

Boost.Checks

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Boost.Checks

Overview

This library provides a collection of functions for validating and creating check digits.

Most are primarily for checking the accuracy of short strings of typed input (though it obviously also provides against a mis-scan by a device like a bar code or card reader). The well-known ISBN is a typical example. All single altered digits, most double altered digits, and transpositions of two digits are caught, and the input rejected as an invalid ISBN.



Important

This is not (yet) an official Boost library. It was a [Google Summer of Code project \(2011\)](#) whose mentor organization was Boost. It remains a library under construction, the code is quite functional, but interfaces, library structure, and names may still be changed without notice. The current version is available at

<https://svn.boost.org/svn/boost/sandbox/SOC/2011/checks/libs/checks/doc/pdf/checks.pdf> PDF documentation

<https://svn.boost.org/svn/boost/sandbox/SOC/2011/checks/libs/checks/doc/html/index.html> HTML document-
ation

<https://svn.boost.org/svn/boost/sandbox/SOC/2011/checks/boost/checksboost> Boost Sandbox checks source
code

[note Comments and suggestions (even bugs!) to Pierre Talbot [pierre.talbot.6114\(at\) herslibramont \(dot\).be](mailto:pierre.talbot.6114@herslibramont.be)

Document Conventions

- **Tutorials** are listed in the *Table of Contents* and include many examples that should help you get started quickly.
- **Source code** of the many *Examples* will often be your quickest start.
- **Reference section** prepared using Doxygen will provide the function and class signatures, but there is also an *index* of these.
- The main *index* will also help, especially if you know a word describing what it does, without needing to know the exact name chosen for the function.

This documentation makes use of the following naming and formatting conventions.

- C++ Code is in `fixed width font` and is syntax-highlighted.
- Other code is in `teletype fixed-width font`.
- Replaceable text that you will need to supply is in *italics*.
- If a name refers to a free function, it is specified like this: `free_function()`; that is, it is in code font and its name is followed by `()` to indicate that it is a free function.
- If a name refers to a class template, it is specified like this: `class_template<>`; that is, it is in code font and its name is followed by `<>` to indicate that it is a class template.

- If a name refers to a function-like macro, it is specified like this: `MACRO()`; that is, it is uppercase in code font and its name is followed by `()` to indicate that it is a function-like macro. Object-like macros appear without the trailing `()`.
- Names that refer to *concepts* in the generic programming sense are specified in CamelCase.
- Many code snippets assume an implicit namespace, for example, `std::` or `boost::checks`.
- If you have a feature request, or if it appears that the implementation is in error, please check the TODO section first, as well as the rationale section.

If you do not find your idea/complaint, please reach the author either through the Boost development list, or email the author(s) direct .

Admonishments



Note

In addition, notes such as this one specify non-essential information that provides additional background or rationale.



Tip

These blocks contain information that you may find helpful while coding.



Important

These contain information that is imperative to understanding a concept. Failure to follow suggestions in these blocks will probably result in undesired behavior. Read all of these you find.



Warning

Failure to heed this will lead to incorrect, and very likely undesired, results.

Introduction

The checks are required in a numerous kind of domains such as the distribution chain (bar codes), the cards number (bank, fidelity cards, ...) and many others. These codes and numbers are often copied or scanned by humans or machines, and both make errors. We need a way to control it and this is why some people created a check digit. A check digit is aimed to control the validity of a number and catch mismatched input (we'll detail further the different errors). Another functionality of this library is to calculate the check digit of a number. There are other fonctionnalités more specific to a number, for example, we can *transform* an ISBN-10 to an ISBN-13.

There are a lot of codes and numbers that use a check digit, for instance : the ISBN for the books or the IBAN for the international account numbers. But many of those are specialisation of well-known algorithms such as Luhn or modulus 11 algorithm. For example : ISBN-13 is a specialisation of the EAN-13 which is a specialisation of the modulus 10 algorithm.

