INTERNATIONAL STANDARD

ISO/IEC 10918-2

First edition
1995-08-15

Information technology — Digital compression and coding of continuous-tone still images: Compliance testing

Technologies de l'information — Compression numérique et codage des images fixes de nature photographique: Test de conformité

Reference number
ISO/IEC 10918-2:1995(E)

CONTENTS

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.

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.

International Standard ISO/IEC 10918-2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information,* in collaboration with ITU-T. The identical text is published as ITU-T Recommendation T.83.

ISO/IEC 10918 consists of the following parts, under the general title *Information technology — Digital compression and coding of continuous-tone still images*:

— *Part 1: Requirements and guidelines*

— *Part 2: Compliance testing*

Annexes A to D form an integral part of this part of ISO/IEC 10918. Annexes E to H are for information only.

Introduction

This Recommendation | International Standard, *Digital Compression and Coding of Continuous-tone Still Images*, is published as two parts:

- ITU-T Rec. T.81 | ISO/IEC 10918-1: *Requirements and guidelines.*
- ITU-T Rec. T.83 | ISO/IEC 10918-2: *Compliance testing.*

ITU-T Rec. T.81 | ISO/IEC 10918-1 sets out requirements and implementation guidelines for continuous-tone still image encoding and decoding processes, and for the coded representation of compressed image data. These processes and representations are intended to be generic, that is, to be applicable to a broad range of applications for colour and grayscale still images within communications and computer systems.

This part, ITU-T Rec. T.83 | ISO/IEC 10918-2, sets out tests for determining whether implementations comply with the requirements for the various encoding and decoding processes specified in ITU-T Rec. T.81 | ISO/IEC 10918-1. ITU-T Rec. T.83 | ISO/IEC 10918-2 also specifies tests for determining whether any specific instance of compressed data complies with the ITU-T Rec. T.81 | ISO/IEC 10918-1 specification for compressed data format.

The committee which has prepared this Specification is the ISO/IEC JTC1/SC29/WG1 Sub Group on JPEG, also known as the Joint Photographic Experts Group (JPEG). Both the committee and the two parts of this Specification continue to be known informally by the name JPEG.

The "joint" in JPEG refers to the committee's collaboration with the ITU-T SG8 Rapporteur's Group on Recommendation Q.16. In this collaboration, WG1 has performed the work of selecting, developing, documenting, and testing the generic compression processes.

ITU-T SG8 has provided the requirements which these processes must satisfy to be useful for specific image communications applications such as facsimile, videotex, and audiographic conferencing.

This Specification is presented in accordance with the rules of ITU-T and ISO/IEC JTC1 established by "Rules for presentation of ITU-T | ISO/IEC common text".

INTERNATIONAL STANDARD

ITU-T RECOMMENDATION

INFORMATION TECHNOLOGY – DIGITAL COMPRESSION AND CODING OF CONTINUOUS-TONE STILL IMAGES: COMPLIANCE TESTING

1 Scope

This Recommendation | International Standard is concerned with compliance tests for the continuous-tone still image encoding processes, decoding processes, and compressed data formats specified in ITU-T Rec. T.81 | ISO/IEC 10918-1.

This Specification:

- specifies compliance tests for the ITU-T Rec. T.81 | ISO/IEC 10918-1 compressed data formats;
- specifies compliance tests for the ITU-T Rec. T.81 | ISO/IEC 10918-1 encoding processes;
- specifies compliance tests for the ITU-T Rec. T.81 | ISO/IEC 10918-1 decoding processes;
- specifies a method for constructing application-specific compliance tests;
- gives guidance and examples on how to implement these tests in practice.

This Specification specifies normative generic compliance tests for the ITU-T Rec. T.81 | ISO/IEC 10918-1 encoding and decoding processes. These compliance tests are applicable to "stand-alone" generic implementations of one or more of the encoding and decoding processes specified in ITU-T Rec. T.81 | ISO/IEC 10918-1. Among the purposes of these tests is to ensure that generic encoder (and decoder) implementations compute the discrete cosine transform (DCT) and quantization functions with sufficient accuracy.

2 Normative references

The following ITU-T Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent editions of the Recommendations and Standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU-T maintains a list of the currently valid ITU-T Recommendations.

2.1 Additional references

- ISO 5807:1985, *Information processing – Documentation symbols and conventions for data, program and system flowcharts, program network charts and system resources charts.*

3 Definitions, abbreviations, symbols, and conventions

3.1 Definitions

For the purposes of this Specification, the following definitions apply.

3.1.1 (coding) process 1: Coding process with baseline sequential DCT, 8-bit sample precision.

3.1.2 (coding) process 2: Coding process with extended sequential DCT, Huffman coding, 8-bit sample precision.

3.1.3 (coding) process 3: Coding process with extended sequential DCT, arithmetic coding, 8-bit sample precision.

3.1.4 (coding) process 4: Coding process with extended sequential DCT, Huffman coding, 12-bit sample precision.

3.1.5 (coding) process 5: Coding process with extended sequential DCT, arithmetic coding, 12-bit sample precision.

3.1.6 (coding) process 6: Coding process with spectral selection only, Huffman coding, 8-bit sample precision.

3.1.7 (coding) process 7: Coding process with spectral selection only, arithmetic coding, 8-bit sample precision.

3.1.8 (coding) process 8: Coding process with spectral selection only, Huffman coding, 12-bit sample precision.

3.1.9 (coding) process 9: Coding process with spectral selection only, arithmetic coding, 12-bit sample precision.

3.1.10 (coding) process 10: Coding process with full progression, Huffman coding, 8-bit sample precision.

3.1.11 (coding) process 11: Coding process with full progression, arithmetic coding, 8-bit sample precision.

3.1.12 (coding) process 12: Coding process with full progression, Huffman coding, 12-bit sample precision.

3.1.13 (coding) process 13: Coding process with full progression, arithmetic coding, 12-bit sample precision.

3.1.14 (coding) process 14: Coding process with lossless, Huffman coding, 2- through 16-bit sample precision.

3.1.15 (coding) process 15: Coding process with lossless, arithmetic coding, 2- through 16-bit sample precision.

3.1.16 (coding) process 16: Coding process with extended sequential DCT, Huffman coding, 8-bit sample precision in hierarchical mode.

3.1.17 (coding) process 17: Coding process with extended sequential DCT, arithmetic coding, 8-bit sample precision in hierarchical mode.

3.1.18 (coding) process 18: Coding process with extended sequential DCT, Huffman coding, 12-bit sample precision in hierarchical mode.

3.1.19 (coding) process 19: Coding process with extended sequential DCT, arithmetic coding, 12-bit sample precision in hierarchical mode.

3.1.20 (coding) process 20: Coding process with spectral selection only, Huffman coding, 8-bit sample precision in hierarchical mode.

3.1.21 (coding) process 21: Coding process with spectral selection only, arithmetic coding, 8-bit sample precision in hierarchical mode.

3.1.22 (coding) process 22: Coding process with spectral selection only, Huffman coding, 12-bit sample precision in hierarchical mode.

3.1.23 (coding) process 23: Coding process with spectral selection only, arithmetic coding, 12-bit sample precision in hierarchical mode.

3.1.24 (coding) process 24: Coding process with full progression, Huffman coding, 8-bit sample precision in hierarchical mode.

3.1.25 (coding) process 25: Coding process with full progression, arithmetic coding, 8-bit sample precision in hierarchical mode.

3.1.26 (coding) process 26: Coding process with full progression, Huffman coding, 12-bit sample precision in hierarchical mode.

3.1.27 (coding) process 27: Coding process with full progression, arithmetic coding, 12-bit sample precision in hierarchical mode.

3.1.28 (coding) process 28: Coding process with lossless, Huffman coding, 2- through 16-bit sample precision in hierarchical mode.

3.1.29 (coding) process 29: Coding process with lossless, arithmetic coding, 2- through 16-bit sample precision in hierarchical mode.

3.1.30 compliance test: The procedures specified in this Specification which determine whether or not an embodiment of an encoding process, compressed data stream, or decoding process complies with ITU-T Rec. T.81 | ISO/IEC 10918-1.

3.1.31 compressed image test data (stream): Compressed image data generated to test a particular coding process. (Distributed as part of the compliance test data.)

3.1.32 compressed image validation data (stream): Compressed image data generated for validation of a particular coding process. (Distributed as part of the compliance test data.)

3.1.33 compressed test data (stream): Either compressed image test data or table specification test data or both.

3.1.34 decoder reference test data: Quantized DCT coefficient data generated by the reference FDCT and reference quantizer from the reconstructed image data output by the reference decoder, the input to which is the compressed image test data to be used in the DCT-based decoder compliance tests. The format of the quantized DCT coefficient data is a file for each component; each component is a two dimensional array of 8×8 blocks stored left-to-right, top-to-bottom order; each 8×8 block has 64 coefficients stored in zigzag order; and each coefficient is represented by two bytes, the most significant byte first. This data includes the blocks which are padded to complete an MCU on the right and bottom of the image. (Distributed as part of the compliance test data.)

3.1.35 encoder reference test data: Quantized DCT coefficient data generated by the reference FDCT and reference quantizer from the source image test data to be used in the DCT-based encoder compliance tests. (Distributed as part of the compliance test data.).

3.1.36 generic: Applicable to a broad range of applications, i.e. application independent.

3.1.37 orthogonal representation: The 2-dimensional row-column format illustrated in Figure A.5 in ITU-T Rec. T.81 | ISO/IEC 10918-1.

3.1.38 quantized coefficient validation data: Quantized DCT coefficient data generated from the source image validation test data to be used in the DCT-based encoder validation tests. (Distributed as part of the compliance test data.).

3.1.39 reference DCT-based decoder: An embodiment of the DCT-based decoding processes which generates the decoder reference test data. It consists of an entropy decoder, a dequantizer, and the reference IDCT.

3.1.40 reference DCT-based encoder: An embodiment of the DCT-based encoding processes which generated the DCT-based compressed image test data streams. It consists of the reference FDCT, the reference quantizer, and an entropy encoder.

3.1.41 reference forward discrete cosine transform; reference FDCT: A double precision (64-bit) floating point embodiment of the FDCT described in A.3.3 of ITU-T Rec. T.81 | ISO/IEC 10918-1.

3.1.42 reference inverse discrete cosine transform; reference IDCT: A double precision (64-bit) floating point embodiment of the IDCT described in A.3.3 of ITU-T Rec. T.81 | ISO/IEC 10918-1.

3.1.43 reference quantizer: An embodiment of the quantization described in A.3.4 in ITU-T Rec. T.81 | ISO/IEC 10918-1.

3.1.44 source image test data: The data sets to be used as input to the encoder compliance tests. This data is a sequence of pseudo-random numbers generated with uniform distribution over the range from 0 to 255. The algorithm used to generate this data is described in Annex A of CCITT Recommendation H.261. (This data is distributed as part of the compliance test data.).

3.1.45 table specification test data (stream): Table specification data generated to test decoder compliance with abbreviated format compressed data. (Distributed as part of the compliance test data.)

3.2 Abbreviations

The abbreviations used in this Specification are listed below.

3.2.1 arith.: An abbreviation for arithmetic coding.

3.2.2 Huff.: An abbreviation for Huffman coding.

3.3 Symbols

The symbols used in this Specification are listed below.

3.3.1 B_{ij}**:** quantization value at the *i*th row and *j*th column in the quantization tables defined in Annex B, appears in Annex E.

3.3.2 DF: differential frame flag, appears in flow charts in clause 5.

3.3.3 **E_{ij}:** quantization value at the ith row and jth column in the quantization tables used in testing for greater accuracy defined in Annex E.

3.3.4 **F:** the scale factor used to generate E_{ij} from B_{ij} as defined in E.1.

3.3.5 **FS:** first scan in frame flag, appears in flow charts in clause 5.

3.3.6 **G:** guaranteed in compressed data, appears in Tables 1 to 5 in clause 5.

3.3.7 **H-L:** hierarchical lossless processes, appears in Table G.1.

3.3.8 **H-S:** hierarchical sequential DCT-based processes without final lossless scans, appears in Table G.1.

3.3.9 **HP:** hierarchical progression flag, appears in flow charts in clause 5.

3.3.10 **LL:** lossless processes, appears in Table G.1.

3.3.11 **o:** optional in compressed data, appears in tables in clause 5.

3.3.12 **P(FULL):** full progressive DCT-based processes with both spectral selection and successive approximation, appears in Table G.1.

3.3.13 **P(SA):** progressive DCT-based successive approximation processes, appears in Table G.1.

3.3.14 **P(SS):** progressive DCT-based spectral selection processes, appears in Table G.1.

3.3.15 **RI:** restart interval flag, appears in flow charts in clause 5.

3.3.16 **S(B):** baseline sequential DCT-based process, appears in Table G.1.

