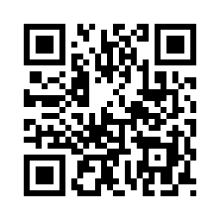
Pixformance Membership Tag Procedures

(QR Code Procedures)

Pixformance Sports GmbH

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| Date | Author | Comments |
| 20. Sept 2013 | Tomasz Naumowicz | first draft |
| 21. Oct 2013 | Tomasz Naumowicz | The “Activation of Pixformance Membership Tags” section as log of a discussion with the Platform-Team. Platform-Team must confirm / adapt |
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# General

QR code (abbreviated from Quick Response Code) is the trademark for a type of matrix barcode. A barcode is an optically machine-readable label. A QR code consists of black modules (square dots) arranged in a square grid on a white background, which can be read by an imaging device (such as a camera).

## Storage

The amount of data that can be stored in the QR code symbol depends on the data type (mode, or input character set), version (1-40, indicating the overall dimensions of the symbol), and error correction level.

## Error correction

Code words are 8 bits long and use the Reed–Solomon error correction algorithm with four error correction levels. The higher the error correction level, the less storage capacity. The following table lists the approximate error correction capability at each of the four levels:

* Level L (Low) 7% of code words can be restored.
* Level M (Medium) 15% of code words can be restored.
* Level Q (Quartile) 25% of code words can be restored.
* Level H (High) 30% of code words can be restored.

## QR Code Version 1

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| http://upload.wikimedia.org/wikipedia/commons/5/5b/Qr-1.png | Version 1 has a size of 21 x 21 modules. It’s the smallest QR code that can be used for the authentication on the Pixformance Station. |

## Variants

Micro QR code is a smaller version of the QR code standard for applications with less ability to handle large scans. There are different forms of Micro QR codes as well. The highest of these can hold 35 numeric characters.

Currently, Micro QR can’t be used with the Pixformance Station because the available software libraries don’t support Micro QR detection, yet. This feature can be added to the Pixformance Station in the future.

## License

The use of QR codes is free of any license. The QR code is clearly defined and published as an ISO standard.

(The general introduction above is a selective citation from Wikipedia[[1]](#footnote-1) and QRcode.com[[2]](#footnote-2))

# QR Code for Pixformance

## The QR Code

The Pixformance Station will use QR Code Version 1 with error correction level H, resulting in the data capacity of 17 digits.

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| --- | --- | --- | --- | --- | --- | --- | --- |
| Version | Modules | ECC Level | Data bits | Numeric | Alphanumeric | Binary | Kanji |
| 1 | 21 x 21 | L | 152 | 41 | 25 | 17 | 10 |
| M | 128 | 34 | 20 | 14 | 8 |
| Q | 104 | 27 | 16 | 11 | 7 |
| H | 72 | **17** | 10 | 7 | 4 |

17 digits is enough to generate (10^17) – 1 unique QR codes.

The QR Code will be scanned by the Pixformance Station at the user log in. The unique number behind the QR code, the UserQR, will be read from the QR code by our detection algorithm. Next, a lookup in the data base happens and returns the user record.

## The serial number

The unique numbers (UserQR) behind each QR code are stored in our data base of known QR codes. In order to know which UserQR is encoded behind each QR code without using a QR reader, e.g. during the registration process or while processing service cases, we have to label them on the QR Code itself. We will use a serial number with a check sum (similar to the check sums used with credit cards) to label the QR codes.

The label will look similar to the example below. The QR Code and the serial number are called Pixformance Membership Tags. Pixformance Membership Tags will be distributed as stickers.

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| http://upload.wikimedia.org/wikipedia/commons/5/5b/Qr-1.png  **435 443 5** |

The UserQR and the serial number of the UserQR must be stored in the data base of known QR codes.

