CARMEN® OCR – for UIC

Wagon/Coach Number Recognition

(Carmen OCR sdk + UIC engine)

Reference Manual

For engine ver. 7.2.3 and above
Document version: 03.06.19

Table of Contents

INTRODUCTION

CARMEN® OCR is the common SDK for recognition of all non-license plate related transportation codes.

This is possible through using different recognition engines with the sdk, like:

- ACCR - Intermodal shipping container codes, BIC/ISO/ILU,
- UIC - Cargo wagon codes,
- USDOT - US Department of Transportation registration number
- MOCO – Moco container codes (8 digits),
- RUS - Russian and Ukrainian wagon codes (8 digits).
- BRA - Brasil wagon codes (10 or 11 digits)
- CHASSIS - US truck chassis code,
- USA_ACCR - US container codes (6 or 10 digits),

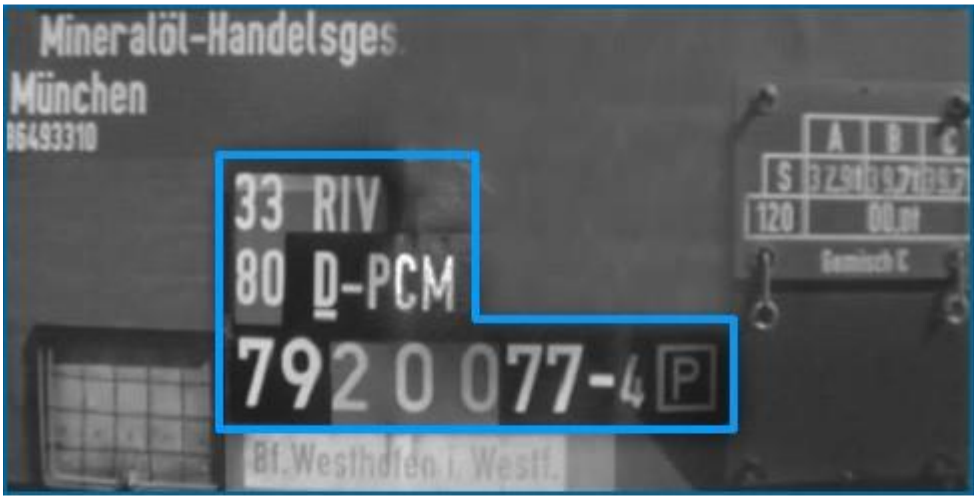
Although the engine properties below are the same for each of the solutions above, this document details the usage and properties of the UIC (Wagon Code / Coach Number Recognition) engine.

UIC wagon/coach numbers

Coach numbers (wagon numbers) are key data for railway operations. This number enables a railway wagon to be positively identified and forms a common language between railway operators, infrastructure companies and the responsible state authorities.

The system of wagon numbering described below has been laid down by the International Union of Railways (*Union internationale des chemins de fer or* ***UIC***) and is used in a similar way to that used for the locomotives and multiple units.

The UIC has agreed the following numbering systems, details of which are given in their leaflets: Leaflet 419-2, 428-1, 438-2, 920-1, 920-2, 920-10 and 920-14. These agreements have not yet achieved the status of a standard or norm.



The complete wagon number comprises 12 digits. The individual digits within the number have the following meaning:

Digits 1-2:	Type of vehicle and indication of the interoperability capacity (on multiple units, type)
Digits 3-4:	Country Code (before 2006: owner)
Digits 5-8:	Vehicle type information
Digits 9-11:	Individual running number (serial number)
Digit 12:	Self-check digit

UIC Country codes

The coding of wagon numbers was changed in 2006. Previously this section (third and fourth digit) indicated the owner (almost exclusively these were state railways), from then on the number became a country code. The owner is indicated by a subsequent letter code.

For a vehicle registered in Germany by the AAE, which previously had its own code as one of the few private railways, the code became, for example, "68 AAE" "80 D-AAE". Click here to see the list of UIC country codes.

Introduction of UIC code recognition

UIC code recognition is a technology which is able to recognize UIC codes from an image or video signal, and returns it in a computer editable format for further processing.