This library is divided into two parts : a low level part (Luhn, modulus 11, modulus 10, ...) and a higher level library (ISBN-10, EAN-13, IBAN, VISA number, ...). The higher level library will use the low level with filter on the length, first X characters, ... Theoretically, the user should only use the high level library which is more specific. In some cases, the user would like to use the lower level library because some kind of exotic numbers (social number of india,...) are not provided by the library.

Type of errors

The following sections will describe some of the errors that an user or a device can make. Those are the most frequent and we are not exhaustive, however we will find out how well our algorithms work. We will calculate (in a mathematical way) the probability of failures and the factors which affect it.

Alteration

Single error

Multiple error

Transposition

Length

Phonetic error

Modular sum algorithms

A *modular sum algorithm* computes the sum of a serie of digits modulo a number. The number obtained is called the *check digit*, in many codes it is added as the last digit. This rubbish algorithm detect all *alteration* of one digit but doesn't detect a simple *transposition* if the check digit is not altered. This is why even the most basic algorithms introduce the notion of *weight*. The weight is the contribution of a number to the final sum. The following algorithms presented are the base of many, many codes and numbers in the world. We could describe a code and his check digit calculation with three characteristics : length, weighth and the modulus. So we could design a generic function but we won't. It wouldn't be efficient and unnecessarily more complicated. The next parts will present the three different algorithms that we have choose to design.

Luhn algorithm



The Luhn algorithm is well-known

Modulus 10 algorithm

Modulus 11 algorithm

ISBN checking

The functions defined at [<boost/checks/isbn.hpp>](http://boost/checks/isbn.hpp) are for validating and computing check digits of [International Standard Book Number \(ISBN\)](#) strings.

Error detecting

You probably want a section on how good things are at detecting changes in the string. This has been well studied for the Verhoeff/Gumm system.

Some of your tests might be devoted to confirming that this is really true?

All alterations of a single digit will be detected.

Most alterations of two digits will be detected.

All two digit transpositions will be detected.

Synopsis

`is_isbn10` function

```
// This function checks if an `isbn10` is a valid ISBN.  
bool is_isbn10(const std::string& isbn);  
  
// This function computes and returns the check digit for a given 9 digit ISBN in `isbn`.  
char isbn_check_digit(const std::string& isbn);
```

Both functions assume that `isbn` is a 10-digit ISBN containing only ANSI digits '0' to '9', or ANSI letters 'X', 'Y', 'x', 'y'.

Universal Product Code (UPC) checking

UPC is a sub-set of [International Article Number \(EAN\)](#) - see [Universal Product Code \(UPC\)](#).

