
**Information technology — International
symbology specification — Data matrix**

*Technologies de l'information — Spécification internationale des
symboles — Matrice de données*



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

© ISO/IEC 2000

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 734 10 79
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Introduction	1
1 Scope	1
2 Normative References	1
3 Definitions and Mathematical Symbols	1
3.1 Definitions	1
3.1.1 Alignment Pattern	1
3.1.2 Codeword	1
3.1.3 Module	2
3.1.4 Convolutional Coding	2
3.1.5 Cyclic Redundancy Check (CRC)	2
3.1.6 Extended Channel Interpretation (ECI)	2
3.1.7 Pattern Randomizing	2
3.2 Mathematical Symbols and Operation	2
4 Symbol Description	2
4.1 Basic Characteristics	2
4.2 Summary of Additional Features	3
4.3 Symbol Structure	3
4.3.1 Finder Pattern	4
4.3.2 Symbol Sizes	4
5 ECC 000 - 140 Requirements	4
5.1 Encode Procedure Overview	4
5.2 Data Encodation	5
5.2.1 Base 11 - Numeric Encodation	6
5.2.2 Base 27 - Upper-case Alphabetic Encodation	6
5.2.3 Base 37 - Upper-case Alphanumeric Encodation	6
5.2.4 Base 41 - Upper-case Alphanumeric plus Punctuation Encodation	6
5.2.5 ASCII Encodation	7
5.2.6 8-bit Byte Encodation	7
5.3 User Selection of Error Correction Level	7
5.3.1 Selection of Error Correction Level	7
5.3.2 Additional Error Correction Levels Based on Convolutional Codes	7
5.4 Constructing the Unprotected Bit Stream	7
5.4.1 Format ID Bit Field	7
5.4.2 CRC Bit Field	7
5.4.3 Data Length Bit Field	7
5.4.4 Data Prefix Construction	7
5.4.5 Completing the Unprotected Bit Stream	7
5.5 Constructing the Unrandomized Bit Stream	7
5.5.1 Header Construction	8
5.5.2 Applying Convolutional Coding to Create the Protected Bit Stream	8
5.5.3 Trailer Construction	8
5.5.4 Completing the Unrandomized Bit Stream	8
5.6 Pattern Randomizing	8
5.7 Module Placement in Matrix	8
6 ECC 200 Requirements	8
6.1 Encode Procedure Overview	8
6.2 Data Encodation	9
6.2.1 Overview	9
6.2.2 Default Character Interpretation	9
6.2.3 ASCII Encodation	9
6.2.4 Symbol Control Characters	10
6.2.5 C40 Encodation	11
6.2.6 Text Encodation	12
6.2.7 ANSI X12 Encodation	12
6.2.8 EDIFACT Encodation	13

6.2.9 Base 256 Encodation	14
6.3 User Considerations	14
6.3.1 User Selection of Extended Channel Interpretation	14
6.3.2 User Selection of Symbol Size and Shape	14
6.4 Extended Channel Interpretation	14
6.4.1 Encoding ECIs	15
6.4.2 ECIs and Structured Append	15
6.4.3 Post-Decode Protocol	17
6.5 ECC 200 Symbol Attributes	17
6.5.1 Symbol Sizes and Capacity	17
6.5.2 Insertion of Alignment Patterns into Larger Symbols	17
6.6 Structured Append	17
6.6.1 Basic Principles	17
6.6.2 Symbol Sequence Indicator	17
6.6.3 File Identification	17
6.6.4 FNC1 and Structured Append	17
6.6.5 Buffered and Unbuffered Operation	18
6.7 Error Detection and Correction	18
6.7.1 Generating the Error Correction Codewords	18
6.7.2 Error Correction Capacity	18
6.8 Symbol Construction	19
6.8.1 Symbol Character Placement	19
6.8.2 Alignment Pattern Module Placement	19
6.8.3 Finder Pattern Module Placement	19
7 Symbol Dimensions	20
7.1 Dimensions	20
7.2 Quiet Zone	20
8 Symbol Quality	20
8.1 Obtaining the Test Image	20
8.2 Symbol Quality Parameters	20
8.2.1 Decode	20
8.2.2 Symbol Contrast	20
8.2.3 "Print" Growth	20
8.2.4 Axial Nonuniformity	20
8.2.5 Unused Error Correction	20
8.3 Overall Symbol Grade	21
8.4 Process Control Measurements	21
9 Reference Decode Algorithm for Data Matrix	21
10 User Guidelines	26
10.1 Human Readable Interpretation	26
10.2 Autodiscrimination Capability	26
10.3 System Consideration	27
11 Transmitted Data	27
11.1 Protocol for FNC1 (ECC 200 Only)	27
11.2 Protocol for FNC1 in the Second Position	27
11.3 Protocol for Macro Characters in the First Position (ECC 200 only)	27
11.4 Protocol for ECIs (ECC 200 Only)	27
11.5 Symbolology Identifier	28
11.6 Transmitted Data Example	28
Annexe A (Normative)	29
ECC 000 - 140 Symbol Attributes	29
A.1 ECC 000	29
A.2 ECC 050	29
A.3 ECC 080	30
A.4 ECC 100	30
A.5 ECC 140	31
Annexe B (Normative)	32