3.3.17 **S(E):** extended sequential DCT-based processes, appears in Table G.1.

3.4 Conventions

The flowcharts use the conventions given in ISO 5807. One of the conventions is that arrows are not needed when the flow is from left-to-right and from top-to-bottom. Arrows are sometimes used in such cases to increase clarity.

4 General

The purpose of this clause is to give an informative overview of this Specification and the principles underlying it. Another purpose is to introduce some of the terms which are defined in clause 3. (Terms defined in clause 3 of ITU-T Rec. T.81 | ISO/IEC 10918-1 continue to apply in this Specification.)

ITU-T Rec. T.83 | ISO/IEC 10918-2 concerns compliance testing for embodiments of the elements specified in ITU-T Rec. T.81 | ISO/IEC 10918-1. For encoders and decoders – embodiments of the ITU-T Rec. T.81 | ISO/IEC 10918-1 encoding and decoding processes – this document makes a distinction between GENERIC embodiments and APPLICATION-SPECIFIC embodiments. For the former, compliance tests themselves are specified herein; for the latter, this document specifies a method for defining compliance tests. Compliance tests are also specified for compressed data streams – embodiments of the ITU-T Rec. T.81 | ISO/IEC 10918-1 compressed data formats.

NOTE – Like many compliance tests, those described in this Specification for generic encoders and decoders are not exhaustive tests of their respective functional specifications. Therefore, passing these tests does not guarantee complete functional correctness. This observation has two implications:

1) the tests do not fully guarantee complete interoperability between independently-implemented encoders and decoders; and

2) the tests for embodiments of the DCT-based processes do not guarantee that encoders or decoders will have some well defined image-quality-producing capability. These limitations are discussed in more detail below.

4.1 Purpose of the compliance tests

The purpose of compliance tests is to provide designers, manufacturers, or users of a product with a set of procedures for determining whether the product meets a specified set of requirements with some confidence. In addition, the compliance tests specified herein are intended to achieve the following specific goals:

- increase the likelihood of compressed data interchange;
- decrease the likelihood that DCT-based encoders or decoders will yield reduced image quality as a result of computing the DCT or quantization procedures with insufficient accuracy;
- help implementors to meet the ITU-T Rec. T.81 | ISO/IEC 10918-1 requirements for encoders and decoders as fully as possible.

4.2 Compressed data compliance tests

The aim of the compliance tests specified in clause 5 is to determine whether a particular compressed image data stream or table-specification data stream meets the interchange format or abbreviated format requirements specified in ITU-T Rec. T.81 | ISO/IEC 10918-1. These tests are performed on the compressed data.

4.3 Encoder and decoder compliance tests

This subclause summarizes the considerations which have led to the encoder and decoder compliance tests set out in this Specification.

4.3.1 Encoder versus decoder requirements

ITU-T Rec. T.81 | ISO/IEC 10918-1 imposes more requirements on decoders than on encoders. This difference is based on the philosophy that any encoder should be allowed to produce only compressed images with a limited range of parameter values, but that decoders must handle images with broad ranges of parameters in order to facilitate interchange. Specifically, a decoder is required to handle either

a) the full range and combination of the parameter values specified by its coding process (in which case it qualifies as a generic decoder); or

b) a subset of the same defined by some application (in which case it is an application-specific decoder – see 4.3.2).

4.3.2 Generic versus application-specific decoders

Each coding process specified in ITU-T Rec. T.81 | ISO/IEC 10918-1 is defined for a fairly broad range of parameters. It is recognized, however, that many applications may require only a limited subset of these. For example, a simple picture database might use only grayscale images of fixed dimensions.

Consequently, the committee which prepared this Specification has defined a distinction between generic and application-specific decoders. The former concept is important to facilitate interchange as applications become increasingly inter-connected, and for hardware or software decoder products which can be embedded within many different applications. The latter concept allows application-oriented standards bodies to define a subset of a ITU-T Rec. T.81 | ISO/IEC 10918-1 coding process as its requirements.

This distinction, along with the decoder requirements philosophy in 4.3.1, means that the compliance test for generic decoders should exercise, as much as possible, the full range and combination of the parameter values specified by its coding process. It also means that a compliance test for application-specific decoders should exercise only the combination and range specified by the application.

Although comprehensive in many ways, the compliance tests for generic decoders do not test the full allowed range of all parameters. Many parameters have larger allowed ranges than it is feasible to test. Also, for some parameters, e.g. Number of samples per line (X) and Number of lines (Y), it is not desirable to test their full allowed range since few applications require functionality over the entire range.

According to the encoder requirements philosophy, any encoder may operate on limited ranges of parameter values only, suggesting that encoders are by nature application-specific. Therefore, there is no concept of a generic encoder, and no defined encoder compliance test intended to exercise different parameter values. (The only generic aspect of encoder compliance concerns DCT accuracy, as explained in 4.3.3.)

4.3.3 Computational accuracy of DCT and quantization

In ITU-T Rec. T.81 | ISO/IEC 10918-1, the FDCT, quantizer, and IDCT are defined as ideal mathematical formulae. Because these formulae imply infinite precision, implementors must decide how to approximate them. Efficiency or cost considerations may encourage lower-accuracy approximations, but it is the combination of the DCT and the table-based method of quantization – which accommodates psychovisual thresholding – that gives the DCT-based processes their excellent image-quality-producing capability. This capability may be degraded if the DCT and quantization procedures are computed with insufficient accuracy. Therefore, this Specification provides a method of compliance testing aimed at discouraging such degradation.

Because there is no point in requiring that the FDCT be computed with greater accuracy than necessary for the subsequent quantization procedure, the compliance testing method for DCT-based encoders is concerned with the accuracy of the quantized DCT coefficients. (Basing the test on quantized coefficients also meets the practical constraint that, for product implementations, unquantized coefficients are typically not externally observable.) For symmetry, the method of decoder compliance testing imposes IDCT/dequantization accuracy requirements which are consistent with those imposed on the FDCT/quantization.

It is important to note that required accuracy is a function of the quantization tables used in these tests. A table with larger (coarser) quantization values will make for a less stringent test than one with smaller (finer) values. Therefore, passing the accuracy test means that the encoder or decoder is likely to perform comparably to an encoder or decoder with an ideal FDCT or IDCT, but only when using the specific quantization table employed in the test. An encoder which passes the test with a moderately coarse quantization table will not be guaranteed to perform as well, with a finer quantization table, as an ideal encoder.

For the generic DCT-based compliance tests specified herein, a set of quantization tables requiring moderate accuracy is specified. Encoders and decoders which achieve this accuracy will yield image quality sufficient for many applications, without incurring undue computational burden. Applications requiring greater or lesser accuracy may specify different quantization tables for application-specific compliance tests.

4.3.4 Summary – Generic compliance test considerations

The compliance tests for generic decoders have been defined to exercise the full range and combination of parameter values specified by the coding process being tested. The compliance tests for generic decoders have been designed so that decoders which satisfy the requirements of these tests are likely to be suitable for use within many different applications or for interchanging data between applications.

The generic compliance tests for DCT-based encoders and decoders define quantization tables requiring a level of computational accuracy which will yield image quality sufficient for many applications.

4.3.5 Procedures for constructing application-specific compliance tests

Application-specific compliance tests are used for testing compliance of application-specific decoders, i.e. decoders which implement a subset of a coding process, or for testing the accuracy of encoders and decoders for use in applications which have greater or lesser accuracy requirements than specified by the generic compliance tests. Application-specific compliance tests are constructed by applications standards bodies to satisfy the requirements of a particular application. This Specification contains the procedures for constructing application-specific compliance tests.

Two different procedures are defined for construction of application-specific compliance tests: one for DCT-based processes and one for lossless processes. Application-specific compliance tests for DCT-based processes may specify quantization tables which are selected according to the accuracy requirements of the application.

4.4 Availability of compliance test data

Standardized compliance test data is used to perform the encoder and decoder compliance tests. There are two types of compliance test data which are used by the encoder compliance tests: source image test data and encoder reference test data. Similarly, there are two types of compliance test data which are used by the decoder compliance tests: compressed test data and decoder reference test data.

The compliance test data for the encoder compliance tests and the generic decoder compliance tests are available on 3 diskettes and are included with the copy of this ITU-T Recommendation | ISO/IEC International Standard for parties who wish to determine compliance of an encoder or decoder. The diskettes were created under MS-DOS operating system (version 3.0 or newer), and are of the 1.4 M-byte high-density double-sided 96 tracks per inch MS-DOS format.

5 Compressed data format compliance testing

In order to determine compressed data format compliance, the test procedures in 5.1, 5.2 or 5.3 shall be performed. These test procedures utilize the common additional procedures in 5.4.

There are separate tests for the following compressed data streams:

a) Compressed image data encoded by non-hierarchical processes in interchange format (see 5.1.1);

b) Compressed image data encoded by hierarchical processes in interchange format (see 5.1.2);

c) Compressed image data encoded by non-hierarchical processes in abbreviated format (see 5.2.1);

d) Compressed image data encoded by hierarchical processes in abbreviated format (see 5.2.2);

e) Compressed data in abbreviated format for table specifications (see 5.3).

Twenty-nine coding processes are defined in each of the first paragraphs of ITU-T Rec. T.81 | ISO/IEC 10918-1, Annexes F, G, H, and J. They are assigned numbers in ITU-T T.83 | ISO/IEC 10918-2, clause 3 (Definitions) as "(coding) process *n*" where *n* is an integer from 1 to 29.

ITU-T Rec. T.81 | ISO/IEC 10918-1, Annex B, contains the syntax requirements for the compressed data. ITU-T Rec. T.81 | ISO/IEC 10918-1, B.1.3 and Figure B.1, give the conventions for the syntax figures. The markers are identified by the marker assignments in ITU-T Rec. T.81 | ISO/IEC 10918-1, Table B.1.

Tables 1, 3, and 5 in this clause give specific references to syntax requirements for markers. Markers and marker segments which are required in the compressed data are denoted 'G'. Those that may optionally be present in the compressed data are denoted 'o'. A dash (–) indicates non-compliance if the particular marker or marker segment is present in the compressed data for that coding process.

If a marker is present, its parameters are required and not optional.

The ITU-T Rec. T.81 | ISO/IEC 10918-1 references in the left-most columns of Tables 1, 3 and 5 indicate where the syntax requirements for each marker segment are stated.

There is no significance to the order of markers in the tables.

NOTES

1 The tests are partial as they check mainly the syntactical correctness of the data. Passing the test does not ensure that the compressed data comply with all the requirements of ITU-T Rec. T.81 | ISO/IEC 10918-1.

2 The flow charts do not use most values of the parameters. Future extensions may include more elaborate test procedures based on parameters' values.

3 There is no requirement in this Specification that any tester shall implement the procedures in precisely the manner specified by the flow charts in this clause. It is necessary only that a tester implement the equivalent function specified in this clause.

4 For simplicity of exposition, the buffer holding the compressed data is assumed to be large enough to contain the entire compressed data stream.

5 In any case that there is conflict between this clause and ITU-T Rec. T.81 | ISO/IEC 10918-1, ITU-T Rec. T.81 | ISO/IEC 10918-1 shall take precedence.

5.1 Interchange Compressed Image Data Format Syntax Compliance Tests

5.1.1 Non-hierarchical coding processes syntax compliance test

Figure 1 gives the non-hierarchical coding processes syntax compliance test main procedure.

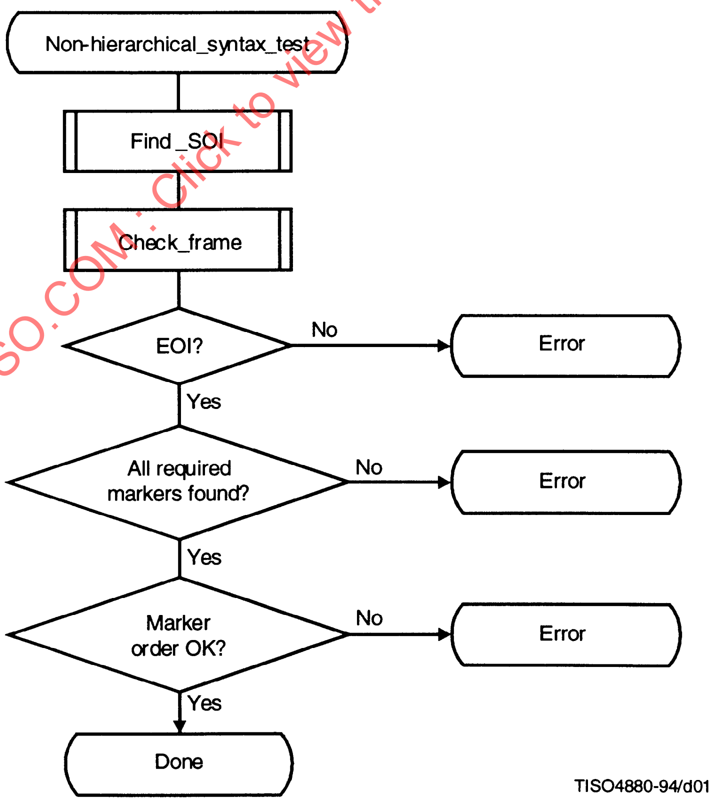


Figure 1 – Non-hierarchical syntax test procedure

"All required makers found" means that all markers designated with 'G' in the Table 1 column of the process under test were found. A missing required marker makes the compressed data under test non-compliant with the syntax. All other markers found should have an 'o' in the column for the corresponding process. A marker found in the compressed data which has a (–) in the column for the corresponding process or is missing from the table makes the compressed data under test non-compliant with the syntax.