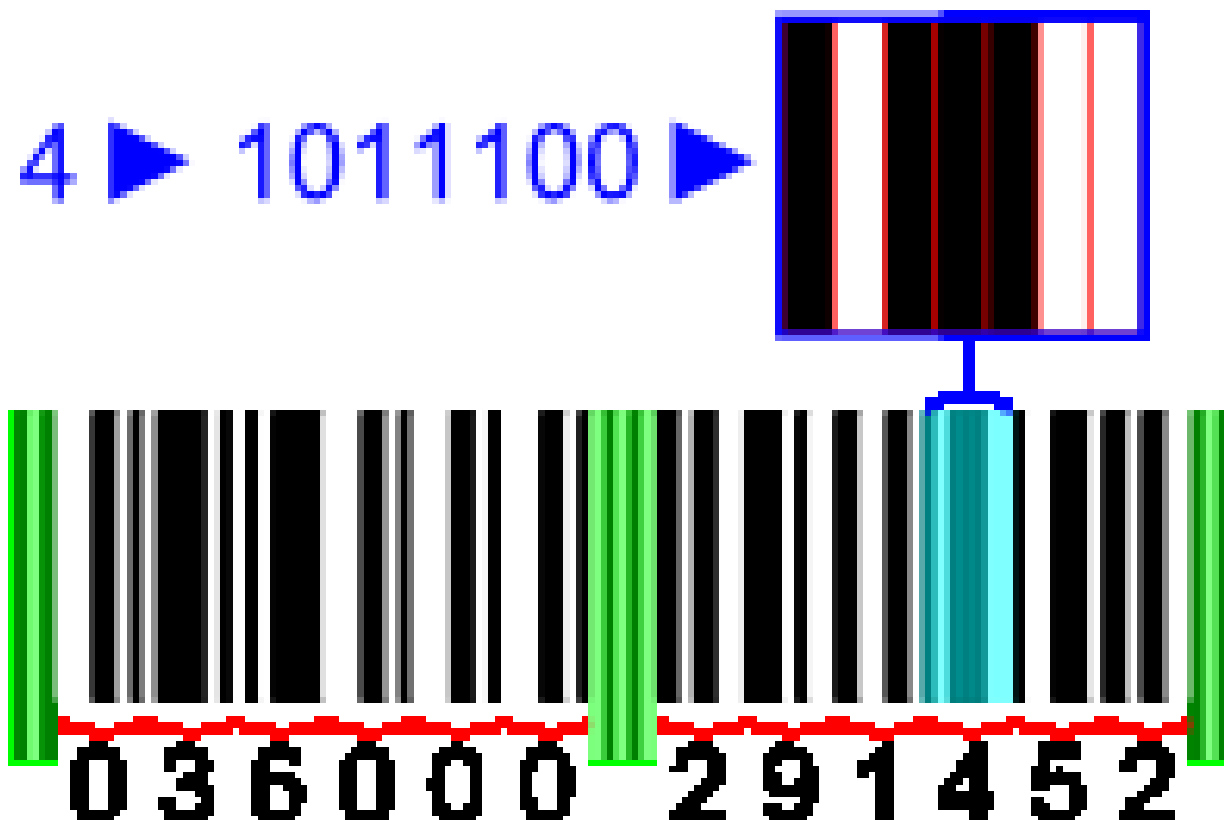
The original UPC is still in use and has 12 decimal digits, for example, a UPC for a box of tissues)

"03600029145X" where X is the check digit, in this case having a value of 2.

On products, it is usually printed as a barcode, but the decimal digits are visible too.

[UPC EANUCC 12 barcode](#)

This is a local copy of the barcode:



International Article Number (EAN) checking

EAN is a super-set of the original US 12-digit Universal Product Code (UPC) UPC13 digit (12 + check digit) barcoding standard.

See ????

Tutorial Examples

Here some general tutorial stuff.

followed by specific examples??

ISBN example

Here is a really trivial example of making an ISBN check and also computing the check digit.

First we need to include the appropriate file including the check and compute functions.

```
#include <boost/checks/ISBN_PAB.hpp> // ISBN for books (Old PAB version using just string parameter).
```

Then assuming that the ISBN is in a `std::string`, we can check a complete ISBN, and also compute the check digit from one lacking the check digit.

```
string s1 = "1232563456465";

//cout << "ISBN " << s1 << (ISBNcheck(s1) ? " is OK" : " is Wrong!") << endl;

string s2 = "020170073";

cout << "Check digit of " << s2 << " is " << ISBNcompute("020170073") << endl;

Sleep(5000);
```

This provides this output:



[checks_isbn_output_1]

Hints and Tips

- This manual is also available as a single PDF file which may be easily emailed and printed.
- This is another tip?

Acknowledgements

- Thanks to Google for providing the Summer of Code Program 2011 that enabled Pierre Talbot to write this library.
- [UPC EANUCC 12 barcode](#) is copied from Wikipedia under the Creative Commons license.

FAQs

- Why are checks needed?
- How many alterations to the strings are detected (or undetected)?

References

1. [International Standard Book Number \(ISBN\)](#)
2. [International Standard Serial Number \(ISSN\)](#)

Rationale

This section records the rationale and compromises for some design decisions.

