Technical guide to car plates reading

A useful guide to provide insight into the several car plates reading systems, whether PC-based or made with ANPR cameras.

The guide simply wants to shed light on the most important aspects of the car plates reading systems regardless of who produces them and the type of product. The topic has been divided into sections to simplify the display and make it accessible to everyone. We tried to use content very practical examples limiting specialist technical knowledge.

Topics

0° - Pictures speak for themselves

1° - How to choose

2° - Accuracy

3° - Pitfalls

4° - Technologies

5° - Critical elements

6° - Pc based or ANPR?

7° - Comparative chart

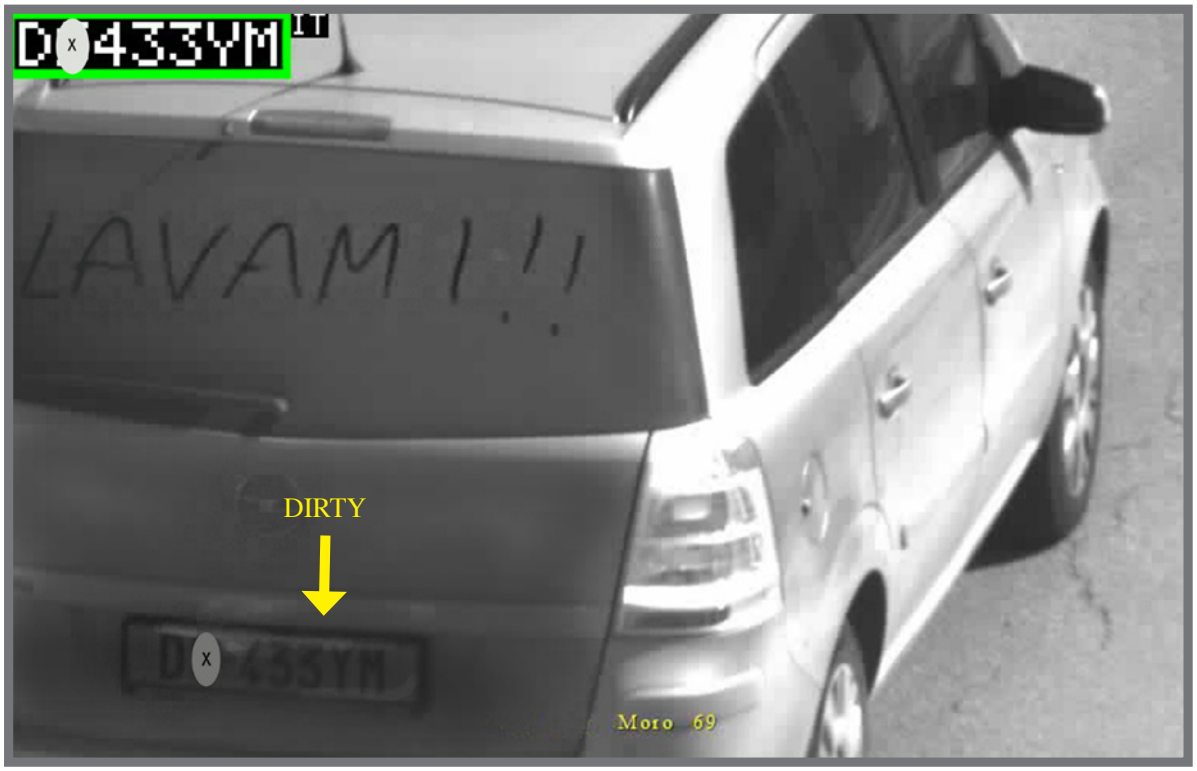
8° - Insights

9° - Story of a choice

10 ° - Failing systems

0° - Look carefully at these pictures

Sometimes few pictures paint a thousand words. The images were taken on the road from our car plates reading camera. It is important to observe the condition in which the plate is located. These are the plates with which the reading system will have to do in different periods of the year.