The high-level syntax in ITU-T Rec. T.81 | ISO/IEC 10918-1 B.2.1 and ITU-T Rec. T.81 | ISO/IEC 10918-1, Figure B.2 specifies the required order for the "Marker order OK?" test for non-hierarchical coding processes.

Table 2 specifies the parameter column in ITU-T Rec. T.81 | ISO/IEC 10918-1, Tables B.2 through B.11 that should be used to determine the allowed range of parameter values in marker segments for non-hierarchical processes.

Table 1 – Marker syntax requirements for non-hierarchical coding processes

ITU-T Rec. T.81 | ISO/IEC 10918-1				Process														
	Reference	Figure	Table	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SOI	B.2.1	B.2		G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
EOI	B.2.1	B.2		G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
RST_m	B.2.1	B.2		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
SOS	B.2.3	B.4	B.3	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
DNL	B.2.5	B.12	B.10	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Non-differential frames																		
SOF_0	B.2.2	B.3	B.2	G	–	–	–	–	–	–	–	–	–	–	–	–	–	–
SOF_1	B.2.2	B.3	B.2	–	G	–	G	–	–	–	–	–	–	–	–	–	–	–
SOF_2	B.2.2	B.3	B.2	–	–	–	–	–	G	–	G	–	G	–	G	–	–	–
SOF_3	B.2.2	B.3	B.2	–	–	–	–	–	–	–	–	–	–	–	–	–	G	–
SOF_9	B.2.2	B.3	B.2	–	–	G	–	G	–	–	–	–	–	–	–	–	–	–
SOF_{10}	B.2.2	B.3	B.2	–	–	–	–	–	–	G	–	G	–	G	–	G	–	–
SOF_{11}	B.2.2	B.3	B.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	G
Tables/miscellaneous																		
DQT	B.2.4.1	B.6	B.4	G	G	G	G	G	G	G	G	G	G	G	G	G	o	o
DHT	B.2.4.2	B.7	B.5	G	G	o	G	o	G	o	G	o	G	o	G	o	G	o
DAC	B.2.4.3	B.8	B.6	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
DRI	B.2.4.4	B.9	B.7	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
COM	B.2.4.5	B.10	B.8	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
APP_n	B.2.4.6	B.11	B.9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o

Table 2 – Parameter column in ITU-T Rec. T.81 | ISO/IEC 10918-1, Annex B tables for non-hierarchical processes

	Sequential DCT		Progressive	Lossless
	Baseline	Extended	DCT	
Non-differential frames				
SOF_0	G	–	–	–
SOF_1	–	G	–	–
SOF_2	–	–	G	–
SOF_3	–	–	–	G
SOF_9	–	G	–	–
SOF_{10}	–	–	G	–
SOF_{11}	–	–	–	G

5.1.2 Hierarchical coding processes syntax compliance test

Figure 2 gives the hierarchical coding processes syntax compliance test main procedure.

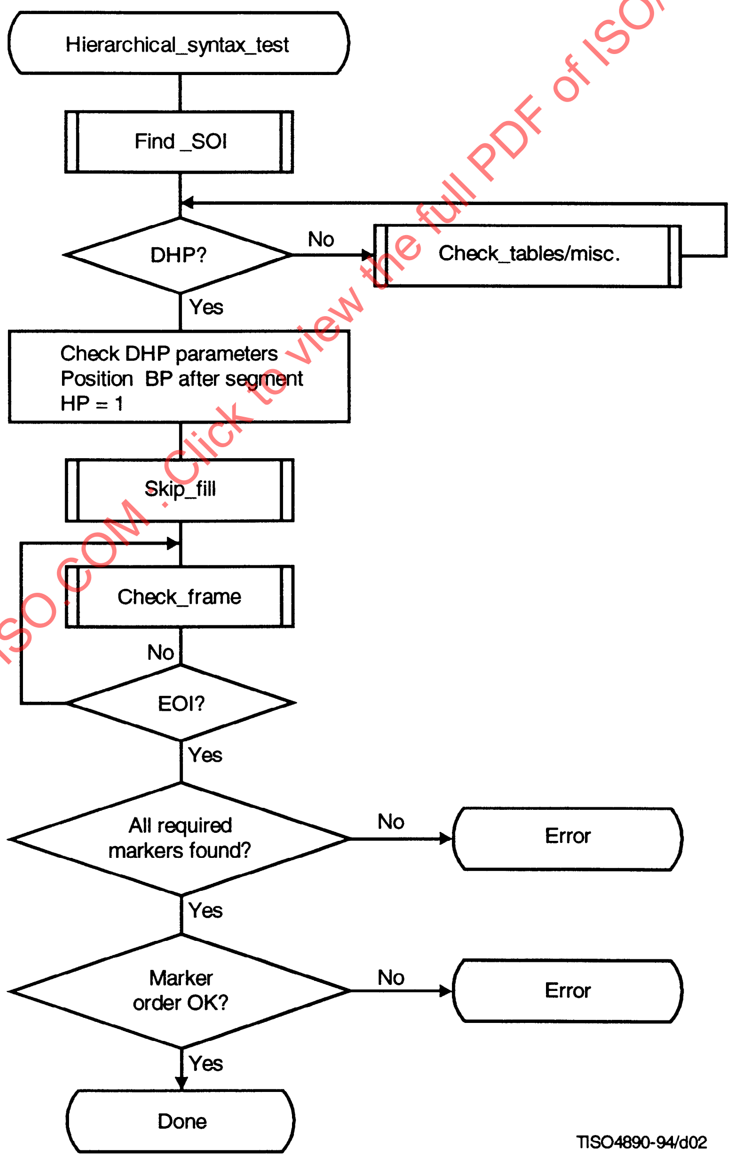


Figure 2 – Hierarchical syntax test procedure

The "Check DHP parameters" procedure is not specified here and is left to the tester. The tester should use the references given in Table 3 in the line containing DHP. The appropriate column to be used to check that the parameters' values are valid can be found in Table 4.

Table 3 – Marker syntax requirements for hierarchical coding processes

ITU-T Rec. T.81 | ISO/IEC 10918-1				Process													
	Reference	Figure	Table	16	17	18	19	20	21	22	23	24	25	26	27	28	29
SOI	B.3.1	B.13		G	G	G	G	G	G	G	G	G	G	G	G	G	G
EOI	B.3.1	B.13		G	G	G	G	G	G	G	G	G	G	G	G	G	G
RST_m	B.2.1	B.2		o	o	o	o	o	o	o	o	o	o	o	o	o	o
SOS	B.2.3	B.4	B.3	G	G	G	G	G	G	G	G	G	G	G	G	G	G
DNL	B.2.5	B.12	B.10	o	o	o	o	o	o	o	o	o	o	o	o	o	o
DHP	B.3.2	B.13	B.2	G	G	G	G	G	G	G	G	G	G	G	G	G	G
EXP	B.3.3	B.14	B.11	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Non-differential frames																	
SOF_0	B.2.2	B.3	B.2	o	o	–	–	o	o	–	–	o	o	–	–	–	–
SOF_1	B.2.2	B.3	B.2	o	–	G	–	o	–	o	–	o	–	o	–	–	–
SOF_2	B.2.2	B.3	B.2	–	–	–	–	o	–	o	–	o	–	o	–	–	–
SOF_3	B.2.2	B.3	B.2	–	–	–	–	–	–	–	–	–	–	–	–	G	–
SOF_9	B.2.2	B.3	B.2	–	o	–	G	–	o	–	o	–	o	–	o	–	–
SOF_{10}	B.2.2	B.3	B.2	–	–	–	–	–	o	–	o	–	o	–	o	–	–
SOF_{11}	B.2.2	B.3	B.2	–	–	–	–	–	–	–	–	–	–	–	–	–	G
Differential frames																	
SOF_5	B.2.2	B.3	B.2	o	–	o	–	o	–	o	–	o	–	o	–	–	–
SOF_6	B.2.2	B.3	B.2	–	–	–	–	o	–	o	–	o	–	o	–	–	–
SOF_7	B.2.2	B.3	B.2	o	–	o	–	o	–	o	–	o	–	o	–	o	–
SOF_{13}	B.2.2	B.3	B.2	–	o	–	o	–	o	–	o	–	o	–	o	–	–
SOF_{14}	B.2.2	B.3	B.2	–	–	–	–	–	o	–	o	–	o	–	o	–	–
SOF_{15}	B.2.2	B.3	B.2	–	o	–	o	–	o	–	o	–	o	–	o	–	o
Tables/miscellaneous																	
DQT	B.2.4.1	B.6	B.4	G	G	G	G	G	G	G	G	G	G	G	G	o	o
DHT	B.2.4.2	B.7	B.5	G	o	G	o	G	o	G	o	G	o	G	o	G	o
DAC	B.2.4.3	B.8	B.6	o	o	o	o	o	o	o	o	o	o	o	o	o	o
DRI	B.2.4.4	B.9	B.7	o	o	o	o	o	o	o	o	o	o	o	o	o	o
COM	B.2.4.5	B.10	B.8	o	o	o	o	o	o	o	o	o	o	o	o	o	o
APP_n	B.2.4.6	B.11	B.9	o	o	o	o	o	o	o	o	o	o	o	o	o	o

Table 4 – Parameter column in ITU-T Rec. T.81 | ISO/IEC 10918-1, Annex B tables for hierarchical processes

	Sequential DCT		Progressive	Lossless
	Baseline	Extended	DCT	
Non-differential frames				
SOF_0	G	–	–	–
SOF_1	–	G	–	–
SOF_2	–	–	G	–
SOF_3	–	–	–	G
SOF_9	–	G	–	–
SOF_{10}	–	–	G	–
SOF_{11}	–	–	–	G
Differential frames				
SOF_5	–	G	–	–
SOF_6	–	–	G	–
SOF_7	–	–	–	G
SOF_{13}	–	G	–	–
SOF_{14}	–	–	G	–
SOF_{15}	–	–	–	G

BP is the pointer to the compressed data stream bytes. After checking parameters, BP is positioned after the segment. HP is the hierarchical progression flag.

An EOI marker determines the end of the compressed data stream. If an EOI marker has not been found before BP points outside the compressed data, the compressed data stream under test is non-compliant.

The "All required makers found" test means that all markers designated with 'G' in the column of the process of Table 3 for hierarchical processes were found. A missing required marker makes the compressed data under test non-compliant with the syntax. All other markers found should have an 'o' in the column for the corresponding process. A marker found in the compressed data which has a (–) in the column for the corresponding process makes the compressed data under test non-compliant with the syntax.

The high-level syntax in ITU-T Rec. T.81 | ISO/IEC 10918-1, B.3.1 and ITU-T Rec. T.81 | ISO/IEC 10918-1, Figure B.13 specifies the required order for the "Marker order OK?" test for hierarchical coding processes.

Table 4 specifies the parameter column in ITU-T Rec. T.81 | ISO/IEC 10918-1, Tables B.2 through B.11, that should be used to determine the allowed range of parameter values in marker segments for hierarchical processes.

5.2 Abbreviated Compressed Data Format Syntax Requirements

5.2.1 Abbreviated format non-hierarchical coding processes syntax compliance test

The compliance testing for abbreviated format compressed image data syntax is the same as for the interchange format compressed image data given in 5.1.1 except that some or all of the table specifications may be omitted (see ITU-T Rec. T.81 | ISO/IEC 10918-1 B.4). If all of the tables are removed from a marker segment, the marker and its length parameter are also removed.

5.2.2 Abbreviated format hierarchical coding processes syntax compliance test

The compliance testing for abbreviated format compressed image data syntax is the same as for the interchange format compressed image data given in 5.1.2 except that some or all of the table specifications may be omitted (see ITU-T Rec. T.81 | ISO/IEC 10918-1, B.4). If all of the tables are removed from a marker segment, the marker and its length parameter are also removed.

5.3 Abbreviated format for table specification data syntax compliance test

Figure 3 gives the abbreviated format for table specification data syntax compliance test main procedure.