The CARMEN® OCR - UIC code recognition software is an Optical Character Recognition (OCR) technology based, intelligent image processor. It has two essential technological challenges:

- the quality of the OCR software with its applied recognition algorithm
- the quality of the image acquisition technology, the camera and the illumination

The key factor is the quality of the recognition software. The sophistication of the recognition software, the intelligence and quality of the applied recognition algorithms, the mathematical knowledge and the years of experience behind determines the capabilities of the recognition software.

The better the algorithms are, the higher the quality of the recognition software is:

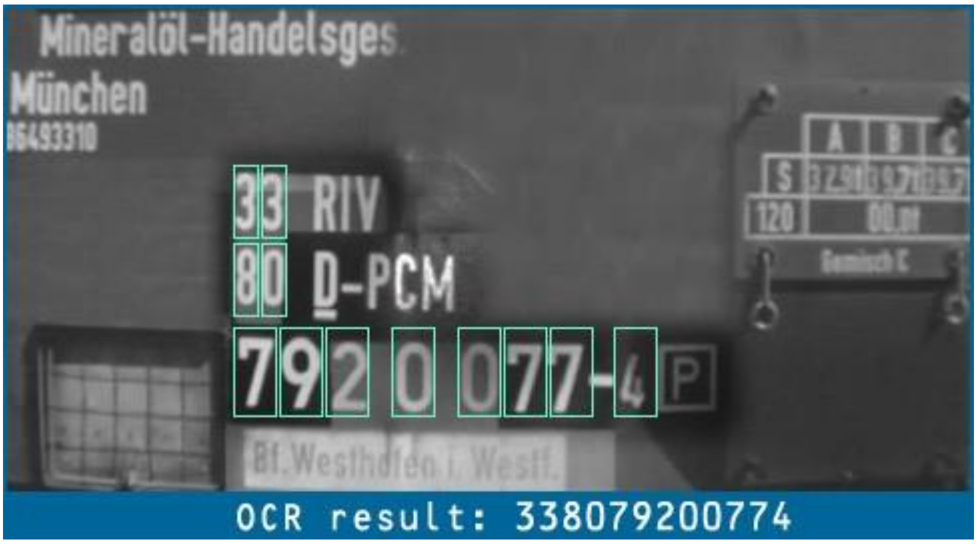
- the higher recognition accuracy it has,
- the faster processing speed it has:
    - the widest range of picture quality it can handle,
    - the most tolerant against distortions of input data it is.

UIC code recognition software

ARH Inc. has developed a special recognition software which is capable of recognizing UIC codes of transport units. The CARMEN® UIC Code Recognition Software offers great flexibility for manufacturers and integrators of various recognition systems.

It provides the highest technological performance amongst today's code readers. It can be integrated into practically any vehicle identification system which needs automatic transport unit recognition.

The CARMEN® UIC Code Recognition Software Development Kit (SDK) makes integration of optical plate recognition easy, fast and cost effective, still maintaining the highest performance.



CARMEN® OCR is an optical character code recognition software of **ARH Inc**, designed for codes in the cargo and transportation sector. It provides an easy-to-program Application Programming Interface (API) for software developers.

The name of the SDK is **CARMEN® OCR,** which is able to read wagon/coach codes through the **Carmen® UIC engine**.

The currently supported programming languages and the available interfaces are the following:

- C, C++ (cmaccr.h)
- Java (jcmaccr.jar)
- C# (cmaccrdotnet8.dll) (.NET 4.0 interface)

BASIC FUNCTIONALITY

The functionality of **CARMEN® OCR** is centered upon the ***FindFirstContainerCode*** function. This takes wagon images and returns the code read, the overall confidence level[1] and separately the read results for each image.

Initialization

On startup, **CARMEN® OCR** loads the UIC engine and reads its data files from the module folder. The name of the default data file is {engine name}.dat (i.e. ***cmaccr-2.17-uic.dat*** for the ***cmaccr-uic-7.3.2.17_18Q1*** engine).

Compatibility

In most cases, the **CARMEN® OCR** system retains the backward compatibility with the older versions so, the compiled programs run perfectly well even if the system is upgraded to a newer version.