The images **are original** and are taken by our car plates reading camera installed in the field. Some characters have been deliberately obscured for privacy reasons

SEMICOVERED

COVERED

DIRTY

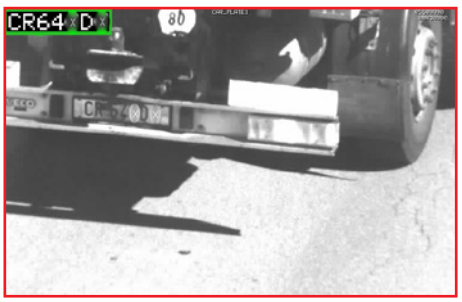
SCOOTER WITH PLATE IN SHADOWA

DAMAGED CHARACTERS

DAMAGED CHARACTERS

OVEREXPOSED

DIRTY AND DEFORMED



SHADOW

These are the conditions on the road

Speaking of reading is easy. Demonstrate the real capabilities IN THE FIELD, we guarantee it, it is quite another thing! On advertising level, all can be said. All are ready to declare that their system works perfectly. So, the first thing you'll notice is: NO DIFFERENCE. But this is not true.

Deteriorated, deformed, half-covered characters, as long as snow, mud, mosquitoes, symbols, dazzling light are some of the phenomena are present every day on the plates (night and day, summer and winter) and are considered the enemy number 1 of any car plate reading system. All these variables combine to make the reading difficult and inaccurate and lead consequently to several mistakes.

The accuracy thus becomes the first characteristic to keep in due consideration in order to assess the quality of a product / system for license plate reading.
TRUE! But there is a "but", or rather two:
- the standard by which we measure accuracy;
- the existence of correlation between accuracy and other characteristics.

1°- How to choose a car plates reading system

Car plates reading systems manufacturers usually develop their solutions basing on the existence of two different types of application:

- those in which the vehicle is stationary or at low speed, mainly used in access control and parking lots;
- those in which the vehicle is traveling at high speeds on road (free flow).

The field of application determines what type of technology should be used to create a good license plate reading system.

In this regard, we found that people who are not skilled in license plate reading systems tend to assume that all systems, from the most expensive to the cheapest, can perfectly read the car plates, be they clean or dirty, both day and night. Well, they are wrong.
.

2°- Accuracy

Accuracy is the resultant of all the technological devices integrated within a plate reading system and that materializes into a final result: the percentage of readings of the plates with the correct value.

Speaking of plate reading is easy and everyone seems to confirm that their system works perfectly. Demonstrate the real capabilities ON THE ROAD: that is another thing! Advertising can tell you a story, but the last word is left to the system installed on the road. We all know that reading CLEAN license plates is easy for any system, especially in summer.

Some phenomena like the deteriorated characters, deformed plates, or half-covered with snow, mud, mosquitoes, backlit plates (see examples), and so on, are the real enemies of any license plate reading system; these variables combine to make it difficult to read and determine the accuracy of a good license plate reading system.

There are two methods used to measure the accuracy of a plate reading system:

- through a laboratory test (controlled environment)
- through a direct test on the field (the system is installed on road)

The laboratory method can be done either by the manufacturer or by an independent auditor. It takes place in a controlled environment. It 's definitely the fastest and economic way to measure and the precision of a license plate reading system. No wonder that it is the most adopted method. However, it presents a major flaw: once installed on the road, the stated accuracy of the system can reserve disappointing surprises. Lab tests, unfortunately, are not able to simulate the environmental conditions in which the the system will be operating. In laboratory tests they use clean, perfectly reflective plates, without shadows or backlit: in other words, plates in optimal conditions. It's definitely a starting point of reference (if provided by third parties), but far from demonstrating the real accuracy of the product once it is installed on the field. Some systems that declared a class A (accuracy greater than 95%), have then demonstrated an accuracy lower than 60% on the road..

As there are no automated systems to calculate the real accuracy of a license plate reading system, the correct method is still the human visual analysis, which is to manually count the number of plates without errors, comparing the total captured. This measurement method is called "on field" or "on the road", if you prefer.

The method "on field" takes place outdoors, collecting thousands of images one by one and analyzing all the images captured over the 12 months in different atmospheric conditions (in different seasons with fog, sun, rain, snow, during day and at night). The test is very challenging, long and with high operating costs (and therefore adopted by a few manufacturers). It is, however, the method that gives the customer the real guarantee that the product will offer accuracy performance correspondent to those declared once purchased and installed on the road..

Rarely on datasheets it is described the method by which the given accuracy was obtained and this is not the only source of misunderstanding.

3°- Pitfalls

Misunderstanding that often creates confusion to those who have to buy a car plate reading system, is the one regarding the technical data

Correlation of data

Many datasheets of systems / products for plate reading present technical information that make them think of a promising and performant product. Unfortunately, most of these data have no correlation (connection) between them. The lack of a link hides a thousand question marks on the real conditions in which the technical performances declared on the product description were obtained.