Function parameter

- Functions that take a single `std::string` are convenient for users with simple requirements. This may be simplest what a string is typed in.
- Functions that use `std::` iterators `begin` and `end` allow efficient use of a decimal digits string within other text, for example when a record is retrieve from a database.

Scope of the project

- Scott McMurray has identified four fairly distinct types of check:
 1. ISBN/ISSN/UPC/EAN/VISA/etc, for catching human-entry errors.
 2. hash functions as in hash tables, which only care about distribution.
 3. checksums like CRC32, for catching data transmission errors.
 4. and cryptographic hash functions, the only ones useful against malicious adversaries.

This project is directed first at the first class. Others might be the subject of future additions or other libraries.

- Performance is not a major objective, as most input is tiny, and the number of items often likely to be quite small.
- Convenience and flexibility for the user is the highest priority.

History



1. Project started by Pierre Talbot June 2011 as a Google Summer of Code Project.
2. First release in Boost Sandbox for public comment ????

TODO

This section lists items that are acknowledged as work still TODO.

1. Produce 1st version for comment.
2. Produce version for pre-review.

Version Info

Last edit to Quickbook file D:\boost-sandbox\SOC\2011\checks\libs\checks\doc\checks.qbk was at 11:22:31 PM on 2011-Jul-04.



Tip

This version information should appear on the pdf version (but is redundant on html where the last revised date is on the bottom line of the home page).



Warning

Home page "Last revised" is GMT, not local time. Last edit date is local time.



Caution

It does not give the last edit date of other included .qbk files, so may mislead!

Checks Reference

Header <[boost/checks/adler.hpp](#)>

Header <[boost/checks/amex.hpp](#)>

Header <[boost/checks/checks_fwd.hpp](#)>

Boost.Checks forward declaration of function signatures.

This file can be used to copy a function signature, but is mainly provided for testing purposes.

```
namespace boost {
  namespace checks {
    template<typename In> bool check_luhn(In &, const In &, unsigned int = 0);
    template<typename In> bool check_mod11(In &, const In, unsigned int = 0);
    template<typename Out, typename In>
      Out compute_luhn(In &, const In &, unsigned int = 0);
    template<typename In>
      char compute_luhn(In & begin, const In & end,
        unsigned int nbr_digits = 0);
    template<typename Out, typename In>
      Out compute_mod11(In &, const In, unsigned int = 0);
    template<typename In> bool Is_isbn10(In, In);
    template<typename In> char isbn10_check_digit(In, In);
  }
}
```


Function template check_luhn

boost::checks::check_luhn

Synopsis

```
// In header: <boost/checks/checks_fwd.hpp>

template<typename In>
bool check_luhn(In & begin, const In & end, unsigned int nbr_digits = 0);
```

Description

Validate the check digit of the number provided with the Luhn algorithm.

| | | | | | |
|-----------------|--|-------|--|-----|--|
| Parameters: | <table><tbody><tr><td>begin</td><td>Represents the beginning of the sequence to check.</td></tr><tr><td>end</td><td>Represents one off the limit of the sequence to check.</td></tr></tbody></table> | begin | Represents the beginning of the sequence to check. | end | Represents one off the limit of the sequence to check. |
| begin | Represents the beginning of the sequence to check. | | | | |
| end | Represents one off the limit of the sequence to check. | | | | |
| Requires: | begin and end are valid initialized iterators. They represent a sequence of character encoded in big-endian mode in a format compatible with the 7 bits ASCII. | | | | |
| Postconditions: | begin is equal to the position of the check digit plus one if the expression provided is correct, otherwise is equal to end. | | | | |
| Returns: | true is returned if the expression given have a valid check digit and have nbr_digits (or more than 0 digit if nbr_digits is equal to 0). | | | | |



Function template check_mod11

boost::checks::check_mod11

Synopsis

```
// In header: <boost/checks/checks_fwd.hpp>

template<typename In>
    bool check_mod11(In & begin, const In end, unsigned int nbr_digits = 0);
```

Description

Calculate the check digit of the number provided with the modulus 11 algorithm.