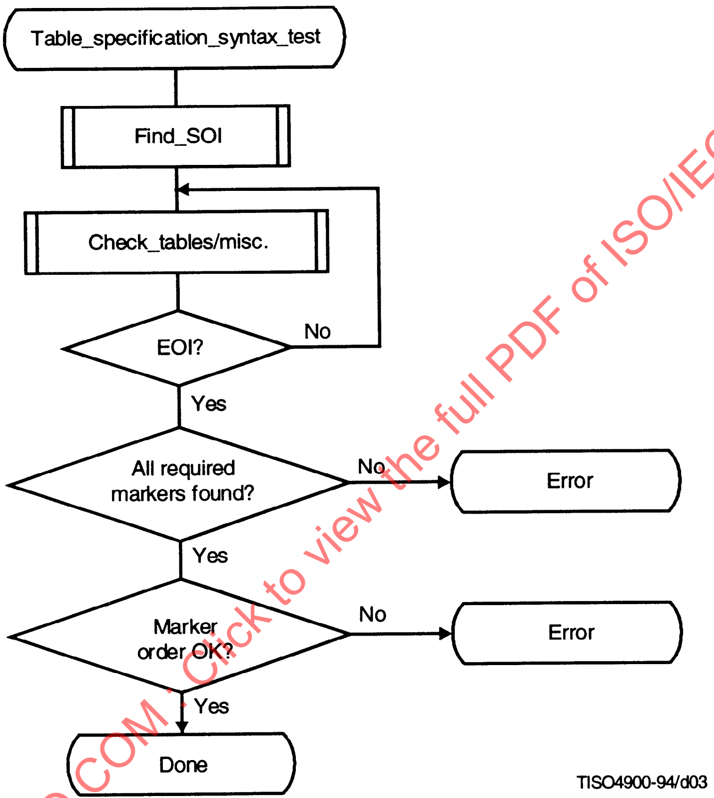


Figure 3 – Table specification syntax test procedure

An EOI marker determines the end of the compressed data stream. If an EOI marker has not been found before BP points outside the compressed data, the compressed data stream under test is non-compliant.

The "All required makers found" test means that all markers designated with 'G' in the column of the process of Table 5 for abbreviated format for table specifications were found. A missing required marker makes the compressed data under test non-compliant with the syntax. All other markers found should have an 'o' in the column for the corresponding process. A marker found in the compressed data which has a (–) in the column for the corresponding process or is missing from Table 5 makes the compressed data under test non-compliant with the syntax.

The high-level syntax in ITU-T Rec. T.81 | ISO/IEC 10918-1 B.5 and ITU-T Rec. T.81 | ISO/IEC 10918-1, Figure B.15, specifies the required order for the "Marker order OK?" test for abbreviated format for table-specification data.

Table 5 – Marker syntax requirements for abbreviated format for table specification data

ITU-T Rec. T.81 | ISO/IEC 10918-1				
Marker	Reference	Figure	Table	
SOI	B.5	B.15		G
EOI	B.5	B.15		G
Tables/miscellaneous				
DQT	B.2.4.1	B.6	B.4	o
DHT	B.2.4.2	B.7	B.5	o
COM	B.2.4.5	B.10	B.8	o
APP_n	B.2.4.6	B.11	B.9	o

5.4 Additional procedures

Figure 4 gives the "Find_SOI" procedure in which the SOI marker is identified. This determines the start of the compressed data stream.

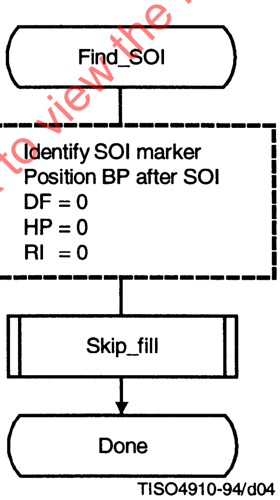


Figure 4 – Procedure to find the SOI marker

The procedure of identifying the SOI marker skips any preceding fill bytes and may require information about where the compressed data starts which is outside of this Specification. A failure to find SOI at the start of the compressed data makes the compressed data under test non-compliant.

The hierarchical-progression flag (HP), the differential-frame flag (DF), and restart-interval flag (RI) are cleared. They will be set by a DHP marker, an EXP marker, and a DRI marker, respectively. The HP and DF flags allow some procedures to be shared for the testing of both non-hierarchical and hierarchical processes.

Figure 5 shows the "Skip_fill" procedure.

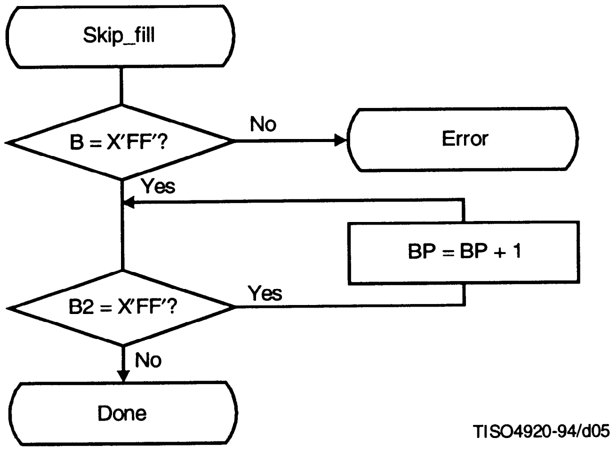


Figure 5 – Skip fill bytes procedure

First, the byte B pointed to by BP shall be an X'FF' byte. Then BP is incremented past any extra "fill" X'FF' bytes so that it will point to last X'FF' byte. Note that B2 is the byte next to B and is pointed to by BP + 1.

Figure 6 gives the "Check_frame" procedure.

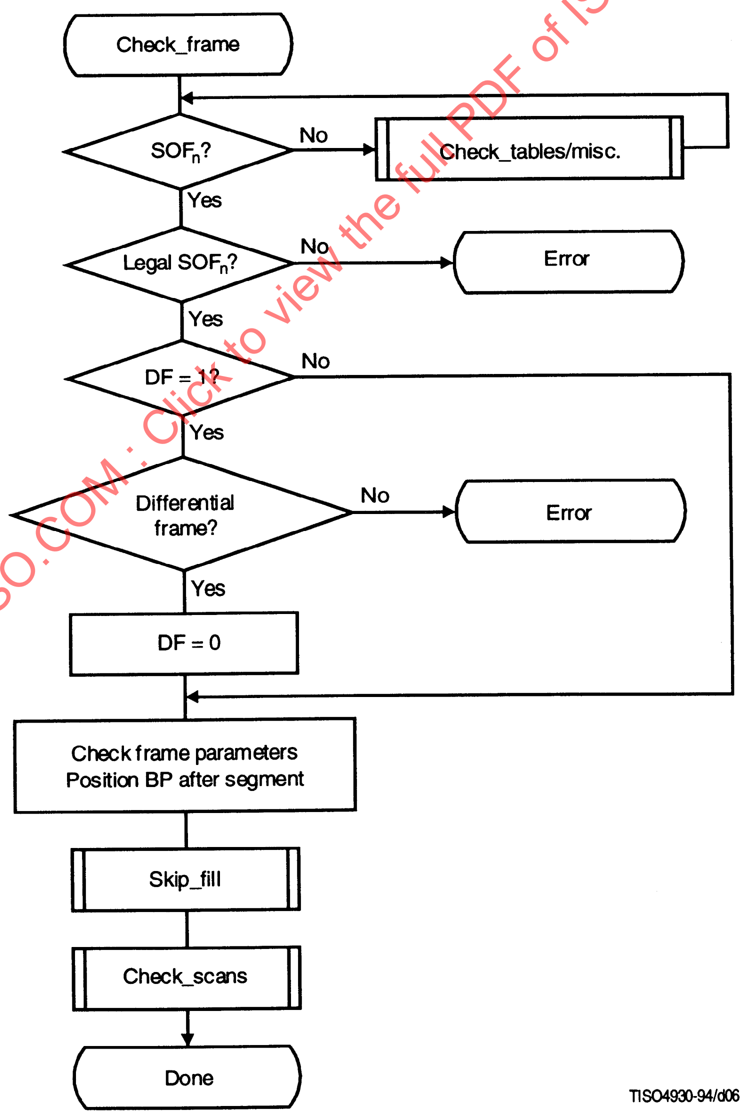


Figure 6 – The procedure for checking a frame for all coding processes

The "Legal SOFn?" test verifies that, in Table 1 for non-hierarchical processes, and Table 3 for hierarchical processes, the intersection of the column of the given process number and the line of the found SOF_n marker code, is designated by either 'G' or 'o'.

If the EXP marker has set the DF flag to 1 (in hierarchical processes only), a differential frame must follow.

The "Check_frame parameters" procedure is not specified here and is left to the tester. The tester should use the references given in Table 1 in the line containing the found SOF_n for non-hierarchical coding processes. Table 2 gives the column which is used to determine allowed range of parameter values based on the SOF_n marker for non-hierarchical coding processes. The tester should use the references for hierarchical coding processes given in Table 4 in the line containing the SOF_n for hierarchical frames. Table 4 also gives the column which is used to determine allowed range of parameter values based on the SOF_n marker for differential frames.

Figure 7 gives the "Check_tables/misc." procedure for all processes.

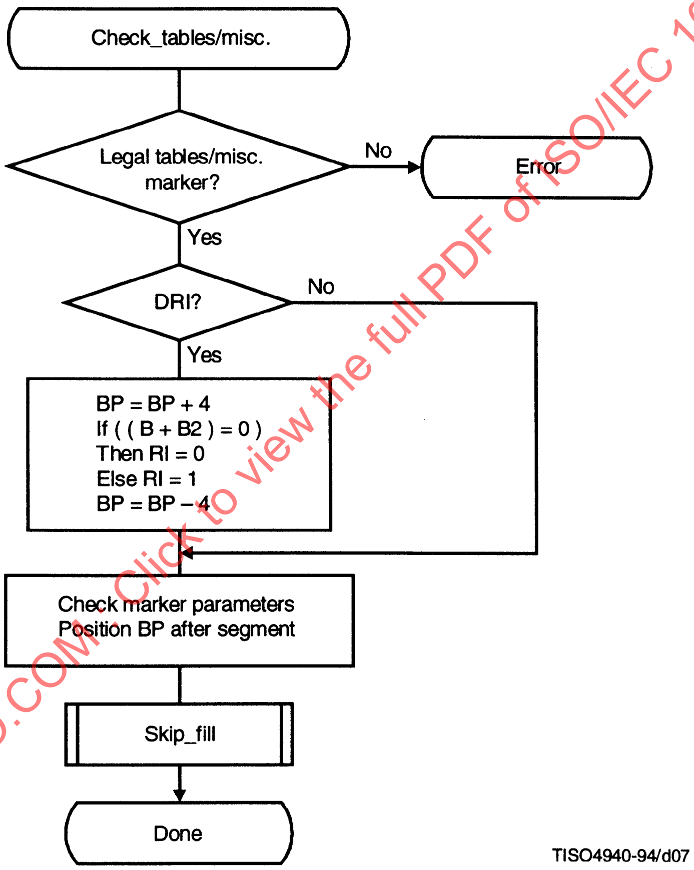


Figure 7 – Procedure to check the tables/miscellaneous markers

The "Legal tables/misc. marker?" test verifies that, in Table 1 for non-hierarchical processes, Table 3 for hierarchical processes, and Table 5 for abbreviated format for table specifications, under the tables/miscellaneous caption, the intersection of the column of the given process number and the line of the marker code to be checked, is designated by either 'G' or 'o'.

If the marker is DRI (Define Restart Interval), four is added to BP so that B points at the most significant byte and B2 at the least significant byte of the parameter Ri in order to use them to set the restart-interval flag RI. Then, four is subtracted from BP to reposition BP at the DRI marker.

The "Check marker parameters" procedure is not specified here and is left to the tester. The tester should use the references given in Table 1 for non-hierarchical processes, Table 3 for hierarchical processes, and Table 5 for abbreviated format for table specifications, in the line containing the found table/misc. marker. The appropriate column to be used to check that the parameters' values are valid can be found in Table 2 for non-hierarchical processes and Table 4 for hierarchical processes.

Figure 8 gives the "Check_scans" procedure for all coding processes.