For example, declaring that a license plate reading system reads at speeds above 200 km / h, with 95% accuracy and viewing angle of 50 degrees, makes us immediately think that the camera gets all these benefits when installed on the real field.

It often turns out, however, that the camera reads the license plates of up to 200 Km / h (as the maximum limit), but that speed accuracy does not exceed 60%. To achieve an accuracy of 90% (the minimum wage) you might find that the speed should be reduced to 70 km / h and the angle of reading must not exceed 25 degrees.

A serious datasheet should at least report the technical performance related to the only important feature for the customer: the real accuracy of reading on the road. Starting with the latter, all the technical data should be tied to that value. If I declare an accuracy of 95% and a read speed of up to 200 Km / h, this should mean that I get that precision at that speed, once installed on the road in all weather conditions, and not only with clean plates but also with plates of all kinds: dirty, wrinkled, old, deformed, etc.
.

Acronyms

A second type of misunderstanding arises from the acronyms used to define the type of technology used to create the license plate reading system. Because of an unscrupulous commercial use, enormous confusion has been generated in the use of acronyms that were used to distinguish the technologies used in the license plate reading system, such as:

LPR (Licenze Plate Recognition),
CPR (Car Plate Recognition),
NPR (Number Plate Recognition),
ANPR (Automatic Number Plate Recognition).

Today these acronyms are used without distinction to indicate both an ordinary IP / analog camera adapted to read license plates, and an intelligent camera with on-board OCR. To the unsuspecting purchaser, the misleading aspect is that many cameras are described as capable to read characters by themselves. Instead, they are nothing more than simple cameras holding

an anti-glare filter, only useful to the transmission of images. To read the plate, you must later use the appropriate license plate recognition software to install on your computer.

Therefore, the next step is to make us clear about the kind of technologies that exist in the world of reading license plates.

4°- Different types of technology

There are only two technologies available to provide a system for reading car plates:

- a technology based on software installed on PC (PC-based system, also known as LPR);
- a technology based on smart camera that is the kind of camera in which the license plate reading software (OCR) is integrated into the camera itself (also called ANPR cameras).

Software systems, often called PC-based or LPR, are made of cameras which transfer images to a PC with an OCR software for license plate. The images transfer should be continuous and at high frame rate. The cameras suitable for this purpose must be capable of providing at least 25 images per second, be endowed with an anti-glare filter (because of car's headlights) and for this reason shall be provided of infrared illuminator. The latter is often a fixed illuminator with constant power delivery, both day and night.

On smart cameras with on-board OCR (also called ANPR) the processing is done within the camera itself which not only processes the images, but it acts in real time on the illuminator by varying the power with the purpose of illuminating the license plate according to the reflectance or the light already present, thus obtaining a better recognition accuracy and in different atmospheric conditions both by day and by night.

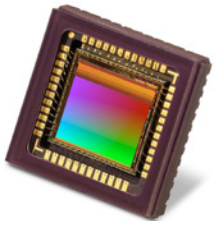
For both technologies exist critical elements that you need to know before deciding on which one to trust.

5°- Critical elements of a car plates reading system

Any car plates reading system, whether PC-based or with smart cameras, consists of the following three critical elements:

- The sensor
- The illuminator
- OCR and compensation algorithms (the software)

The sensor



To obtain a good result the camera (that is the eye of plate reading system) must be endowed with a Global Shutter sensor (acquisition of the pixels simultaneously and at high speed). When using cameras with Rolling Shutter sensor (in which the acquisition of the pixels is sequentially and low speed) you are obtained blurred images when the vehicle is in motion, in particular at night. In other words you will get a bad result.
Rolling Shutter sensors are widely used in video surveillance cameras for their low cost: this is the reason why you should never use a video surveillance equipment to make even the license plate reading.

The illuminator

All cameras for plate reading use a filter that blocks the visible component of the light, letting only the infrared rays in order to eliminate the blinding headlights. This anti-glare filter makes the image completely dark and therefore it is essential to illuminate the license plate with an IR illuminator.

This is the reason why the illuminator is one of the most important components of a plate reading system. It contributes 50% of the result of reading in terms of accuracy.
There are two types of IR illuminators:

- emitting constant light (the most used in the PC-based systems), where power remains unchanged;
- with automatic adjustment, that is self-regulated (used in cameras with OCR) where the power continuously changes.