ECC 000 - 140 Data Module Placement Grids	32
Annexe C (Normative)	41
ECC 000 - 140 Character Encodation Schemes	41
C.1 Base 11 Encodation Scheme	44
C.1.1 First Stage Procedure	44
C.1.2 Second Stage Procedure	44
C.1.3 Example	44
C.2 Base 27 Encodation Scheme	45
C.2.1 First Stage Procedure	45
C.2.2 Second Stage Procedure	45
C.2.3 Example	45
C.3 Base 37 Encodation Scheme	46
C.3.1 First Stage Procedure	46
C.3.2 Second Stage Procedure	46
C.3.3 Example	46
C.4 Base 41 Encodation Scheme	47
C.4.1 First Stage Procedure	47
C.4.2 Second Stage Procedure	47
C.4.3 Example	47
Annexe D (Normative)	48
ECC 000 - 140 CRC Algorithm	48
D.1 CRC State Machine	48
D.2 CRC Polynomial	48
D.3 CRC 2-Byte Header	48
Annexe E (Normative)	49
ECC 000 - 140 Error Checking and Correcting Algorithms	49
E.1 ECC 000	49
E.2 ECC 050	49
E.3 ECC 080	49
E.4 ECC 100	49
E.5 ECC 140	49
E.6 Processing the Convolutional Code	49
E.7 Convolutional Codes Reference Decode Algorithm	49
Annexe F (Normative)	55
ECC 000 - 140 Master Random Bit Stream	55
Annexe G (Normative)	56
ECC 200 Interleaving Process	56
G.1 Schematic Illustration	56
G.2 Starting Sequence for Interleaving in Different Sized Symbols	57
Annexe H (Normative)	59
ECC 200 Pattern Randomizing	59
H.1 253-State Algorithm	59
H.1.1 253-State Randomizing Algorithm	59
H.1.2 253-State Un-Randomizing Algorithm	59
H.2 255-State Algorithm	59
H.2.1 255-State Randomizing Algorithm	59
H.2.2 255-State Un-Randomizing Algorithm	59
Annexe J (Normative)	60
ECC 200 Encodation Character Sets	60
J.1 C40 Encodation Character Set	60
J.2 Text Encodation Character Set	61
J.3 EDIFACT Encodation Character Set	62
Annexe K (Normative)	63
ECC 200 Alignment Patterns	63
Annexe L (Normative)	65
ECC 200 Reed-Solomon Error Detection and Correction	65
L.1 Error Correction Codeword Generator Polynomials	65