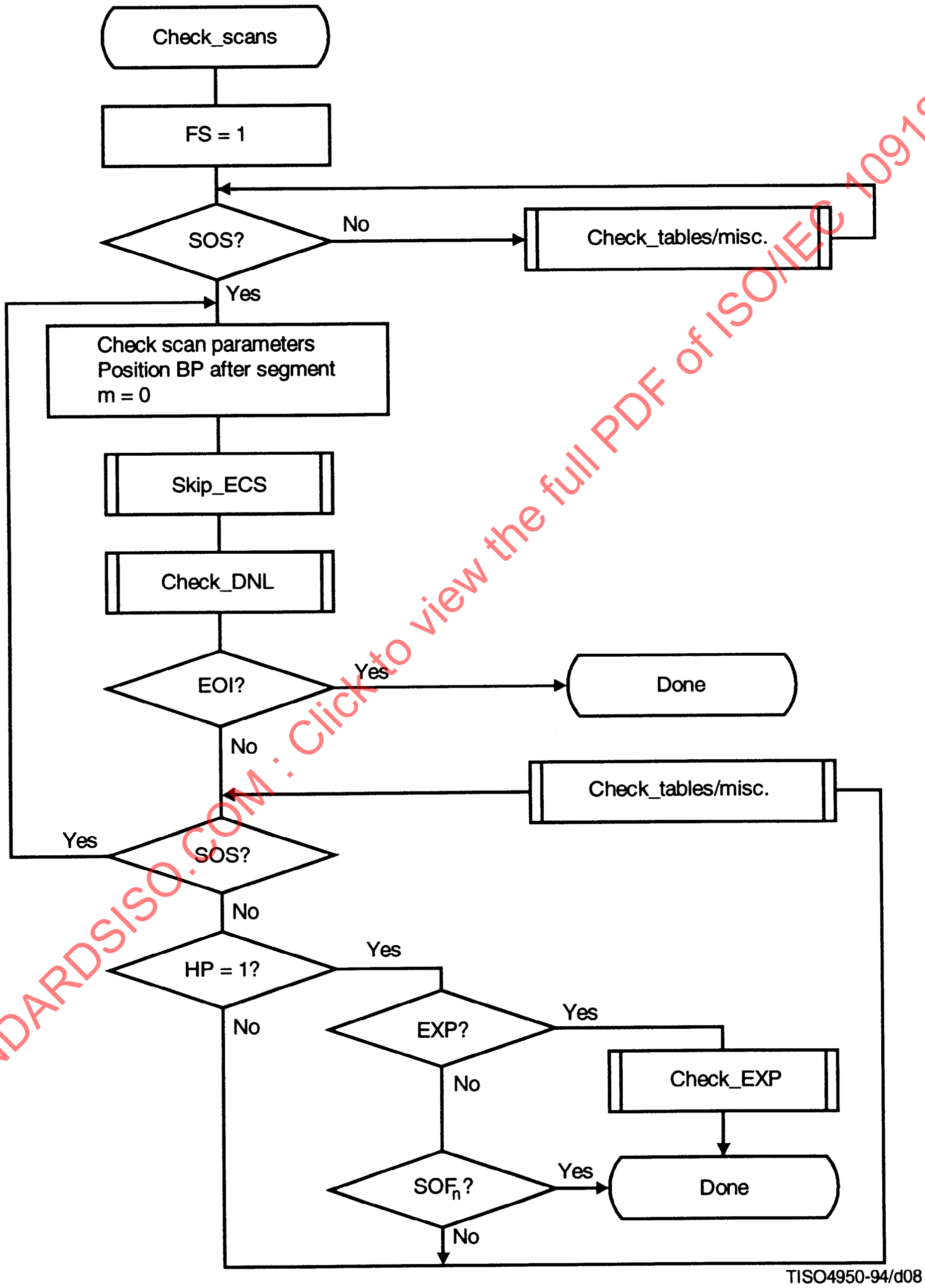


Figure 8 – The procedure for checking scans

FS is the first-scan-in-frame flag needed for syntax checking of the DNL marker in the "Check_DNL" procedure.

The "Check scan parameters" procedure is not specified here and is left to the tester. The tester should use the references given in Table 1 for non-hierarchical processes and Table 3 for hierarchical processes on the line containing SOS. The appropriate column to be used to check that the parameters' values are valid can be found in Table 2 for non-hierarchical processes and Table 4 for hierarchical processes.

An EOI marker determines the end of the compressed data stream. If an EOI marker has not been found before BP points outside the compressed data, the compressed data stream under test is non-compliant.

Figure 9 gives the "Skip_ECS" procedure.

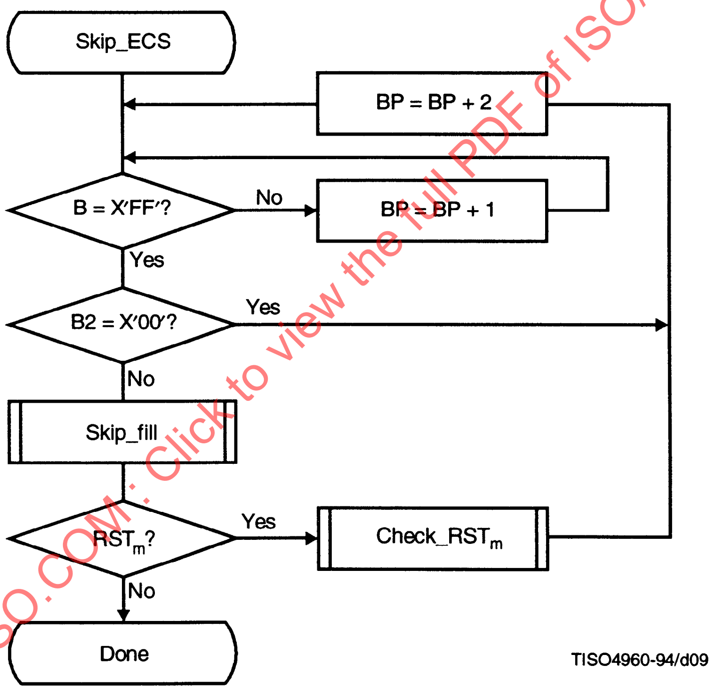


Figure 9 – Skip over entropy-coded segment procedure

Figure 10 gives the "Check_DNL" procedure.

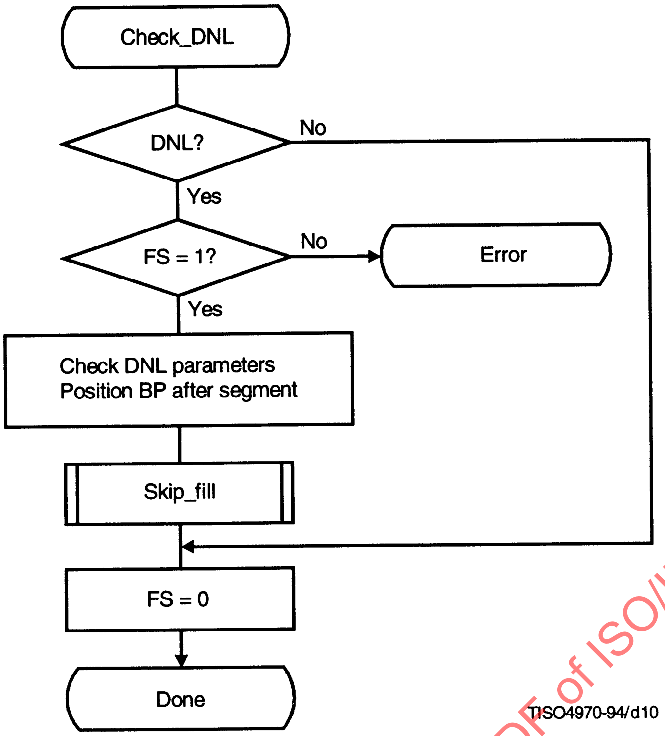


Figure 10 – Check DNL procedure

The "Check DNL parameters" procedure is not specified here and is left to the tester. The tester should use the references given in Table 1 for non-hierarchical processes, and in Table 3 for hierarchical processes, in the line containing DNL. The appropriate column to be used to check that the parameters' values are valid can be found in Table 2 for non-hierarchical processes and Table 4 for hierarchical processes.

Figure 11 gives the "Check_EXP" procedure.

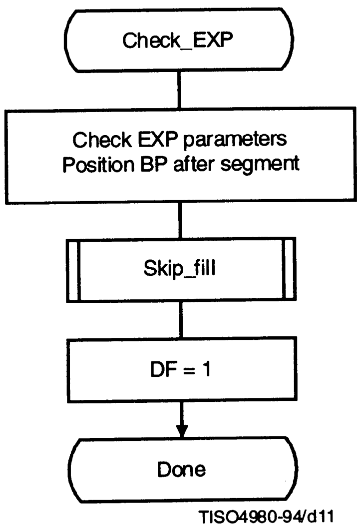


Figure 11 – Check EXP procedure

The "Check EXP parameters" procedure is not specified here and is left to the tester. The tester should use the references given in Table 3 for hierarchical processes, in the line containing EXP. The parameters' values are independent of the process. DF is set to check that the next SOF_n is a differential SOF marker.

Figure 12 gives the "Check-RST_m" procedure.

If the restart-interval flag (RI) is zero, RST_m markers are not allowed. The three least significant bits of the RST_m marker shall agree with the modulo counter m.

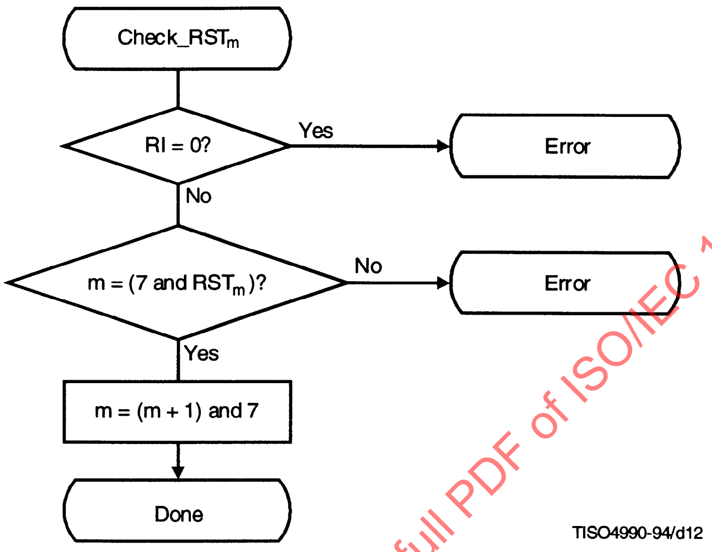


Figure 12 – Check restart marker procedure

6 Encoder compliance tests

An encoder is considered compliant to an encoding process if it satisfies the requirements stated in clause 6 of ITU-T Rec. T.81 | ISO/IEC 10918-1 and satisfies the requirements on accuracy for the compliance tests defined for that process in this Specification.

6.1 Compliance tests for DCT-based encoders

In order to determine compliance of DCT-based encoders, the test procedure set forth in A.1.1 and A.1.2 shall be performed. An encoder is found to be compliant if the resulting test data meet the requirements on accuracy specified in A.1.2.

6.2 Compliance tests for lossless encoders

No lossless encoder compliance tests are defined or required.

6.3 Availability of compliance test data

Source image test data and encoder reference test data are available from ISO/IEC and ITU (see 4.4) to parties who wish to determine compliance of a DCT-based encoder.

7 Decoder compliance tests

A decoder is considered compliant to a decoding process if it satisfies the requirements stated in clause 7 of ITU-T Rec. T.81 | ISO/IEC 10918-1 and satisfies the requirements on accuracy for the compliance tests defined for that process in this Specification.

7.1 Compliance tests for DCT-based decoders

In order to determine compliance of DCT-based decoders, the test procedure set forth in A.1.3 and A.1.4 shall be performed. A decoder is found to be compliant if the resulting test data, for all the tests specified for a particular process in 7.4, 7.5, 7.7.1 or 7.7.2, meet the requirements on accuracy specified in A.1.4.

7.2 Compliance tests for lossless decoders

In order to determine compliance of lossless decoders, the test procedure set forth in A.2.2 shall be performed. A decoder is found to be compliant if the resulting test data, for all the tests specified for a particular process in 7.6 or 7.7.3, exactly match the decoder reference test data.

7.3 Availability of compliance test data

Compressed image test data and decoder reference test data are available from ISO/IEC and ITU (for contact points see 4.4) to parties who wish to determine compliance of a DCT-based decoder.

7.4 Compliance tests for DCT-based sequential mode decoding processes (Tests A, B, C, D, E and F)

A list of the compliance tests for processes which utilize the DCT-based sequential mode of operation follow below:

- *Process 1* Baseline DCT, 8-bit sample precision.
  Required tests: A, B.
- *Process 2* Extended sequential DCT, Huffman decoding, 8-bit sample precision.
  Required tests: A, B, C.
- *Process 3* Extended sequential DCT, arithmetic decoding, 8-bit sample precision.
  Required tests: A, B, D.
- *Process 4* Extended sequential DCT, Huffman decoding, 12-bit sample precision.
  Required tests: A, B, C, E.
- *Process 5* Extended sequential DCT, arithmetic decoding, 12-bit sample precision.
  Required tests: A, B, D, F.

Compliance for baseline decoders (Process 1) requires successful completion of two tests, tests A and B. Each test defines its own compressed image test data structure. The testing procedure shall be repeated for each test using the specified compressed image test data as test input and the output data produced by each test must satisfy the requirements on accuracy for all DCT-based decoders.