The serial number consist of two blocks, the first one consist of few digits, the second one of 1 digit:

**AAAAC**

The block **AAAA** is generated by Pixformance and represents a simple unique serial number:

**00001C**

The serial number must be unique, the same as the QR codes have to be. The QR codes are numbers encoded as a QR code. Numbers are always unique assuming Pixformance never generates the same QR code again. Under this assumption, the following way of computing a serial number was selected:

* The input (the number encoded as QR) is converted to a different representation of the same number. The base 27 was selected.
* Converting a number to a different base guarantees that the serial numbers are collision free (again, under the assumption, that the QR codes were collision free).
* Converting to a different base, e.g. base 16, is a well-known procedure. For Pixformance it was important to reduce the length of the serial number. This is easy to achieve by increasing the count of available digits/characters. Base 16 uses the following characters: “0123456789ABCDEF”.
* While increasing the number of available characters it is important to avoid characters that can be easily misinterpreted, e.g. “0” (zero) and “O” (the letter o) are to be avoided.
  + Reference:  
    <http://www.bmi.bund.de/cae/servlet/contentblob/374538/publicationFile/17985/epass_d_alphanumerische_seriennummer_flyer.pdf>
  + Such mistakes could be avoided by selecting a good font for printing of the serial number.
* The following set of 27 characters was selected “123456789ABCDEFHKLMNPRSTWXYZ”.
* The number of characters can be further reduced or extended before the first prints are produced.

The block **C** is the checksum computed over the block **AAAA**. The checksum is as well stored in the base 27.

The checksum is computed using the Luhn algorithm.

The length of the serial number can and will grow over time.

## The Luhn algorithm

The Luhn algorithm or Luhn formula, also known as the "modulus 10" or "mod 10" algorithm, is a simple checksum formula used to validate a variety of identification numbers, such as credit card numbers, IMEI numbers, National Provider Identifier numbers in US and Canadian Social Insurance Numbers. It was created by IBM scientist Hans Peter Luhn and described in U.S. Patent No. 2,950,048, filed on January 6, 1954, and granted on August 23, 1960.

The algorithm is in the public domain and is in wide use today. It is specified in ISO/IEC 7812-1. It is not intended to be a cryptographically secure hash function; it was designed to protect against accidental errors, not malicious attacks. Most credit cards and many government identification numbers use the algorithm as a simple method of distinguishing valid numbers from collections of random digits.

### Strength and weaknesses

The Luhn algorithm will detect any single-digit error, as well as almost all transpositions of adjacent digits. It will not, however, detect transposition of the two-digit sequence 09 to 90 (or vice versa). It will detect 7 of the 10 possible twin errors (it will not detect 22 ↔ 55, 33 ↔ 66 or 44 ↔ 77).

Other, more complex check-digit algorithms (such as the Verhoeff algorithm and the Damm algorithm) can detect more transcription errors. The Luhn mod N algorithm is an extension that supports non-numerical strings.

(The general introduction above is a selective citation from Wikipedia[[3]](#footnote-3))

## The Verhoeff algorithm

In the future releases of the Pixformance system, a transition to the Verhoeff algorithm should be considered. The additional overhead occurs only during the production of the QR code cards and has no negative impact on the performance or usability of the system in other phases.

# Activation of Pixformance Membership Tags

## Introduction

Pixformance Membership Tags must be activated and assigned to a club prior to registration of a new member and his Pixformance Membership Tag. The activation creates a user account that is assigned to a club. This enables the following features:

1. Workout even before the member registration with the default workout that is assigned to a club and is valid.
2. Storage of workout results before the registration.
3. Registration of the new member and his Pixformance Membership Tag from home and access to the data about workouts performed prior to the registration.

Those features enable access to the Pixformance station to all user groups, even those groups without a need for full support provided by the platform – they will still get the default program that’s created by the club owner.

## Activation

The activation is performed by the club owner within the Pixformance Online Platform. The club owner will be asked to fill out a form online and enter the serial numbers of the Pixformance Membership Tags he wants to activate. Inactive Pixformance Membership Tags cannot be used for registration.

# Registration of new Pixformance member

1. New Pixformance member receives a sticker, the Pixformance Membership Tag, provided by Pixformance from the club operator.

Pixformance will provide the club owner with a large number of pre-printed Pixformance Membership Tags, e.g. as a roll or a pack of sheets. The preprinted Pixformance Membership Tags aren’t activated but they must be registered as “in use” in order to make sure that no other club receives the same Pixformance Membership Tags.

