertical surfaces, and dust deposits are less likely to remain there, so the degree of fouling is substantially lower in practice than with identifiers that are placed on horizontal surfaces [26]. With respect to horizontal surfaces, it is appropriate to use various protective coverings with transparent films, the application of various protective paints, wax layers, etc. To better protect the VIN against corrosion, some manufacturers position the identifier vertically into the front ("A") pillar of the vehicle (some Renault and Dacia models).

With vehicles having a frame structure, the VIN is usually placed externally, on the bottom frame of the vehicle. It is normally found on the frame near the rear wheel, often covered in a protective paint, wax or asphalt compound [27]. A VIN is also located externally in some vans, in the area of the front wheel. However, these positions are not too successful because the VIN is normally covered in mud in these places, and if we do not know exactly where to look for it, we will have great difficulty finding it. Furthermore, such positions are usually only accessible after the wheels are turned in one of the extreme directions (to the left, to the right) using the steering wheel. External identifiers are normally placed from the right side of the vehicle to ensure that access to the identifier is safe and that the examining person does not find themselves on the side with heavy road traffic. However, placing it towards the "pavement" may be problematic with respect to those models that are supplied by the manufacturers simultaneously to markets with right- and left-hand road traffic.



Fig. 8. Renault Talisman. The VIN is positioned unusually vertically in the space of the A-pillar. When the VIN is positioned vertically, dirt, water and service fluids do not cling to it as much

5. Protective mechanical covering

The use of a protective mechanical covering may for several reasons be a logical conclusion. The first one is mechanical. A protective cover prevents dirt or small objects from falling or getting into the opening through that provides direct visual access to the VIN, which is technologically made in metal material. The second reason tends to be aesthetic, i.e., a visual covering of the opening with the VIN identifier and its "aesthetic" incorporation primarily into the vehicle interior so that everything matches [25].

Mechanical coverings of a VIN identifier are common if the VIN is executed in the floor of the vehicle (usually under the front passenger's seat) or in the inner interior part of the vehicle in the area of the A-pillar (a pillar of the body between the windshield and front door of the vehicle), in the floor of the vehicle near front passenger's legs below the dashboard or on the inside of the door frame above a wheel arch. In some vehicles, the VIN is exceptionally placed behind the folding elbow rest between the rear seats, etc.

In the vehicle interior, mechanical coverings tend to be executed either only as a part of the bottom carpet laid on the metal floor of the vehicle, which is usually partially cut during manufacture, or by means of a plastic, hinged or entirely separable guard. In the first instance, it is sometimes necessary to carefully cut the carpet completely with a sharp knife to secure the first access to the VIN in such a way as not to damage the paint on the floor underneath it and, at the same time, not to extend the cutting of the carpet unnecessarily. If the VIN is located under the front passenger's legs (i.e. not under their seat), one should first remove the removable covering carpet from the fabric or rubber.

Plastic guards (predominantly black or grey) tend to be marked with a pressed-in inscription "VIN" or "frame number", etc., in a well-visible way. Plastic guards are designed to be

easily opened without the use of great force, or should be carefully "lifted" with a tool similar to a screwdriver. Some hinged guards are slid on the access hole to the VIN, and it is thereby possible to slide them out carefully together with their plastic perimeter frame. In some specific vehicles (currently manufactured luxury Mercedes Benz S class vehicles), a plastic guard cover is used to access the vehicle's fuse box, near which a VIN is stamped on the body as well). In such cases, a VIN marking on the plastic guard is absent.

In the engine compartment, the VIN identifier is usually protected by a mechanical covering in the dividing space between the engine section and the cabin of the vehicle [27]. In this case, the VIN tends to be placed near the bottom edge of the vehicle's windscreen (e.g., some Peugeot, Citroen and Honda cars). The covering tends to be either plastic (similar to the solution described above) or even made only of soundproofing material which covers the engine bonnet. For strengthening by powder-actuated metal clips, the soundproofing material may be attached to the base material, which resembles a paper carton. The VIN covering is attached by means of a swivel pin and is thus unscrewed upwards, or may even only be on hook-and-loop fasteners.

In exceptional cases, the VIN is hidden under a plastic cover that stretches along the entire windscreen. To secure access to the VIN, it is then necessary to remove the sealing rubber carefully by hand and carefully lift up the plastic cover in the corner [20].