The best result is obtained by using illuminators with automatic adjustment. In fact, the illuminator should read the light conditions present on the plate and automatically adjust (as a photographer would) the illuminator power (e.g., by increasing the power at night or with dirty plates and decrease it at day with clean plates, already enlightened by sunlight).

For this reason manufacturers of smart OCR cameras do use adaptive illuminators fitted with automatic adjustment of the emission intensity which varies according to the amount of radiation reflected from the plate and the light level in the environment.

Some OCR cameras, as well as using self-regulated illuminators, have a function of image analysis that allows you to weigh every single image frame and provide the sensor and the illuminator appropriate values of regulation. The ultimate aim of all this process is to get the best reading performance.

The algorithms and the OCR

The OCR is the third element in the chain of a license plate reading system and consists of that mathematical function that can extrapolates everything looks like letters and numbers in an image. It is often used to store paper documents in electronic format.

To function properly an OCR must be able to operate on sharp, blur-free images, at high contrast where the characters are well-defined (black on white). For this reason the illuminator plays a decisive role in reading license plates.

The OCR alone is not however a sufficient condition for recognizing letters and numbers stored in the plate. Counting on the OCR algorithm only will provide really poor results, beacause of dirt, flies, deterioration of characters, headlights, sun and shadows that inevitably affect the plate's image.

To get a correct reading the image (which comes from the sensor) must be further processed by compensation algorithms. Many of these calculations are effective when there is cooperation between the three major subsystems: illuminator, sensor function and processing.

In PC-based systems there is no cooperation between the camera and the PC (which are two separate devices), and the less you can adjust the power of the illuminator based on the result of processing. Only in smart cameras we will find these inter-connections between the various subsystems.

Among the main compensation algorithms that technology makes available to us we mention the most important ones for accuracy:

- Multi exposure: that means take multiple frames with different lighting levels (also called triple exposure);
- Shadows deleting: useful to delete harsh shadows covering the characters in full summer sun. The elimination of shadows is done through a special use of the illuminator;
- Reconstruction of damaged, half-covered or partially damaged characters;
- Recognition of symbols and written advertising to avoid the reading of false characters that have nothing to do with the plate;
- Compensation of the different reflectance of plates composed of a new part and an old part;
- Compensation of the angles, in order to avoid deformation of characters due to the different perspectives of vision and installation
- Probabilistic analysis, performed by assigning the characters and the readings of likelihood ratios, then choosing those close to 100% confidence.

From these elements and the quality of these algorithms depends the final result of accuracy.

6°- PC based solutions or ANPR cameras?

Being the software-based technology and one based on intelligent camera two completely opposite "parties", we could say someone takes sides in favor of a party and someone in the other.
To better understand the existence of these two "parties", you need to know that there are basically two types of manufacturers:

- developers of car plates reading software
- developers of ANPR cameras (embedded systems)

The former generally do not produce their cameras: they offer third-party products. Those few who also develop their own products use industrial PCs with on-board software (which are nothing more than a PC-based solution). Those who move the algorithms of their software on embedded systems, get ANPR cameras that offer poor results.

Who actually produces professional ANPR cameras, rarely sell a separate reading software and if they do that, the software is usually third party. This is because the OCR developed for the "embedded" that interacts with the system's hardware components is completely different from a stand-alone software.

Indeed, procedures and algorithms developed for a stand-alone software are so different from those developed for ANPR cameras (embedded systems), that a manufacturer is led to join one either party, unless he wants **to double the costs for R & D department**

Having said that, we present a summary of the opinions of different parties expressed by people of all nationalities who are expert in this field.

➡ *All agree*

There is an aspect on which, without distinction by "party", all the experts agree: the better the image quality, the better the accuracy of reading.

➡ *In favor of PC-based systems*

We report the views of those in favor of PC-based systems:

- It is a cheaper solution when you need to manage one or two access points at low speed (access control);
- It allows you to use various OCR and activate the one offering the best performance or use a more accurate OCR to read car plates in a given Country;

- It offers the possibility to use a CPU with computational capabilities superior to those of the smart cameras and a more sophisticated OCR;
- The choice of the sensor is limited in a smart camera while in a PC-based system customers can choose the camera they prefer and availability is much wider;
- For low speed transit you may also choose economic cameras.