| | |
|-----------------|--|
| Parameters: | begin Represents the beginning of the sequence to check. end Represents one off the limit of the sequence to check. |
| Requires: | begin and end are valid initialized iterators. They represent a sequence of character encoded in big-endian mode in a format compatible with the 7 bits ASCII. |
| Postconditions: | begin is equal to the position of the last digit encountered plus one if the expression provided is correct, otherwise is equal to end . |
| Returns: | 0 is returned if the expression given have not nbr_digits (or no digit if nbr_digits is equal to 0). Otherwise the ASCII character of the check digit is returned. |



Function template compute_luhn

boost::checks::compute_luhn

Synopsis

```
// In header: <boost/checks/checks_fwd.hpp>

template<typename Out, typename In>
Out compute_luhn(In & begin, const In & end, unsigned int nbr_digits = 0);
```

Description

Calculate the check digit of the number provided with the Luhn algorithm.

| | |
|-----------------|--|
| Parameters: | begin Represents the beginning of the sequence to check. end Represents one off the limit of the sequence to check. |
| Requires: | begin and end are valid initialized iterators. They represent a sequence of character encoded in big-endian mode in a format compatible with the 7 bits ASCII. |
| Postconditions: | begin is equal to the position of the last digit encountered plus one if the expression provided is correct, otherwise is equal to end . |
| Returns: | 0 is returned if the expression given have not nbr_digits (or no digit if nbr_digits is equal to 0). Otherwise the ASCII character of the check digit is returned. |



Function template compute_mod11

boost::checks::compute_mod11

Synopsis

```
// In header: <boost/checks/checks_fwd.hpp>

template<typename Out, typename In>
Out compute_mod11(In & begin, const In end, unsigned int nbr_digits = 0);
```

Description

Validate the check digit of the number provided with the modulus 11 algorithm.

| | |
|-----------------|--|
| Parameters: | begin Represents the beginning of the sequence to check. end Represents one off the limit of the sequence to check. |
| Requires: | begin and end are valid initialized iterators. They represent a sequence of character encoded in big-endian mode in a format compatible with the 7 bits ASCII. |
| Postconditions: | begin is equal to the position of the check digit plus one if the expression provided is correct, otherwise is equal to end . |
| Returns: | true is returned if the expression given have a valid check digit and have nbr_digits (or more than 0 digit if nbr_digits is equal to 0). |



Function template `Is_isbn10`

`boost::checks::Is_isbn10`

Synopsis

```
// In header: <boost/checks/checks_fwd.hpp>

template<typename In> bool Is_isbn10(In isbn_begin, In isbn_end);
```

Description

Check the validity of the International Standard Book Number (ISBN) of size 10.

| | |
|-----------------|--|
| Parameters: | <code>isbn_begin</code> Represents the beginning of the ISBN sequence to check. |
| | <code>isbn_end</code> Represents one off the end of the ISBN sequence to check. |
| Requires: | <code>isbn_begin</code> and <code>isbn_end</code> are valid initialized iterators. The length of the sequence should be at least of size 10 and the sequence should contains only dash(es) and digits. |
| Postconditions: | <code>isbn_begin</code> and <code>isbn_end</code> are unchanged. |
| Returns: | true if the sequence is a valid ISBN of size 10, otherwise false. |



Function template isbn10_check_digit

boost::checks::isbn10_check_digit

Synopsis

```
// In header: <boost/checks/checks_fwd.hpp>

template<typename In> char isbn10_check_digit(In isbn_begin, In isbn_end);
```

Description

Compute the check digit of the International Standard Book Number (ISBN) of size 10.

Parameters: isbn_begin Represents the beginning of the ISBN sequence to check.
 isbn_end Represents one off the end of the ISBN sequence to check.


Requires: isbn_begin and isbn_end are valid initialized iterators. The length of the sequence should be of size 9 and the sequence should contains only digits and dashes.

Postconditions: isbn_begin and isbn_end are unchanged.