L.2 Error Correction Calculation	66
Annexe M (Normative)	68
ECC 200 Symbol Character Placement	68
M.1 Symbol Character Placement Program	68
M.2 Symbol Character Placement Rules	71
M.2.1 Non-standard Symbol Character Shapes	71
M.2.2 Symbol Character Arrangement	71
M.3 Symbol Character Placement Examples for ECC 200	75
Annexe N (Normative)	82
2D Matrix Bar Code Print Quality - Guideline	82
N.1 Obtaining the Test Image	82
N.2 Assessing Symbol Parameters	82
N.2.1 Decode	82
N.2.2 Symbol Contrast	82
N.2.3 "Print" Growth	83
N.2.4 Axial Nonuniformity	83
N.2.5 Unused Error Correction	83
N.3 Overall Symbol Grade	84
Annexe P (Normative)	84
Symbology Identifier	84
Annexe Q (Informative)	84
ECC 000-140 Encode Example Using ECC 050	84
Q.1 CRC Calculation for Example	89
Annexe R (Informative)	90
ECC 200 Encode Example	90
Annexe S (Informative)	91
Encoding Data Using the Minimum Symbol Data Characters for ECC 200	91
Annexe T (Informative)	92
Useful Process Control Techniques	92
T.1 Symbol Contrast	93
T.2 Special Reference Symbol	93
T.3 Assessing Axial Nonuniformity	93
T.4 Visual Inspection for Symbol Distortion and Defects	93
Annexe U (Informative)	94
Autodiscrimination Capabilities	94
Annexe V (Informative)	94
System Considerations	94

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 16022 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

International Standard ISO/IEC 16022 was prepared by AIM International (as ANSI/AIM BC11) and was adopted, under a special "fast-track procedure", by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

Annexes A to P form a normative part of this International Standard. Annexes Q to V are for information only.

Information technology — International symbology specification — Data matrix

Introduction

Data Matrix is a two-dimensional matrix symbology which is made up of square modules arranged within a perimeter finder pattern. Though primarily shown and described in this document as a dark symbol on light background, Data Matrix symbols can also be printed to appear as light on dark.

Manufacturers of bar code equipment and users of the technology require publicly available standard symbology specifications to which they can refer when developing equipment and application standards. The publication of Symbology Specifications is designed to achieve this.

1 Scope

This specification defines the requirements for the symbology known as Data Matrix. It specifies the Data Matrix symbology characteristics, data character encodation, symbol formats, dimensions and print quality requirements, error correction rules, decoding algorithm, and user-selectable application parameters.

2 Normative References

This specification incorporates provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed below. The latest edition of the publication referred to applies.

EN796	Bar Coding : Symbology Identifiers
EN1556	Bar Coding : Terminology
ANSI X3.182	Bar Code Print Quality - Guideline (Same as EN1635 - Bar Coding : Test Specifications for Bar Code Symbols)
ANSI X3.4	Coded Character Sets - 7-bit American National Standard Code for Information Interchange (7-bit ASCII) (equivalent to the US national version of ISO 646)

ISO/IEC 8859-1	Information Processing - 8-bit Single-byte Coded Graphic Character Sets - Part 1 (Latin Alphabet Number 1)
-------------------	---

ECI Assignments Document- AIM International

3 Definitions and Mathematical Symbols

3.1 Definitions

For the purposes of this specification, the following definitions in EN 1556 shall apply:

algorithm, application standard, ASCII, autodiscrimination, binary, bit, CCD, code page, code set, data character, data codeword, data region, data separator character, decode algorithm, decoder, error correction, finder pattern, human readable character, latch character, leading zeros, matrix symbology, modulo, numeric, omnidirectional, orientation pattern, overhead, pad character, pixel, quiet zone, reference decode algorithm, Reed-Solomon error correction, scanner, shift characters, structured append, symbol character, symbology, symbology identifier, X-dimension

The following definitions also apply to this specification. Although some of the terms below are defined in EN1556, the definitions which follow below are more appropriate for this specification.

3.1.1 Alignment Pattern

A unique pattern in larger ECC 200 Data Matrix symbols, made up of a solid line of contiguous dark cells abutting a line of alternating dark and light cells. The alignment patterns run horizontally and vertically within the symbols.

3.1.2 Codeword

A symbol character value. An intermediate level of coding between source data and the graphical encodation in the symbol.