The evolution of the system adds the necessity of changing the SDK by adding new functions, new parameters to functions, eventually changing the type of the return value or moving the deprecated functions into the compatibility section that may not be installed by default. In this way, users are forced to use the newest version each time they compile their programs with the **CARMEN® OCR** SDK, but there is also the possibility to compile the existing sources using the appropriate version.

What to do if you do not want to update your code?

- The old versions of the interface files are available on the install CD or request them from the Support Team.
- Without updating the ActiveX interfaces (Delphi packages, C++ wrapper class files) the old methods do no work appropriately.
- Without updating the Java (jcmaccr.jar, jcmaccr.dll) and .NET (cmaccrdotnet7.dll) interfaces the old methods will work appropriately.

View the cmaccr.h for full reference and check the Change Log for differences against the previous versions.

For complete understanding of the system internals, consult the GX Reference Manual.

[1] **Confidence level**

The confidence level value represents that to what extent the engine is sure about the result. Dirt and damages on wagons or poor image quality increase the risk of mistakes. The greater amount of risk is represented with low confidence level values by the engine.

PROPERTIES OF THE AUTOMATIC WAGON NUMBER READER MODULE

Property list of the CARMEN® OCR engines

PROPERTIES OF THE CARMEN OCR ENGINES	
Properties related to the identification of the current engine	datafile
Properties related to processing time	timeout
	contrast_min
Properties related to the geometry of plates	size
	size_min
	size_max
	slant
	slope
	slope_min
	slope_max
	xtoyres
Properties related to the position of the codes in input images	posfreq
	posfreqhistxs
	posfreqhistys
	posfreqhalflife
	posfreqweight
Properties related to code type	filterlongcodes
	isocode
	checksum

1. DATAFILE – NAME OF DATA FILE OF THE ENGINE

Specifies the name of the module data file located in the module folder. If not set, then the default data file will be used as follows: engine_name.dat (i.e. ***cmaccr-2.17-uic.dat*** for the ***cmaccr-uic-7.3.2.17_18Q1*** engine).
Default value: engine_name.dat

Properties related to processing time

2. TIMEOUT – RECOGNITION TIME LIMIT

The length of the time interval in milliseconds in which the module tries to find wagon numbers. The interval starts when cmaccr_findfirstcontainercode is called. At the end of this period, the engine tries to finish searching for codes. Zero timeout value means no time limit.

Note: In case of multiple images load with the same wagon code, timeout applies for recognition of the full image series. If timeout runs out before all images processed, only the codes for the number of images fit into the timeout frame will be resulted.
Default value: 1000

3. CONTRAST_MIN – MINIMAL CONTRAST

The supposed minimal difference between the grayscale value of the characters and the background.

Properties related to the geometry of the wagon numbers

By setting the below properties of the engine appropriately, the recognition time of the engine can be decreased. Properties effecting recognition time significantly are **size_min**, **size_max** and **contrast_min**. These are set appropriately if the intervals defined by them are as narrow as possible (suited to camera environment).

4. SIZE – AVERAGE HEIGHT OF THE CHARACTERS

The average height of the characters in the image in pixels. No default value.

NOTE: size_min ≤ size ≤ size_max. Therefore, the size value has to be equal to or greater than size_min and equal to or less than size_max otherwise the engine may return no data.

5. SIZE_MIN – MINIMUM HEIGHT OF THE CHARACTERS

The minimum height of the characters in the image in pixels. No default value.

6. SIZE_MAX – MAXIMUM HEIGHT OF CHARACTERS

The maximum height of the characters in the image in pixels. No default value.

7. **SLOPE** – AVERAGE SLOPE OF THE CHARACTERS

The average slope of the characters in the image. This value is represented in percent (%) and it is positive if the horizontal axis of the character slopes downwards viewing from left to right.

NOTE: slope_min ≤ slope ≤ slope_max
So, the slope value has to be equal to or greater than slope_min and equal to or less than slope_max otherwise the engine may return no data.