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| http://upload.wikimedia.org/wikipedia/commons/5/5b/Qr-1.png  **435 443 5** |

Example of a Pixformance Membership Tag

1. The Pixformance Membership Tag contains a QR code (which encodes the UserQR) and a unique serial number. The Pixformance Membership Tag can be placed on a membership card of the club or somewhere else, e.g. on an armband (sold/provided separately).
2. The Pixformance Membership Tag can be used straight away at any Pixformance station in the assigned club.
   1. There is a basic “welcome” program assigned to each Pixformance Membership Tag that shows off the best exercises that are also “safe to use” for the majority of potential members (e.g. no heavy weight lifting, some simple balance exercises).
   2. The history of all performed exercises is being stored within the Pixformance system.
3. The new member is asked to register their Pixformance Membership Tag.
   1. This is not necessary to begin with the workout right away, but it’s necessary to begin to update the workout, to block the exercises, or to check the results from previous workouts.
4. In order to register the Pixformance Membership Tag, the member visits the Pixformance Online Platform.
   1. This can happen straight away in the club or at home.
   2. This can be done by the club operator together with the new member.
5. The welcome page of the Pixformance Online Platform contains a large button for “Registration” of not yet registered Pixformance Membership Tags.
6. During the registration of the Pixformance Membership Tag, the new member is asked to provide personal data such as
   1. The first name, last name, address etc. (fields to be defined).
   2. User name and password for future access to the Pixformance Online Platform.

**AND**

* 1. The serial number printed below the QR code on the Pixformance Membership Tag.

Based on the serial number of the Pixformance Membership Tag, the Pixformance Online Platform is able to match the UserQR to the newly registered user.

# Replacement of lost Pixformance Membership Tags

## Scenario 1: Self-Service done by the member

1. Member receives the new Pixformance Membership Tag from the club operator.
2. Member logs in to the Pixformance Online Platform.
3. Member activates the function “Register new Pixformance Membership Tag” within the Pixformance Online Platform.
4. Member provides the serial number printed below the QR code on the Pixformance Membership Tag.
5. The Pixformance Online Platform updates the UserQR assigned to the member.
   1. The old UserQR will be deactivated.
6. The member can use his new Pixformance Membership Tag to log in on a Pixformance Station.

## Scenario 2: Service done by the club operator

1. Club operator prepares the new Pixformance Membership Tag
2. Club operator logs in to the Pixformance Online Platform as the operator.
3. Club operator finds the member record within the Pixformance Online Platform
4. Club operator activates the function “Register new Pixformance Membership Tag”.
5. Club operator provides the new serial number printed below the QR code on the Pixformance Membership Tag.
6. The Pixformance Online Platform updates the UserQR assigned to the member.
   1. The old UserQR will be deactivated.
7. The club operator hands over the Pixformance Membership Tag to the member
8. The member can use his new Pixformance Membership Tag to log in on a Pixformance Station.

# Forgotten Pixformance Membership Tags

## Scenario 1: Providing a printout of the Pixformance Membership Tag

The club operator could print the original Pixformance Membership Tag of the member and hand it over to her/him. The printout could be used to perform the workout at a station.

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| --- | --- |
| PRO | CONTRA |
| * The member is enabled to continue with their workout even when the Pixformance Membership Tag is missing. | * The club operator must have a printer * The club operator must invest time to handle the issue. * The print out of the Pixformance Membership Tag might get lost somewhere in the club.   + Unauthorized people will be able to perform workouts on behalf of the member.   + The member might lose confidence in the security of the system. |

### Summary

This scenario won’t be supported.

## Scenario 2: Applying the “Lost Pixformance Membership Tag” procedure

The club operator follows the procedure defined in the “Replacement of lost Pixformance Membership Tags” section and hands over a new Pixformance Membership Tag to the member.

|  |  |
| --- | --- |
| PRO | CONTRA |
| * The member is enabled to continue with their workout even when the Pixformance Membership Tag is missing. | * The club operator must invest time to handle the issue. * The member must replace his now old and invalid Pixformance Membership Tag with the new one. |

### Summary

This scenario can be considered. It’s only a procedure. Support in software is not necessary.

## Scenario 3: Not handling the issue

The member who forgets the Pixformance Membership Tag is not allowed to access the Pixformance Station without saying that the Pixformance Membership Tag is lost (fallback to the Scenario 2). This is similar to the procedures currently applied when a member forgets the membership card of their club.

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| PRO | CONTRA |
| * No special handling of this issue. | * The member is not allowed to continue with their workout without initiating the “Lost Pixformance Membership Card” procedure. |

### Summary

This scenario should be implemented.

1. <http://en.wikipedia.org/wiki/QR_code> [↑](#footnote-ref-1)
2. <http://www.qrcode.com/en/codes/microqr.html> [↑](#footnote-ref-2)
3. <http://en.wikipedia.org/wiki/Luhn_algorithm> [↑](#footnote-ref-3)