In absolutely exceptional cases, it is necessary to expertly dismantle some components requiring specialist tools to secure access to the VIN. A Renault Kadjar vehicle is an example; it is first necessary to dismantle the windscreen wiper using a special wrench in order to loosen the plastic cover for lifting.

6. Protective paints and coats

Protective paints and coats have a dual purpose in practice: they primarily protect against damage, fouling and corrosion of the VIN identifier executed in the metal of the body and, at the same time, they secondarily provide protection against improper interventions that may be aimed to change the vehicle's identity by changing its VIN. In this case, protective paints and coats help guarantee the originality of execution of the VIN through the originality of the protective paints and coats.

A VIN identifier is more susceptible to corrosion the lower it is placed towards the roadway on an exterior part of the vehicle. Thus, it is exposed to the greatest corrosion if it is stamped into the frame of the vehicle in its chassis part and, at the same time, it is not provided with any further special protection. Some vehicle manufacturers make a VIN identifier without even spraying a bare minimum primer over it.

Fortunately, such approaches rather belong to the past, though. At the present time, an identifier on the vehicle's exterior is normally protected by asphalt-rubber or wax or resin protective sprayed coats, or coatings or protective layers applied in another way.



Fig. 9. Volkswagen Amarok. The VIN identifier is located outside the vehicle on its chassis part and is protected by a transparent cover label. Placing the VIN in this part of the vehicle is not too fortunate – comfortable for practical inspection (one has to bend down and, at the same time, turn the wheels), the vehicle chassis tends to be very heavily fouled, so one has to know exactly where to look for the identifier. After several years of operation, the identifier is severely corroded, so its legibility decreases abruptly.

In the engine compartment, German manufacturers (Audi, Bentley, BMW, VW, Škoda, Seat, etc.) cover VINs with self-adhesive transparent stickers that primarily protect the identifier from damage, fouling and corrosion and, simultaneously, warn secondarily that the VIN identifier also needs to be protected against any attempts to alter it illegally. On Land Rover / Range Rover vehicles, the self-adhesive transparent stickers have coloured warning edges that visibly show that it is an inviolable protective zone.

Protective self-adhesive, transparent stickers are made of materials that must withstand an aggressive environment (washing and cleaning agents, service fluids, etc.) in the engine compartment; they should not become brittle, dull and peel off spontaneously owing to time, temperature, moisture or UV radiation. Also, they should not be easy to remove without any trace or have the ability of being reattached [13], [14].

The intensity of the impact of corrosion on the identifier (serial number) is also decided by its design location on the vehicle. If the identifier is placed on a horizontal surface, moisture, dirt and aggressive substances are more likely to remain there and, thus, corrosion will penetrate the material more intensively.

From this point of view, placing identifiers or stamped characters onto vertical surfaces is much better as less initiators of negative reactions remain there. This approach was primarily used for French and Japanese vehicles, with the VIN being placed on a vertical dividing surface between the engine compartment and the cabin for the transport of the crew.

Corrosive processes are also determined by the selection of the material in which the VIN is stamped [2]. If the material is anodised aluminium in various forms or composite materials (especially in luxury vehicles), corrosion does not occur or, more precisely, occurs only very, very slowly.

7. Conclusion

Knowing the physical location of a VIN, the methods of its production and all the factors affecting the preservation of the VIN in its original form is of crucial importance for efficient work during the identification of a vehicle [1]. A VIN (Vehicle Identification Number) stamped in the metal of a vehicle body is a key primary identifier of every vehicle on a global scale and, thus, it is also the object of the illegal interest of offenders who try to hide the real identity of a stolen or otherwise defective vehicle.

In order for vehicle checks to be efficient, it is necessary to check, simultaneously, in one place (i.e. at one location), the physical correspondence of the VIN identifier on the vehicle, in its papers and in relevant information systems. Otherwise, the real identity of the vehicle is very likely to be concealed [1], [13].

Knowing the physical location of the VIN in each vehicle is a basic condition for every identification check on a vehicle. Every vehicle (depending on the model and year of manufacture) has its identifier located in a different place and, therefore, knowing this location can considerably reduce the time needed for an identification check [4].

Regularities concerning the effects of various negative factors (such as corrosion, damage due to operation, soiling, offenders' efforts to change the identifier, etc.) allow a better understanding of the issues concerning the physical identification of a vehicle, and thus better, higher-quality and more secure production of the VIN identifier on each vehicle as well.

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