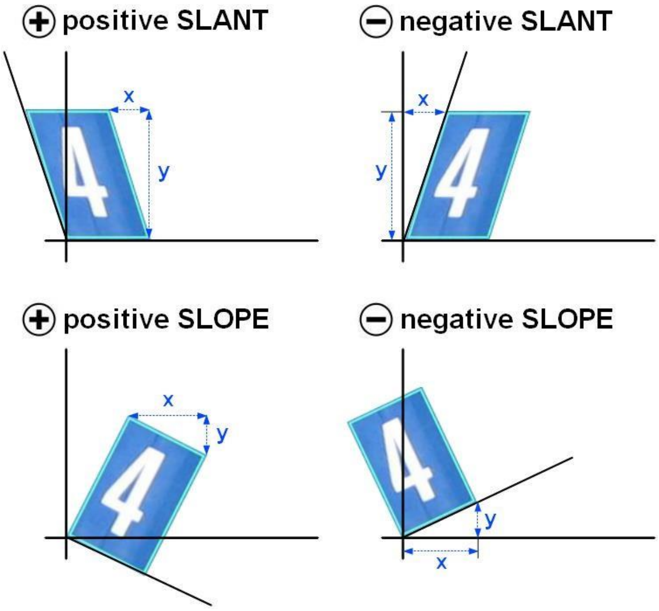
8. **SLOPE_MIN** – MINIMUM SLOPE OF THE CHARACTERS

The minimum slope of the characters in the image. This value is represented in percent (%) and it is positive if the horizontal axis of the character slopes downwards viewing from left to right.

9. **SLOPE_MAX** – MAXIMUM SLOPE OF THE CHARACTERS

The maximum slope of the character in the image. This value is represented in percent (%) and it is positive if the horizontal axis of the character slopes downwards viewing from left to right.

10. **SLANT** – AVERAGE SLANT OF THE CHARACTERS



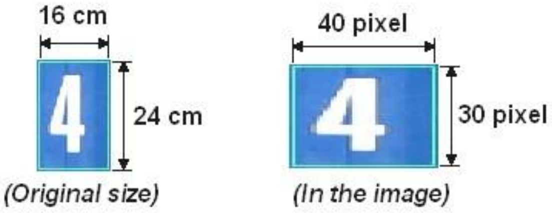
11. **XTOYRES** – THE RATIO OF HORIZONTAL AND VERTICAL RESOLUTIONS

The average slant of the container code character in the image. This value is represented in percent (%) and it is positive if the vertical axis of the characters slants to the left viewing from bottom to top.

The ratio of the horizontal and vertical resolutions of the frame of the character area. This value is represented in percent (%). The horizontal resolution is the ratio of the width of the character frame in the image and the real width of the character. The vertical resolution is the ratio of the height of the character frame in the image and the real height of the character.

If the original height of a character is (Ys) 24 cm and the width is (Xs) 16 cm but in the image the height of the character is (Ysi) 30 pixels and the width is (Xsi) 40 pixels, than

$$xtoyres = 100 \cdot \frac{\frac{Xsi}{Ysi}}{\frac{Xs}{Ys}} = 100 \cdot \frac{\frac{40}{30}}{\frac{16}{24}} = 200$$



Default value: 100

Properties related to the position of the wagon numbers

An area can be specified for the UIC engine, which is more superior to the others.

With the following parameters, the algorithm can be set to search for wagon numbers on specific parts of the image. Moreover, some parts can be differentiated according to probability of the occurrence of the wagon code. The essence of the method is that the image is divided into zones with identical areas and each zone has a weight.

The correct value assignment of the weight increases the effectiveness of the searching process. With the growth of the weight of the appointed zone, the probability of finding the code increases and the time required for reading the code decreases.

The weights can be initialized by the equal spread function, by the assigning of the weight values of zones and finally by defining a polygon that should contain all the codes.
There is a possibility for adoption of the weights as well. In this case, each found code increases the weight of that zone which contains the code.

12. **POSFREQ -** CODE POSITION FREQUENCY

String – which can be an empty string – may contain numbers divided by ',' and ';' within a row.
If the string is empty, it initializes the grid with uniform distribution (the weight of each zone will be the same positive number).

Otherwise, ',' separates the numbers while the ';' separates the line wrap.
If there are two columns and at least three rows, the string defines a polygon. Otherwise, it defines zones, where the given numbers are the starting weights of the zones.
The data is invalid if the rows are not the same length.