➡ *In favor of smart cameras with on-board OCR*

We report the views of those in favor of smart cameras with on-board OCR:

- It offers a reading accuracy superior to any PC-based system both in reading at high speed and in access-control applications;
- It is the best solution to save bandwidth;
- It is the most simple and quick to install;
- It is a green solution, since the OCR camera consumes much less power than a PC-based system. Furthermore, the camera does not need a suitable (conditioned) environment, allowing a considerable saving in money and time;
- It is safer because in case of disconnection of the control center the OCR camera will keep storing images on board and will not miss a transit. A PC-based solution will automatically stop if it does not receive images;
- A fault in the PC means a knock-out of the entire plant for plate reading;
- Thanks to internal storage of the permits list (white list), OCR cameras allow night and day the operation of access control even if the central PC is off (often required in campsites);
- You can expand the system with an infinite number of cameras, essential in all applications which require a high number of reading points (city surveillance or highway);
- In applications at high speed (free flow), the OCR camera does not require, as in most PC-based systems, a sync pulse for reading;
- A good OCR camera costs more or less as much as a good camera for PC-based systems;
- The computational power of the current chips for OCR cameras is almost equal to that of a Computer.

7°- Summary table

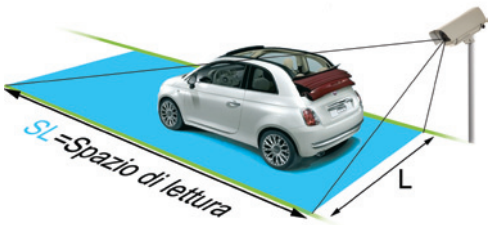
Here then the comparative overview of the two technologies for car plates reading.

	PC based	OCR Camera
On-road accuracy	60% to 90% ☆☆★★★	85% to 99% ★★★★★
Max number of point per PC	4 ☆☆☆☆★	unlimited ★★★★★
Computational resources required	High ☆☆☆☆★	Low ★★★★★
Reliability	Medium-low ☆☆★★★	High ★★★★★
Installation time	Medium-high ☆☆☆☆★	Low ★★★★★
Energy savings	Low ☆☆☆★★	High ★★★★★
Maintenance costs	High ☆☆☆★★	Low ☆★★★★
Illuminator	Fixed IR ☆☆☆★★	Adaptative IR ★★★★★
Disaster recovery	Low ☆☆☆★★	High ★★★★★
Bandwidth occupied	High ☆☆☆☆☆	Low ☆★★★★
Temperature di lavoro	0 ~ +30°C (standard PC)	-25°C ~ +50°C

8°- Insights

We will describe some characteristics of the car plate reading systems that are not critical, but if held can be extremely advantageous in many applications.

READING AREA



"Reading area" means the distance, in meters, between two opposite extremes beyond which the system is no longer able to read the car plate. Usually such extremes are equidistant from a central point which is the point where the camera has its focusing. The greater the distance between one extreme and the other (reading area), fewer will be the constraints during the installation phase. A large reading area indicates that the product is able to read car plates from both near and far.

Few plate reading systems have large reading area. Most have reduced reading area (1.5 m + 1.5 m after the first focal point, or a reading area total of 3 meters only). A reduced reading area is a troublesome constraint that does not admit mistakes and obliges the installer to determine precisely both the point of installation and the type of lens to use.

LENSES

If we explicitly refer to cameras with on-board OCR only, we can see that currently there are only two solutions: cameras with a fixed lens and others with adjustable lenses (varifocal). The first are comfortable because they do not require adjustments in the field, but are binding especially when you are not sure of the exact installation point. The latter are more flexible and adaptable, and allow better to control the framing and increase the reading accuracy, even if they require, once fixed, a few minutes for the adjustment of the focus and the frame

SYNTAX

Some plate reading systems integrate the function of recognition of the syntax, which would, theoretically, define the nationality source of the vehicle.

Too bad the lack of a legal system among nations means that this feature is practically useless. Mistakes due to the lack of certain rules are not negligible: France has more than 12 different syntaxes; Germany likewise; England exceeds 15. In some countries, the syntax is customizable, so it can not be assessed. Several nations, European or not, have the same syntax and this makes it impossible to identify the correct origin. The on-board syntax is the most economical method for discriminating advertising signs from those contained in the plate.