Returns: The check digit of the ISBN of size 9 provided, which can be between '0' and '9' or 'X'. Otherwise -1 is returned if the ISBN of size 9 provided is not correct.

Header <boost/checks/crc.hpp>

Header <boost/checks/ean.hpp>



```
namespace boost {
  namespace checks {
    template<typename In> char ean13_check_digit(In, In);
    template<typename In> char ean8_check_digit(In, In);
    template<typename In, typename Prefix>
      bool Is_ean13(In, In, Prefix = null, Prefix = null);
    template<typename In> bool Is_ean8(In, In);
  }
}
```

Function template ean13_check_digit

boost::checks::ean13_check_digit

Synopsis

```
// In header: <boost/checks/ean.hpp>

template<typename In> char ean13_check_digit(In ean_begin, In ean_end);
```

Description

Compute the check digit of the European Article Numbering of size 13 (EAN-13) provided.



Function template ean8_check_digit

boost::checks::ean8_check_digit

Synopsis

```
// In header: <boost/checks/ean.hpp>

template<typename In> char ean8_check_digit(In ean_begin, In ean_end);
```

Description

Compute the check digit of the European Article Numbering of size 8 (EAN-8) provided.



Function template Is_ean13

boost::checks::Is_ean13

Synopsis

```
// In header: <boost/checks/ean.hpp>

template<typename In, typename Prefix>
bool Is_ean13(In ean_begin, In ean_end, Prefix ean_prefix_begin = null,
              Prefix ean_prefix_end = null);
```

Description

Check the validity of the European Article Numbering of size 13 (EAN-13) provided.

| | | |
|-----------------|--|---|
| Parameters: | ean_begin | Represents the beginning of the EAN sequence to check. |
| | ean_end | Represents one off the end of the EAN sequence to check. |
| | ean_prefix_begin | Represents the beginning of the prefixes sequence to allow. Default : null, all the prefixes are allowed. |
| | ean_prefix_end | Represents the ending of the prefixes sequence to allow. Default : null, all the prefixes are allowed. |
| Requires: | ean_begin and ean_end are valid initialized iterators. If ean_prefix_begin and ean_prefix_end are passed as arguments, they must be valid initialized iterators. | |
| Postconditions: | ean_begin, ean_end, ean_prefix_begin, and ean_prefix_end are unchanged. | |
| Returns: | True if the EAN delimited by ean_begin and ean_end is a valid EAN of size 13 with a prefix | |



Function template `Is_ean8`

`boost::checks::Is_ean8`

Synopsis

```
// In header: <boost/checks/ean.hpp>

template<typename In> bool Is_ean8(In ean_begin, In ean_end);
```

Description

Check the validity of the European Article Numbering of size 8 (EAN-8) provided.

Header <boost/checks/EANcheck.cpp>

```
bool EAN8check(std::string s);
char EAN8compute(std::string s);
bool EANcheck(std::string s);
char EANcompute(std::string s);
```

Header <boost/checks/EANcheck.hpp>

```
bool EANcheck(std::string s);
char EANcompute(std::string s);
```



Header <boost/checks/fletcher.hpp>

Header <boost/checks/iban.hpp>

Header <boost/checks/IBMCheck.hpp>

```
bool IBMcheck(string s);
char IBMcompute(string s);
```

Header <boost/checks/isan.hpp>

Header <boost/checks/isbn.hpp>

```
namespace boost {
  namespace checks {
    template<typename In> bool Is_isbn13(In, In);
    template<typename In> char isbn13_check_digit(In, In);
  }
}
```

Function template Is_isbn13

boost::checks::Is_isbn13

Synopsis

```
// In header: <boost/checks/isbn.hpp>

template<typename In> bool Is_isbn13(In isbn_begin, In isbn_end);
```

Description

Check the validity of the International Standard Book Number (ISBN) of size 13. (It is a ISBN encapsulated into a EAN).