For example:

Defining a zone:

<posfreq value=“1,1,1;4,9,4;1,1,1”/>

1	1	1
4	9	4
1	1	1

The image is divided into 3×3 zone with the given starting weights.

Defining a polygon:

<posfreq value="100,100;500,100;500,500;100,500"/>

(The order of the coordinates has to be set clockwise)

In this case, a square is designated in the center of the image, on the score of which the algorithm produces the zones (posfreqhistxs*posfreqhistys is the number of zones, 16*16 by default) in such a way that:

- the starting weight of the zones – contained by the polygon – will be maximal,
- the weight of the zones intersected by the polygon will be lower in proportion to the intersection.
- finally, the weight of the outer (untouched by the polygon) zones will be 0.

It does not return any character from the zones with 0 weight.

13. **POSFREQHISTXS,POSFREQHISTYS** - [2..64],[2..64]

The number of the rows and columns.
Both are 16 by default.

14. **POSFREQHALFLIFE -** [0..1048576]

If its value is 0, the weights will not be adopted (it does not learn from the previous cases). It will use the original settings all the time.
Otherwise, after 'posfreqhalflife' number of evaluations, the starting information will be half lapsed and the new information will be half freshened. Half-life: after evaluation of many images, the total weight of the histogram will be twice as much.

15. **POSFREQWEIGHT -** [0..100]

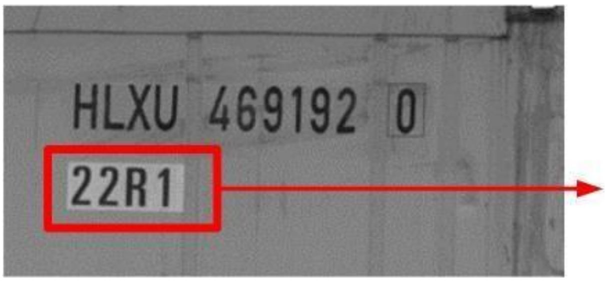
This parameter defines how the system has to take into account the position of the container code.
If this parameter is 0, the system doesn't distinguish between the non-0 weight zones. In this case, the searching does not exploit the distribution of the position of container code.
If this parameter is 100, the system tries to exploit maximally the distribution of the position of container code.

Properties related to code type

16. **FILTERLONGCODES** – LONG CODE FILTERING

If there is no code on a container but there is other kind of text on it then the engine may return with false (container) codes. The FilterLongCodes option helps to reduce the occurrence of these false codes, increases runtime length (approx 5%), and worsens the recognition of container codes on pictures having a container code (approx 0.5%). If this option is set to 1 then filtering is enabled. (If set to 0, filtering is disabled) Default value: 1.

17. **ISOCODE** – ISO CODE RECOGNITION **(ONLY FOR ACCR ENGINES)**



1 – the engine searches for the last four digits of the entire ISO code as well.

Note: only works with ACCR - ISO engine.

Possible values: 0 – the engine does not search for the last four digits.

Default value is 1.

18. **CHECKSUM** – FLAG TO MARK THE PRESENCE OF CHECKSUM

Earlier, this parameter used to determine the recognised codes. Recently, this is fixed for each recognition engine **– do not change this property**.

1 - USA ACCR: 6 number code,
2 - MOCO: 8 character MOCO codes,
4 - USA ACCR: 10 character codes,
5 - USA ACCR: for 6 and 10 character codes,
8 - ISO / ILU: 11 character codes – ISO 6346 (+ optional 4 ISO code character)
16 - RUS: (8 characters, numeric - Russian and Ukrainian wagon codes).
32 - BRA container
64 - USDOT
256 - UIC
512 - Chassis – US truck chassis code

APPENDICES

Confidence Level Calculation

$$\frac{k}{n+1} * $$ ***the highest image confidence***

Where:

- **k** stands for the number of images, where the SAME result was read
- **n** stands for the number of all images of the container
- **"the highest image confidence" =** highest confidence of the image series where the confidence level of one image equals the minimum confidence of the characters on the actual image

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