Without this logic, some products fail to distinguish the content of the plate by the writings and symbols, generating a multitude of mistakes. The syntax oblige the purchaser to submit to limitation of libraries built into the camera (often limited to a few countries) or to purchase extensions. The best technology available today are recognition algorithms using no library syntax called "*Sintax-free*"systems

.

9°- Story of a choice

When SELEA decided to produce its own system of car plates reading many years ago, the first choice was to develop a PC-based software, instead of producing cameras.

Designing and creating software meant facing **lower development costs** and fewer project complications, so we started by testing software for license plate reading from the most renowned manufacturers.

From the first experiments (made with cameras we already owned) we quickly realized that to achieve a reliable and accurate product, it was essential to use a good camera. This meant searching a device that would be suitable for the purpose, possibly with excellent optical qualities, not creating problems with the glare of the headlights and with a good illuminator to function properly even at night. It was by the quality of the images, and not so much by the software, which depended most of the reliability and accuracy of license plates reading.

Find a suitable camera at a good price has been not simple at all. There were hard-to-find products that often leave production overnight. World is full of cheap cameras, but they procure more trouble than satisfaction. Those of good quality are very expensive (almost equal to the cost of a camera with OCR) and the price of the camera is always added to the cost of the license plate software and the PC.

We asked advice from people more experienced than us. We found out that basically they all had the same problem:

- low cost camera = dissatisfaction and problems;
- professional camera = high cost.

To take away the last doubts we started to do some tests with the cameras with built-in OCR (by purchasing the best known). We noticed that although there were those that worked worse than others, OCR cameras always provided better results than the best plates reading software connected to the best professional camera.

We realized then, that designing a camera with OCR would be the most advantageous choice:

- It represented an all-in-one solution that guaranteed the best performance in car plates reading (exactly what we were looking for);
- It costed less than the sum of the cost of a good camera + license plate reading software;
- We could make any desired changes to the product without relying on third parties.

And thus TARGHA was born!

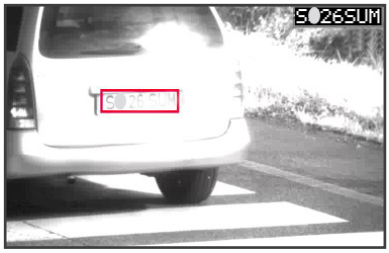
10° - Failing systems.

We end this guide showing you some of the key issues on which different plate reading systems fail

SHADOWS

The shading on the plate can occur in various ways (horizontal, vertical or oblique) and of different intensity (weak or strong). Not every car plate reading system can solve this problem. The solution consists of a mix of automatic adjustments of the illuminator and sensor.

OVER-LIGHTING

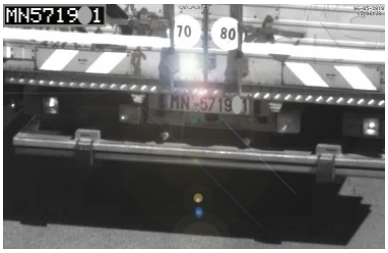


In different periods of the year the sun (at the end of the day) emits so a high quantity of rays that reflective plates are put in overexposure. Adding IR lighting, like in cameras with fixed illuminators, means to obscure the plate.

CREEPING EFFECT

The "creeping" effect prevents characters reading. The phenomenon occurs with rolling shutter, especially megapixel sensors, in low light conditions. Using a powerful spotlight to compensate for low light means to solve the problem at night, but run into problems over the day. The solution is using Global Shutter sensors.

REFLECTIONS



They are called "smeering" and "blooming" effect a series of straight beams of light that affect the reading of the characters. CCD sensors are by their nature are very sensitive to these phenomena. The only solution to eliminate this phenomenon is to use cameras with CMOS-type Global Shutter sensors with high frame rate.

DAMAGED PLATES

Characters that suffer most from deformation and damage are those of the front plates. Walls, stones and insects are the main cause. These problems are also present on the rear plates. In the presence of seriously damaged characters our intelligent algorithms based on predictive analysis will help you understand the correct value of the character.

DIRTY PLATES

It's very frequent to be confronted with passages of cars with dirty plates with the following car gleaming straight out of the wash. In these cases, cameras with adaptive pulsed illuminators will adapt to the reflectance conditions of the plate and take into consideration the IR in the environment.

SELEA

I T A L Y

Via Aldo Moro, n. 69

46019 Cicognara (MN)

Tel +39 0375 889091

www.selea.com