The structure of the compressed image test data used by the baseline process tests (Tests A and B) are described below:

- *Test A*:

  Compressed image test data stream A1:
  - Interchange format syntax
  - 4 components
  - A single interleaved scan
  - Restart interval = 1/2 block row - 1
- *Test B*:

  Compressed image test data stream B1:
  - Abbreviated format syntax
  - Huffman and quantization tables
  - No entropy coded segments

Compressed image test data stream B2:

- Abbreviated format syntax
- 255 components non-interleaved

Test A specifies a compressed image test data stream which conforms to the syntax of the Interchange Format. Test B employs two compressed image test data streams (B1 and B2) which conform to the abbreviated format syntax. These two compressed image test data streams must be decoded in succession, with compressed image test data stream B2 immediately following the EOI marker of compressed image test data stream B1. The output test data produced after compressed image test data stream B2 is decoded must satisfy the requirements on accuracy for all DCT-based decoders.

All other tests defined for the DCT-based sequential processes (tests C, D, E and F) employ two compressed image test data streams as input: one interleaved and one non-interleaved. Each of the two compressed image test data streams is tested separately. See Annex C for a specification of the compressed image test data streams utilized.

7.5 Compliance tests for DCT-based progressive mode decoding processes (Tests G, H, I, J, K, L, M and N)

A list of the compliance tests for decoding processes which utilize the DCT-based progressive mode of operation follow below:

- *Process 6* Spectral selection only, Huffman decoding, 8-bit sample precision.
  Required tests: A, B, C, G.
- *Process 7* Spectral selection only, arithmetic decoding, 8-bit sample precision.
  Required tests: A, B, D, H.
- *Process 8* Spectral selection only, Huffman decoding, 12-bit sample precision.
  Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, C, E, G, I.
- *Process 9* Spectral selection only, arithmetic decoding, 12-bit sample precision.
  Required tests: A, B, D, F, H, J.
- *Process 10* Full progression, Huffman decoding, 8-bit sample precision.
  Required tests: A, B, C, G, K.
- *Process 11* Full progression, arithmetic decoding, 8-bit sample precision.
  Required tests: A, B, D, H, L.
- *Process 12* Full progression, Huffman decoding, 12-bit sample precision.
  Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, C, E, G, I, K, M.
- *Process 13* Full progression, arithmetic decoding, 12-bit sample precision.
  Required tests: A, B, D, F, H, J, L, N.

The tests defined for the DCT-based progressive processes each employ a single compressed image test data stream to be used as input. See Annex C for a specification of the compressed image test data utilized.

7.6 Compliance tests for lossless mode decoding processes (Tests O and P)

A list of the compliance tests for processes which utilize the lossless mode of operation follow below:

- *Process 14* Lossless, Huffman decoding, 2- through 16-bit sample precision.
  Required tests: O.
- *Process 15* Lossless, arithmetic decoding, 2- through 16-bit sample precision.
  Required tests: P.

The required tests of each lossless mode process each utilize two compressed image test data streams having different sample precision: 8 and 16 bits respectively. Also, the compressed image test data streams have different encoding order: interleaved and non-interleaved. Each of the two compressed image test data streams is tested separately. See Annex C for a specification of the compressed image test data utilized.

7.7 Compliance tests for hierarchical mode decoding processes

Hierarchical compliance tests utilize compressed image test data comprized of several stages as input. Every stage within a particular hierarchical compliance test employs one of the processes numbered 2-15, as modified for hierarchical mode.

Every hierarchical compliance test designates that a decoder shall pass additional tests which address functional subsets of the current test.

7.7.1 Compliance tests for hierarchical mode with DCT-based sequential decoding processes (Tests Q and R)

A list of the compliance tests for decoders which utilize DCT-based sequential processes in the hierarchical mode of operation follow below:

– *Process 16* Extended sequential DCT, Huffman decoding, 8-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, C, Q.

– *Process 17* Extended sequential DCT, arithmetic decoding, 8-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, D, R.

– *Process 18* Extended sequential DCT, Huffman decoding, 12-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, C, E, Q.

– *Process 19* Extended sequential DCT, arithmetic decoding, 12-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, D, F, R.

The tests which address DCT-based sequential configurations (Tests Q and R) utilize compressed image test data streams having 6 frames. See Annex C for a specification of the compressed image test data utilized.

When compliance test data becomes available, decoders capable of processing a final lossless stage shall also complete an additional test: Test S for Huffman decoders and test T for arithmetic decoders.

7.7.2 Compliance tests for hierarchical mode with DCT-based progressive processes (Tests Q and R)

A list of the compliance tests for decoders which utilize DCT-based progressive processes in the hierarchical mode of operation follow below:

– *Process 20* Spectral selection only, Huffman decoding, 8-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, C, G, Q.

– *Process 21* Spectral selection only, arithmetic decoding, 8-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, D, H, R.

– *Process 22* Spectral selection only, Huffman decoding, 12-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, C, E, G, I, Q.

– *Process 23* Spectral selection only, arithmetic decoding, 12-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, D, F, H, J, R.

– *Process 24* Full progression, Huffman decoding, 8-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, C, G, K, Q.

– *Process 25* Full progression, arithmetic decoding, 8-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, D, H, L, R.

– *Process 26* Full progression, Huffman decoding, 12-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, C, E, G, I, K, M, Q.

– *Process 27* Full progression, arithmetic decoding, 12-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: A, B, D, F, H, J, L, N, R.

When compliance test data becomes available, decoders capable of processing a final lossless stage shall also complete an additional test: test S for Huffman decoders and test T for arithmetic decoders.

7.7.3 Compliance tests for hierarchical mode with lossless decoding processes (Tests S and T)

A list of the compliance tests for decoders which utilize lossless processes in the hierarchical mode of operation follow below:

– *Process 28* Lossless, Huffman decoding, 2- through 16-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: O, S.

– *Process 29* Lossless, arithmetic decoding, 2- through 16-bit sample precision.
Compliance test data for this process is not yet available and thus there is no normative compliance test at this time. When compliance test data becomes available, the required tests will be: P, T.

The tests which address lossless configurations (tests S and T) utilize compressed image test data streams having 5 frames. See Annex C for a specification of the compressed image test data utilized.

7.8 Summary of decoder compliance test requirements

Assuming the availability of all compliance test data, Table 6 summarizes the tests required to determine compliance for each decoding process.

NOTE – The compressed image test data streams for the compliance tests of some processes are not available at this time and thus, there are no normative compliance tests for those processes. Therefore, Table 6 gives the tests required to determine compliance once all compliance test data becomes available. The decoding processes which have no normative compliance tests at this time are: processes 8, 12, and 16-29.

Table 6 – Decoder compliance test requirements for each process

Process	Test																			
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	G	G																		
2	G	G	G																	
3	G	G		G																
4	G	G	G		G															
5	G	G		G		G														
6	G	G	G				G													
7	G	G		G				G												
8	G	G	G		G		G		G											
9	G	G		G		G		G		G										
10	G	G	G				G				G									
11	G	G		G				G				G								
12	G	G	G		G		G		G		G		G							
13	G	G		G		G		G		G		G		G						
14															G					
15																G				
16	G	G	G														G		o	
17	G	G		G														G		o
18	G	G	G		G												G		o	
19	G	G		G		G												G		o
20	G	G	G				G										G		o	
21	G	G		G				G										G		o
22	G	G	G		G		G		G								G		o	
23	G	G		G		G		G		G								G		o
24	G	G	G				G				G						G		o	
25	G	G		G				G				G						G		o
26	G	G	G		G		G		G		G		G				G		o	
27	G	G		G		G		G		G		G		G				G		o
28															G				G	
29																G				G

NOTE – Required tests are denoted "G". Optional additional tests are denoted "o".

Annex A

Procedures for determining generic encoder and decoder compliance

(This annex forms an integral part of this Recommendation | International Standard)

The compliance test procedures defined within this Specification require that output data sets generated by the device under test match reference data sets within the requirements on accuracy for the process being tested. Compliance test procedures for DCT-based processes are defined separately from the test procedures for lossless processes.

A.1 Compliance test procedures for DCT-based processes

This subclause describes the compliance tests for DCT-based processes. DCT-based process implementation accuracy is always assessed by comparison of quantized DCT data. Processes with 8-bit sample precision and the corresponding processes with 12-bit sample precision are tested using identical test procedures. However, DCT-based encoders are tested for compliance with processes having 12-bit sample precision by first left justifying the 8-bit source image test data within the 12-bit samples. Left justification can be accomplished by multiplying the 8-bit samples by 16.

A.1.1 DCT-based encoder compliance test procedure – Introduction

The encoder compliance test procedure for DCT-based processes creates a compressed image data set from the source image test data. The compressed image data is then entropy decoded using a reference entropy decoder and the decoded quantized DCT coefficients are compared with the DCT coefficients of the encoder reference test data. If the uncoded quantized DCT coefficients generated by the encoder under test are directly accessible (as possibly in a software implementation), the entropy encoding and reference entropy decoding steps may be omitted. If the quantized DCT coefficients are not directly accessible, then it is the responsibility of the implementor to provide a reference entropy decoder which is compatible with the generated compressed image data so that the necessary test data can be obtained.

The difference between the encoder implementation's quantized DCT coefficients and the encoder reference test data must not exceed the requirements on accuracy contained in A.1.2. These requirements apply to processes with 8-bit input precision and to processes with 12-bit input precision. A block diagram of the encoder testing procedure is shown in Figure A.1.

Standard data sets can be obtained from ISO/IEC and ITU (for contact points see 4.4) which contain the source image test data and the encoder reference test data to be subtracted from the output data produced by the device under test. Two encoder reference test data sets are available: one for processes employing 8-bit precision and one for processes with 12-bit input precision.

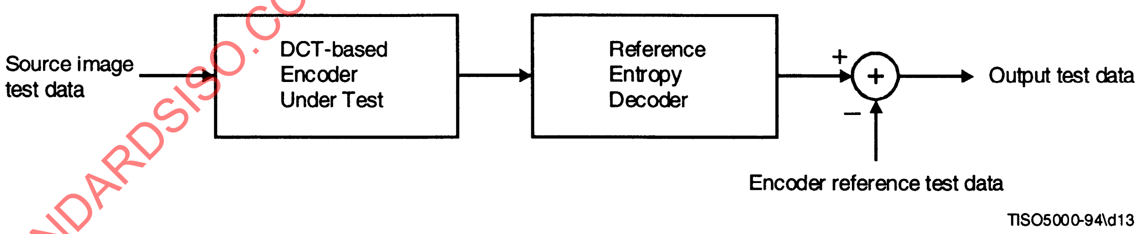


Figure A.1 – Testing procedure for a DCT-based encoder

A.1.2 Procedure for determining compliance of a DCT-based encoder

This procedure is used to determine whether a proposed implementation of a DCT-based encoder satisfies the requirements for compliance. The procedure is as follows:

1) With the supplied source image test data as input and using the quantization tables specified in Annex B, generate compressed image data using the encoder under test. The source image test data has four components designated A to D. The dimensions of the four components are listed in Annex C.

2) Decode the compressed image data using the reference entropy decoder to obtain the quantized transform coefficients for the encoder under test.

3) Subtract the decoded quantized DCT coefficients from the corresponding quantized DCT coefficients of the encoder reference test data supplied to obtain the error values. 8 × 8 blocks that were completed by extension, or blocks that were added to complete an MCU as defined in A.2.4 of ITU-T Rec. T.81 | ISO/IEC 10918-1 shall not be considered. The values of all absolute differences shall not exceed one.

A.1.3 DCT-based decoder compliance test procedure – Introduction

A DCT-based decoder is tested by first decoding the compressed image test data. The output image is then used as input to the reference FDCT and quantizer. The output of the reference FDCT and quantizer is then compared to the decoder reference test data. The reference FDCT and quantizer shall be constructed by the implementor according to the definitions in clause 3.

The quantized coefficients produced from the output image of the decoder under test shall meet the requirement on accuracy given in A.1.4.

These requirements apply to processes with 8-bit output precision and to processes with 12-bit output precision. A block diagram of the decoder testing procedure is shown in Figure A.2.

The compressed image test data and the decoder reference test data are available from ISO/IEC and ITU (for contact points see 4.4) to any parties who wish to determine compliance of a decoder. Two decoder reference test data sets are available: one for processes employing 8-bit output precision and one for processes with 12-bit output precision.

