

# Choosing the Correct License Plate Reader for Your Solution: How License Plate Types, Styles and Design Affect Readability

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## Standardization of License Plates

In the United States, license plates are designed, manufactured and distributed by jurisdiction with very little standardization between them. License plates in the U.S. are standardized to a 6-inch x 12-inch rectangle which is displayed horizontally on either the front or back of the vehicle. Some states only require a rear plate.

For articulating commercial vehicles, a front plate is tied to the tractor and the trailer will have a completely different plate, maybe even from another jurisdiction. Non-articulating trucks, also referred to as straight trucks, follow the requirements of plate positions for passenger vehicles in the jurisdiction of issue.

The alphanumeric registration numbers serve as unique identifiers that are specific to a jurisdiction and/or plate type. Entering this number in the appropriate database can provide information of interest such as make, model, year, and to whom the vehicle is registered.

## Differences in Plate Types, Styles and Design

Even plates within the same jurisdiction can vary significantly. Fonts, syntax, graphics, backgrounds, and the use of special characters such as dashes, can be different within a single jurisdiction. For instance, passenger vehicle plates from a state may have a syntax of ABC-123 whereas a commercial plate from the same state may read A12345. Seemingly similar plates can even use different inks from year to year which can affect readability.

The materials used to manufacture license plates varies, as well. Some plates have embossed characters and some are flat plates with printed information. Some plates are made with a retro reflective material that allows light to be reflected back to its source, while other plates are made with a non-retro reflective material. Retro reflective simply means the light transmitted to a target (in this case a license plate) is reflected to its source. For example, think of a stop sign or exit sign on the highway. When your vehicle's headlights reach the sign, it suddenly looks brighter, as the light is reflected to the eye. Non-retro reflective material is still reflective, but the light is dispersed in many directions making the target look dimmer, especially at night.



## How License Plate Readers Work

To better understand how license plate design can impact automated reads, it is important to understand how license plate readers work. All license plate readers are made up of the same basic components, performing the same basic functions:

- Vehicle detection (trigger): A method of recognizing the presence of a plate or vehicle to initiate the read process.
- Illuminator: A light source to illuminate the license plate being read.
- Camera: Required to capture the image of the plate.
- Optical Character Recognition (OCR) software: This is the “brains” of the system that interprets the plate image.

When a vehicle is detected by the trigger, the LPR will illuminate the front and/or rear of the vehicle and capture an image. This image is then processed by the OCR to locate a license plate and begin the process of identifying the individual characters. Additional information is obtained from the plate image to identify the origin (state or province) of the license plate. The image and data obtained will then be transferred, typically over Ethernet, to the customer.

## The Image Analysis Process

The OCR is the “brains” of the operation. To analyze an image, the OCR software goes through a very specific process.

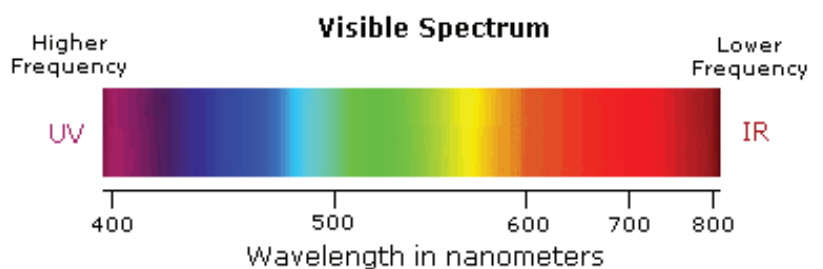
1. License Plate Location: Any area of the image that contains text is carefully examined to locate the best license plate candidate. It is important for the OCR to be able to recognize a license plate versus other text or images on the vehicle.
2. Adaptive Foreground/Background Segmentation: Before the characters are processed, they are isolated from the background, including state logos, and other graphics.
3. Character Contouring: Once the characters have been isolated, the contours of each character are outlined.
4. Feature Extraction: The OCR extracts features from each character then sends it through a character recognition process. These features include number, location and direction of bays in characters such as “E”, “H” and “7”, and number and location of holes in characters such as “6”, “D”, and “8”.
5. Character Recognition: Each character is then analyzed by independent rule-based expert systems, each compiled into an optimal decision tree. Each decision tree uses a different set of features and is optimized to recognize different sets of characters.
6. Context Analysis: After each OCR engine individually identifies a character, they work together to take context into account. Context is the alphanumeric pattern that represents the syntax of the plate. In other words, how many and in what position are the numbers and letters in a state’s plate design. The algorithm also recognizes unique characteristics on plates that are used to identify type.
7. Plate Type/State Identification: After the registration number has been identified, the OCR determines the jurisdiction and plate type. Plate types include but are not limited to: motorcycle, dealer, highway patrol, apportioned truck, and taxi.
8. Confidence Calculation: In addition to the plate number, state and type, the OCR will compute a confidence calculation to determine how confident the system is in its result.
9. OCR Results: An OCR result typically includes the unique transaction ID, date and time of transaction, license plate string, state ID, plate type, confidence factor, LPR image, and patch images.

## Illumination and Imaging

Illumination of the license plate can be achieved by various means. This is often dictated by the location of the installation and potential requirements of individual states. Common illumination types are:

- Infrared (IR) LED’s – varying wavelength
- White Light (LED or other sources)
- Filtered Visible Light

The purpose of using several bands of light is to filter out the effects of background graphics and/or to highlight the alphanumeric characters for the OCR system.



Infrared light is one of the more recognized forms of LPR illumination. Depending upon the wavelength, it ranges from minimally visible to completely invisible to the human eye. That can be a plus in some instances, but IR also has its limitations.

### **How License Plate Designs Affect Accuracy**

IR systems rely on the retro reflective nature of a license plate, however, unfortunately, not all plates are retro reflective. Manufacturers of license plate material will typically guarantee the retro reflective material of the plate for 3-5 years. Many license plates on the road today, especially on commercial vehicles, are much older than this.

The condition of the plate can affect readability. Plates can become coated with road grime, salt in the winter, and exhaust residue. These contaminants can coat the plate and reduce the retro reflective nature. This will also reduce the light received back at the camera, making the plate darker and more difficult to read.

Colors also play a factor. Infrared light can wash out a plate's background, leaving only the characters to read. Reds will appear white. A license plate with red characters on a white background or white characters on a red background become almost impossible to see. The IR makes the red appear white, causing the characters to disappear. If the characters are a similar color to the background, the contrast between the two may not be enough to get a good image. The attach rate is typically lower with IR systems due to dark or low contrast plates being labeled unreadable. Low contrast plates are considered unreadable by the LPR system.

Unfortunately, infrared systems come with challenges because they are designed primarily for retro reflective plates. Non-retro reflective or old plates, plates in poor condition, or plates with red/white color combinations that may be captured during the day will often be missed at night, as the camera relies on the illuminator as its only light source in absence of the sun.

### **Camera Solution Options**

The type of illumination used will impact the camera used. For example, monochrome images can be obtained using white light, optically filtered visible light and IR illumination. To obtain a color image, white light must be used. To minimize the impact of white or visible light to the driver in areas where little or no ambient light exist, it may be necessary to add a light source that is always active.

Color cameras are useful when the color information can be used to improve the separation between characters and background, and for identification of the jurisdiction. As humans are used to seeing the license plates in color, providing this type of image to the user can allow for quicker manual identification.