Function template isbn13_check_digit

boost::checks::isbn13_check_digit

Synopsis

```
// In header: <boost/checks/isbn.hpp>

template<typename In> char isbn13_check_digit(In isbn_begin, In isbn_end);
```

Description

Compute the check digit of the International Standard Book Number (ISBN) of size 13. (It is a ISBN encapsuled into a EAN).

Header <boost/checks/ISBN_PAB.hpp>

Obselete versio of ISBN check and compute.

```
bool ISBNcheck(string s);
bool ISBNcheck(std::string s);
char ISBNcompute(std::string s);
char ISBNcompute(string s);
```

Header <boost/checks/isbn_Vasconcelos.hpp>

```
namespace boost {
    bool is_isbn(const std::string &);
    char isbn_check_digit(const std::string &);
}
```



Function is_isbn

boost::is_isbn

Synopsis

```
// In header: <boost/checks/isbn_Vasconcelos.hpp>

bool is_isbn(const std::string & isbn);
```

Description

This function checks if a `isbn' is a valid ISBN



Function isbn_check_digit

boost::isbn_check_digit

Synopsis

```
// In header: <boost/checks/isbn_Vasconcelos.hpp>

char isbn_check_digit(const std::string & isbn);
```

Description

This function computes the check digit for a given ISBN in `isbn`

Header <boost/checks/ISSN_PAB.hpp>

```
bool ISSNcheck(string s);
char ISSNcompute(string s);
```

Header <boost/checks/luhn.hpp>

Header <boost/checks/mastercard.hpp>

Header <boost/checks/modulus10.hpp>

```
namespace boost {
    namespace checks {
        template<typename In>
            bool check_mod10(In begin, In end, unsigned int[] weight,
                             unsigned int nbr_digits);
    }
}
```

Header <boost/checks/upc.hpp>

```
namespace boost {
    namespace checks {
        template<typename In> bool Is_upca(In, In);
        template<typename In> char upca_check_digit(In, In);
    }
}
```

Function template Is_upca

boost::checks::Is_upca

Synopsis

```
// In header: <boost/checks/upc.hpp>

template<typename In> bool Is_upca(In upc_begin, In upc_end);
```

Description

Check the validity of the Universal Product Code category A (UPC-A) provided.

| | | |
|-----------------|-----------------------|--|
| Parameters: | upc_begin | Represents the beginning of the UPC sequence to check. |
| Requires: | upc_begin and upc_end | are valid initialized iterators. The length of the sequence should be of size 12 and the sequence should contains only digits. |
| Postconditions: | upc_begin and upc_end | are unchanged. |
| Returns: | | true if the UPC sequence is valid which it means that the check digit is equals to the last character. Otherwise false. |



Function template upca_check_digit

boost::checks::upca_check_digit

Synopsis

```
// In header: <boost/checks/upc.hpp>

template<typename In> char upca_check_digit(In upc_begin, In upc_end);
```

Description

Compute the check digit of the Universal Product Code category A (UPC-A) provided /tparam Iterator which represents the beginning or the ending of a sequence of character. /param [in] upc_begin Represents the beginning of the UPC sequence to check. /param [in] upc_end Represents one off the end of the UPC sequence to check. /pre upc_begin and upc_end are valid initialized iterators. The length of the sequence should be of size 11 and the sequence should contains only digits. /post upc_begin and upc_end are unchanged. /result 0 if the check digit couldn't be calculated (Exemple : wrong size, ...). Otherwise, the check digit character between '0' and '9'.

Header <boost/checks/UPCcheck.cpp>

```
bool UPCcheck(std::string s);
char UPCcompute(std::string s);
```

Header <boost/checks/UPCcheck.hpp>



```
bool UPCcheck(std::string s);
char UPCcompute(std::string s);
```

Header <boost/checks/verhoeff.hpp>

Header <boost/checks/visa.hpp>

Header <boost/checks/VISACheck.hpp>

```
bool VISACheck(string s);
char VISACompute(string s);
```


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