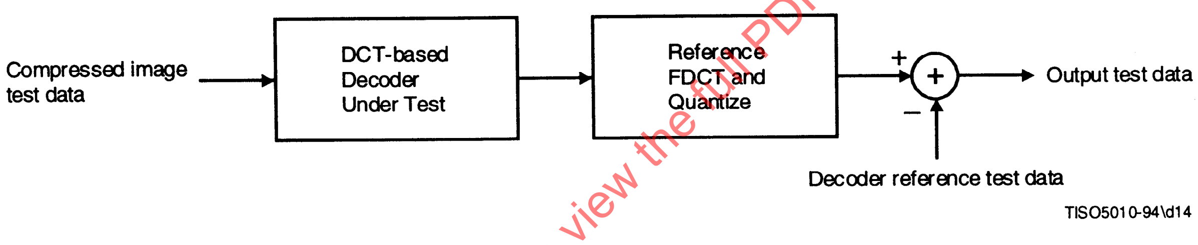


Figure A.2 – Testing procedure for a DCT-based decoder

A.1.4 Procedure for determining compliance of a DCT-based decoder

This procedure is used to determine whether a proposed implementation of a decoder satisfies the requirements for compliance. The procedure is as follows:

1) Decode the supplied compressed image test data using the decoder under test.

2) Calculate the quantized DCT coefficients from the decoded output image according to the FDCT and quantization procedures defined in Annex A of ITU-T Rec. T.81 | ISO/IEC 10918-1 implemented with double precision floating point accuracy.

3) For each quantized coefficient, subtract the reference quantized coefficient in the decoder reference test data supplied. 8 × 8 blocks that were completed by extension, or blocks that were added to complete an MCU as defined in A.2.4 of ITU-T Rec. T.81 | ISO/IEC 10918-1 shall not be considered. The values of all absolute differences shall not exceed one.

A.2 Compliance tests for lossless processes

This subclause describes the compliance test procedure for lossless processes. The lossless compliance tests require exact accuracy; output test data shall match the decoder reference test data with no differences.

A.2.1 Lossless encoder compliance test procedure

No lossless encoder compliance test procedure is defined.

A.2.2 Lossless decoder compliance test procedures

Lossless decoders are tested by decoding the compressed image test data produced by a reference encoder and comparing the output image with the image produced when the same compressed image data is decoded by a reference decoder. The output image produced by the decoder under test shall exactly match the decoder reference test data (no differences). The same requirements apply to all lossless decoders regardless of the output precision. A block diagram of the general lossless testing procedure is shown in Figure A.3.

The compressed image test data and the decoder reference test data are available from ISO/IEC and ITU (for contact points see 4.4) to any parties who wish to determine compliance of a lossless decoder process.

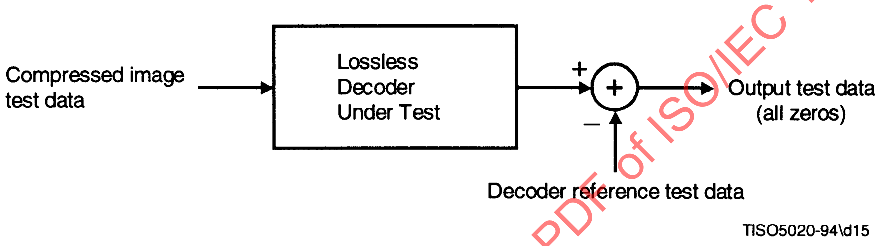


Figure A.3 – General testing procedure for a lossless decoder

Annex B

Quantization tables for generic compliance testing of DCT-based processes

(This annex forms an integral part of this Recommendation | International Standard)

This annex specifies the quantization tables used in compliance tests for all DCT-based processes. These quantization tables are used for compliance testing of generic encoders and decoders. The source image test data are comprised of four components designated A to D and are reused as needed.

The quantization tables are defined in Tables B.1 to B.4. The compliance tests for those processes having 8-bit sample precision use the values in these tables as shown. The compliance tests for those processes having 12-bit sample precision use the table values multiplied by 4. The tables are presented in orthogonal, not "zig-zag", representation.

The values of quantization table for component A are shown in Table B.1.

Table B.1 – Quantization table for component A

8	6	5	8	12	20	26	30
6	6	7	10	13	29	30	28
7	7	8	12	20	29	35	28
7	9	11	15	26	44	40	31
9	11	19	28	34	55	52	39
12	18	28	32	41	52	57	46
25	32	39	44	52	61	60	51
36	46	48	49	56	50	52	50

The values of quantization table for component B are shown in Table B.2.

Table B.2 – Quantization table for component B

9	9	12	24	50	50	50	50
9	11	13	33	50	50	50	50
12	13	28	50	50	50	50	50
24	33	50	50	50	50	50	50
50	50	50	50	50	50	50	50
50	50	50	50	50	50	50	50
50	50	50	50	50	50	50	50
50	50	50	50	50	50	50	50

The values of quantization table for component C are shown in Table B.3.

Table B.3 – Quantization table for component C

16	17	18	19	20	21	22	23
17	18	19	20	21	22	23	24
18	19	20	21	22	23	24	25
19	20	21	22	23	24	25	26
20	21	22	23	24	25	26	27
21	22	23	24	25	26	27	28
22	23	24	25	26	27	28	29
23	24	25	26	27	28	29	30

The values of quantization table for component D are shown in Table B.4.

Table B.4 – Quantization table for component D

16	16	19	22	26	27	29	34
16	16	22	24	27	29	34	37
19	22	26	27	29	34	34	38
22	22	26	27	29	34	37	40
22	26	27	29	32	35	40	48
26	27	29	32	35	40	48	58
26	27	29	34	38	46	56	69
27	29	35	38	46	56	69	83

Annex C

Compressed test data stream structure for generic decoder compliance tests

(This annex forms an integral part of this Recommendation | International Standard)

Decoder compliance tests define specific compressed image data to be used as test input. Compliance tests employ reference test data which are to be compared with the test data generated by the device under test.

This annex contains specifications of the structure of the compressed test data sets utilized by decoder compliance tests.

The compressed test data streams A1, C1, C2, ... T2 define parameter values in the frame header as follows:

Sample precision (P)	=	varies with test
Number of lines (Y)	=	257
Number of samples per line (X)	=	255
Number of components (Nf)	=	4
Component identifiers (C_i)	=	200 (component A)
		150 (component B)
		100 (component C)
		50 (component D)
Horizontal sampling factors (H_i)	=	1, 1, 3, 1
Vertical sampling factors (V_i)	=	1, 2, 1, 4
Quantization table selectors (Tq_i)	=	0, 1, 2, 3

Sample precision (P) utilized is either 8 or 12 for DCT-based processes, and is either 8 or 16 for lossless processes.

These compressed data streams describe an image which, after decoding, has components with the following dimensions:

Component A	85 samples × 65 lines
Component B	85 samples × 129 lines
Component C	255 samples × 65 lines
Component D	85 samples × 257 lines

These dimensions are derived from the number of lines (Y), number of samples per line (X), horizontal sampling factors (H_i), and the vertical sampling factors (V_i) parameters in the frame header.

The compressed test data stream B2 defines parameter values in the frame header as follows:

Sample precision (P)	=	8
Number of lines (Y)	=	257
Number of samples per line (X)	=	255
Number of components (Nf)	=	255
Component identifiers (C_i)	=	254 (component A)
		253 (component B)
		252 (component C)
		251 (component D)
		250 (component A)
		249 (component A)
		248 (component A)

(C_i decrements by 1 for each scan)

... 3 (component A)

2 (component B)

1 (component C)

0 (component D)

Horizontal sampling factors (H_i) = 1, 1, 3, 1, 1, 1, 1, ... 1, 1, 3, 1

Vertical sampling factors (V_i) = 1, 2, 1, 4, 1, 1, 1, ... 1, 2, 1, 4

Quantization table selectors (Tq_i) = 0, 1, 2, 3, 0, 0, 0, ... 0, 1, 2, 3

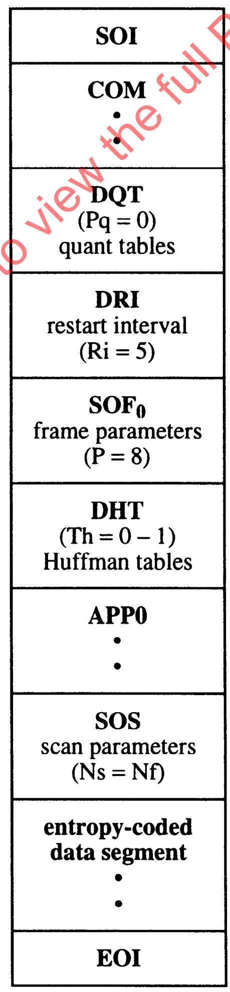
NOTE – The compressed test data streams employ a small number of different Huffman tables. This small number of Huffman tables do not guarantee functional correctness of decoders; any valid Huffman table as defined in ITU-T Rec. T.81 | ISO/IEC 10918-1, Annex C, for a particular Huffman process, shall be supported by generic decoders claiming compliance to that same process.

C.1 Non-Hierarchical decoder compliance tests

This subclause contains specifications of the structure of the compressed test data streams utilized by non-hierarchical decoder compliance tests.

C.1.1 Compressed test data stream structure for the baseline decoding process (Test A)

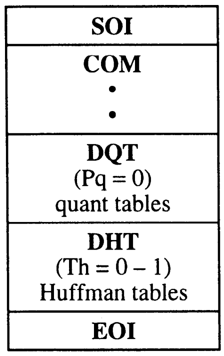
Compressed test data stream A1



(Interchange format for compressed data)

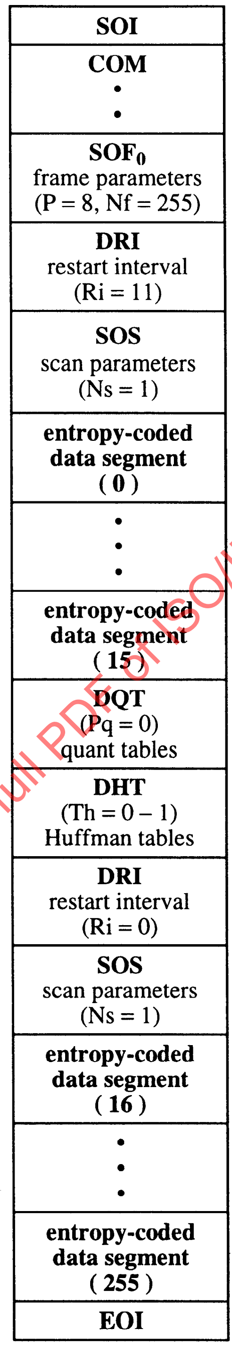
C.1.2 Compressed test data stream structure for the baseline decoding process (Test B)

Compressed test data stream B1



(Abbreviated format for table-specification data)

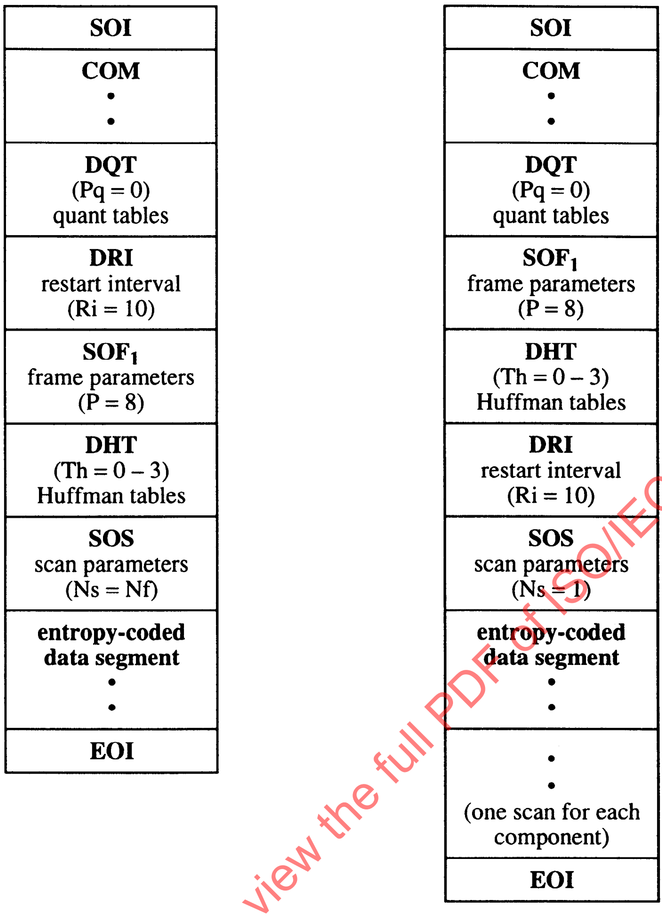
Compressed test data stream B2



(Abbreviated format for compressed image data)

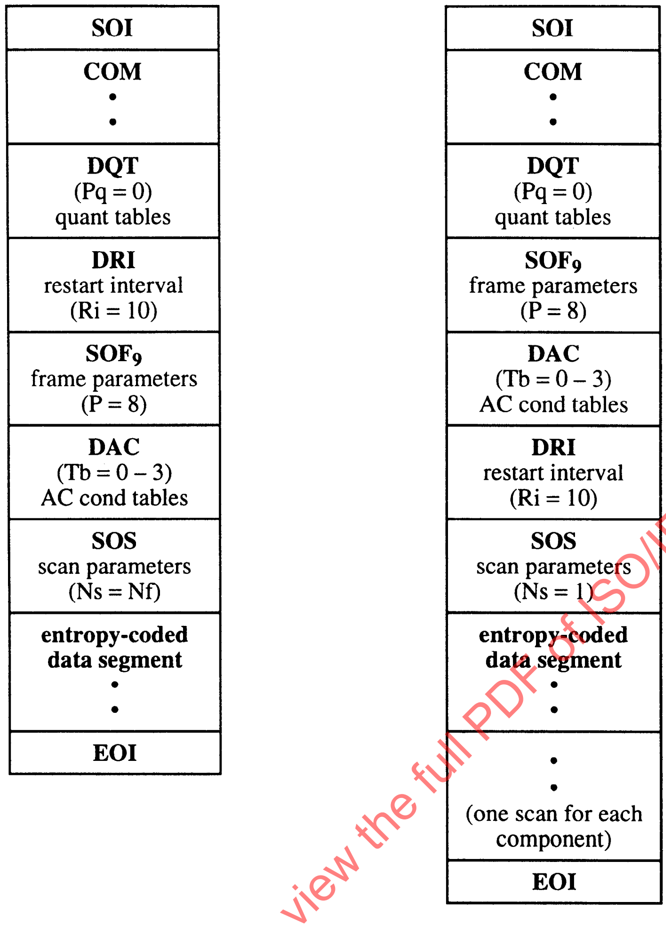
C.1.3 Compressed test data structure for the extended sequential Huffman decoding process, 8-bit sample precision (Test C)

Compressed test data stream C1 **Compressed test data stream C2**

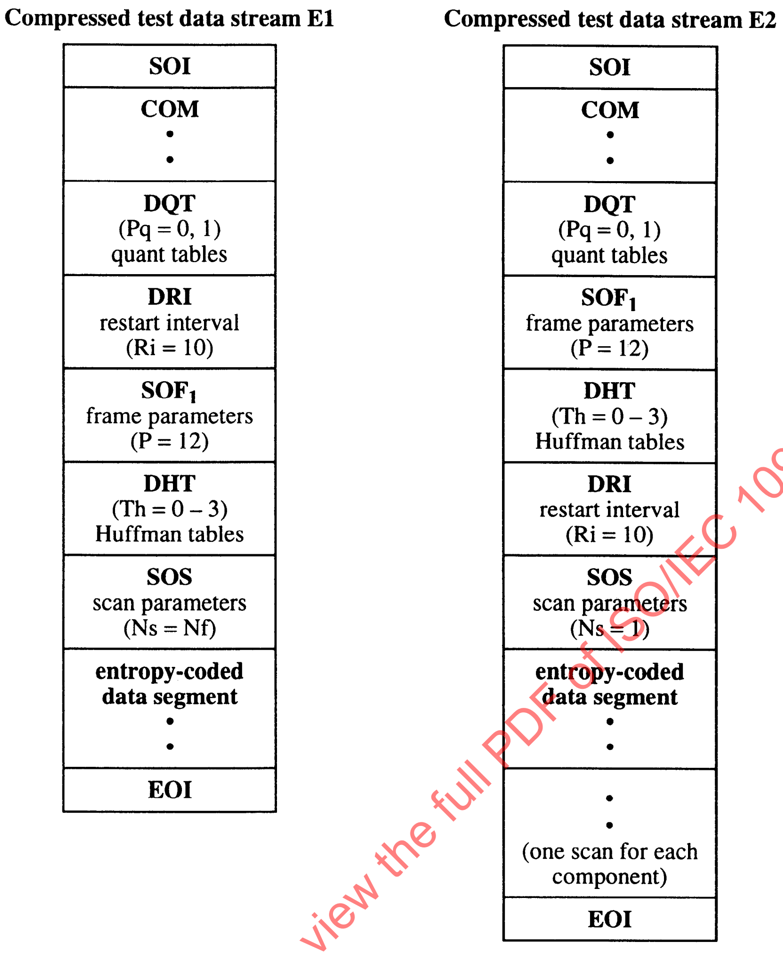


C.1.4 Compressed test data structure for the extended sequential arithmetic decoding process, 8-bit sample precision (Test D)

Compressed test data stream D1 **Compressed test data stream D2**



C.1.5 Compressed test data structure for the extended sequential Huffman decoding process, 12-bit sample precision (Test E)



C.1.6 Compressed test data structure for the extended sequential arithmetic decoding process, 12-bit sample precision (Test F)

Compressed test data stream F1

SOI
COM • •
DQT (Pq = 0, 1) quant tables
DRI restart interval (Ri = 10)
SOF_9 frame parameters (P = 12)
DAC (Tb = 0 – 3) AC cond tables
SOS scan parameters (Ns = Nf)
entropy-coded data segment • •
EOI

Compressed test data stream F2

SOI
COM • •
DQT (Pq = 0, 1) quant tables
SOF_9 frame parameters (P = 12)
DAC (Tb = 0 – 3) AC cond tables
DRI restart interval (Ri = 10)
SOS scan parameters (Ns = 1)
entropy-coded data segment • •
• • (one scan for each component)
EOI

C.1.7 Compressed test data structure for the progressive spectral selection Huffman decoding process, 8-bit sample precision (Test G)

Compressed test data stream G1

SOI
COM • •
DQT (Pq = 0) quant tables
DRI restart interval (Ri = 10)
SOF_2 frame parameters (P = 8)
DHT (Th = 0 – 3) Huffman tables
SOS scan parameters (Ns = 3, Ss = Se = 0, Ah = Al = 0)
entropy-coded data segment • •
DHT (Th = 0 – 3) Huffman tables
SOS scan parameters (Ns = 1, Ss = Se = 0, Ah = Al = 0)
entropy-coded data segment • •
• • (total of 10 scans)
EOI

C.1.8 Compressed test data structure for the progressive spectral selection arithmetic decoding process, 8-bit sample precision (Test H)

Compressed test data stream H1

SOI
COM • •
DQT (Pq = 0) quant tables
DRI restart interval (Ri = 10)
SOF_{10} frame parameters (P = 8)
DAC (Tb = 0 – 3) AC cond tables
SOS scan parameters (Ns = 3, Ss = Se = 0, Ah = Al = 0)
entropy-coded data segment • •
DAC (Tb = 0 – 3) AC cond tables
SOS scan parameters (Ns = 1, Ss = Se = 0, Ah = Al = 0)
entropy-coded data segment • •
• • (total of 10 scans)
EOI

C.1.9 Compressed test data structure for the progressive spectral selection Huffman decoding process, 12-bit sample precision (Test I)

NOTE – The compressed image test data which has the structure specified by this subclause is not yet available.

Compressed test data stream I1

SOI
COM • •
DQT (Pq = 0, 1) quant tables
DRI restart interval (Ri = 10)
SOF_2 frame parameters (P = 12)
DHT (Th = 0 – 3) Huffman tables
SOS scan parameters (Ns = 3, Ss = Se = 0, Ah = Al = 0)
entropy-coded **data segment** • •
DHT (Th = 0 – 3) Huffman tables
SOS scan parameters (Ns = 1, Ss = Se = 0, Ah = Al = 0)
entropy-coded **data segment** • •
• • (total of 10 scans)
EOI

C.1.10 Compressed test data structure for the progressive spectral selection arithmetic decoding process, 12-bit sample precision (Test J)

Compressed test data stream J1

SOI
COM • •
DQT (Pq = 0, 1) quant tables
DRI restart interval (Ri = 10)
SOF_{10} frame parameters (P = 12)
DAC (Tb = 0 – 3) AC cond tables
SOS scan parameters (Ns = 3, Ss = Se = 0, Ah = Al = 0)
entropy-coded data segment • •
DAC (Tb = 0 – 3) AC cond tables
SOS scan parameters (Ns = 1, Ss = Se = 0, Ah = Al = 0)
entropy-coded data segment • •
• • (total of 10 scans)
EOI

C.1.11 Compressed test data structure for the full progressive Huffman decoding process, 8-bit sample precision (Test K)

Compressed test data stream K1

SOI
COM • •
DQT (Pq = 0) quant tables
DRI restart interval (Ri = 10)
SOF_2 frame parameters (P = 8)
DHT (Th = 0 – 3) Huffman tables
SOS scan parameters (Ns = 1, Ss = Se = 0, Ah = 0, Al = 1)
entropy-coded data segment • •
DHT (Th = 0 – 3) Huffman tables
SOS scan parameters (Ns = 3, Ss = Se = 0, Ah = 0, Al = 1)
entropy-coded data segment • •
• • (total of 15 scans)
EOI

C.1.12 Compressed test data structure for the full progressive arithmetic decoding process, 8-bit sample precision (Test L)

Compressed test data stream L1

SOI
COM • •
DQT (Pq = 0) quant tables
DRI restart interval (Ri = 10)
SOF_{10} frame parameters (P = 8)
DAC (Tb = 0 – 3) AC cond tables
SOS scan parameters (Ns = 1, Ss = Se = 0, Ah = 0, Al = 1)
entropy-coded data segment • •
DAC (Tb = 0 – 3) AC cond tables
SOS scan parameters (Ns = 3, Ss = Se = 0, Ah = 0, Al = 1)
entropy-coded data segment • •
• • (total of 15 scans)
EOI

C.1.13 Compressed test data structure for the full progressive Huffman decoding process, 12-bit sample precision (Test M)

NOTE – The compressed image test data which has the structure specified by this subclause is not yet available.

Compressed test data stream M1

SOI
COM • •
DQT (Pq = 0, 1) quant tables
DRI restart interval (Ri = 10)
SOF_2 frame parameters (P = 12)
DHT (Th = 0 – 3) Huffman tables
SOS scan parameters (Ns = 1, Ss = Se = 0, Ah = 0, Al = 1)
entropy-coded data segment • •
DHT (Th = 0 – 3) Huffman tables
SOS scan parameters (Ns = 3, Ss = Se = 0, Ah = 0, Al = 1)
entropy-coded data segment • •
• • (total of 20 scans)
EOI

C.1.14 Compressed test data structure for the full progressive arithmetic decoding process, 12-bit sample precision (Test N)

Compressed test data stream N1

SOI
COM • •
DQT (Pq = 0, 1) quant tables
DRI restart interval (Ri = 10)
SOF_{10} frame parameters (P = 12)
DAC (Tb = 0 – 3) AC cond tables
SOS scan parameters (Ns = 1, Ss = Se = 0, Ah = 0, Al = 1)
entropy-coded data segment • •
DAC (Tb = 0 – 3) AC cond tables
SOS scan parameters (Ns = 3, Ss = Se = 0, Ah = 0, Al = 1)
entropy-coded data segment • •
• • (total of 20 scans)
EOI

C.1.15 Compressed test data structure for the lossless Huffman decoding process, 2- through 16-bit sample precision (Test O)

Compressed test data stream O1

SOI
COM • •
DRI restart interval (Ri = 85)
SOF_3 frame parameters (P = 8)
DHT (Th = 0 – 3) Huffman tables
SOS scan parameters (Ns = Nf)
entropy-coded data segment • •
EOI

Compressed test data stream O2

SOI
COM • •
SOF_3 frame parameters (P=16)
DHT (Th = 0 – 3) Huffman tables
DRI restart interval (Ri = 170)
SOS scan parameters (Ns = 1)
entropy-coded data segment • •
DRI restart interval (Ri = 0)
• • (one scan for each component)
EOI

C.1.16 Compressed test data structure for the lossless arithmetic decoding process, 2- through 16-bit sample precision (Test P)

Compressed test data stream P1

SOI
COM • •
DRI restart interval (Ri = 85)
SOF_{11} frame parameters (P = 8)
DAC (Tb = 0 – 3) AC cond tables
SOS scan parameters (Ns = Nf)
entropy-coded data segment • •
EOI

Compressed test data stream P2

SOI
COM • •
SOF_{11} frame parameters (P = 16)
DAC (Tb = 0 – 3) AC cond tables
DRI restart interval (Ri = 170)
SOS scan parameters (Ns = 1)
entropy-coded data segment • •
DRI restart interval (Ri = 0)
• • (one scan for each component)
EOI

C.2 Hierarchical decoder compliance tests

This subclause contains specifications of the structure of the compressed test data streams utilized by hierarchical decoder compliance tests.

C.2.1 Compressed test data structure for hierarchical DCT-based sequential Huffman decoding processes (Test Q)

NOTE – The compressed image test data which has the structure specified by this subclause is not yet available.

Compressed test data stream Q1 **Compressed test data stream Q2**