International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

H.262

Corrigendum 2
(05/2006)

SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Infrastructure of audiovisual services – Coding of moving video

---

Information technology – Generic coding of moving pictures and associated audio information: Video

Technical Corrigendum 2

ITU-T Recommendation H.262 (2000) – Technical Corrigendum 2

ITU-T

International Telecommunication Union

ITU-T H-SERIES RECOMMENDATIONS

AUDIOVISUAL AND MULTIMEDIA SYSTEMS

CHARACTERISTICS OF VISUAL TELEPHONE SYSTEMS	H.100–H.199
INFRASTRUCTURE OF AUDIOVISUAL SERVICES	
General	H.200–H.219
Transmission multiplexing and synchronization	H.220–H.229
Systems aspects	H.230–H.239
Communication procedures	H.240–H.259
Coding of moving video	**H.260–H.279**
Related systems aspects	H.280–H.299
Systems and terminal equipment for audiovisual services	H.300–H.349
Directory services architecture for audiovisual and multimedia services	H.350–H.359
Quality of service architecture for audiovisual and multimedia services	H.360–H.369
Supplementary services for multimedia	H.450–H.499
MOBILITY AND COLLABORATION PROCEDURES	
Overview of Mobility and Collaboration, definitions, protocols and procedures	H.500–H.509
Mobility for H-Series multimedia systems and services	H.510–H.519
Mobile multimedia collaboration applications and services	H.520–H.529
Security for mobile multimedia systems and services	H.530–H.539
Security for mobile multimedia collaboration applications and services	H.540–H.549
Mobility interworking procedures	H.550–H.559
Mobile multimedia collaboration inter-working procedures	H.560–H.569
BROADBAND AND TRIPLE-PLAY MULTIMEDIA SERVICES	
Broadband multimedia services over VDSL	H.610–H.619

For further details, please refer to the list of ITU-T Recommendations.

INTERNATIONAL STANDARD ISO/IEC 13818-2
ITU-T RECOMMENDATION H.262

Information technology – Generic coding of moving pictures and associated audio information: Video

Technical Corrigendum 2

Source

Corrigendum 2 to ITU-T Recommendation H.262 (2000) was approved on 29 May 2006 by ITU-T Study Group 16 (2005-2008) under the ITU-T Recommendation A.8 procedure. An identical text is also published as Technical Corrigendum 2 to ISO/IEC 13818-2.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

INTERNATIONAL STANDARD
ITU-T RECOMMENDATION

Information technology – Generic coding of moving pictures and associated audio information: Video

Technical Corrigendum 2

1) Clause 2 "Normative references"

In clause 2, make the following changes.

Insert the following reference.

– ISO/IEC 23002-1:2006, *Information technology – MPEG video technologies – Part 1: Accuracy requirements for implementation of integer-output 8x8 inverse discrete cosine transform*.

Remove the following reference:

– IEEE 1180:1990, Standard Specifications for the Implementations of 8 by 8 Inverse Discrete Cosine Transform.

2) Subclause 5.4 "Arithmetic precision"

In subclause 5.4, replace the paragraph which states as follows:

a) Where arithmetic precision is not specified, such as in the calculation of the IDCT, the precision shall be sufficient so that significant errors do not occur in the final integer values.

with the following:

a) Where an arithmetically-precise result is not fully specified, such as in the calculation of the IDCT, the precision shall be sufficient so that significant errors do not occur in the final integer values.

3) Clause 7 "The video decoding process"

In clause 7, replace the paragraph which states as follows:

The IDCT function f[y][x] used in the decoding process may be any of several approximations of the saturated mathematical integer-number IDCT defined in Annex A. Requirements on the accuracy of the IDCT function used in the decoding process are specified in Annex A.

with the following:

The IDCT function used in the decoding process for computation of f[y][x] may use any method of integer approximation of the mathematical integer-number IDCT defined in Annex A, provided the approximation conforms to the accuracy requirements specified in Annex A.

4) Subclause 7.4.4 "Mismatch control"

In subclause 7.4.4, replace Note 2 which states as follows:

NOTE 2 – Warning – Small non-zero inputs to the IDCT may result in zero output for compliant IDCTs. If this occurs in an encoder, mismatch may occur in some pictures in a decoder that uses a different compliant IDCT. An encoder should avoid this problem and may do so by checking the output of its own IDCT. It should ensure that it never inserts any non-zero coefficients into the bitstream when the block in question reconstructs to zero through its own IDCT function. If this action is not taken by the encoder, situations can arise where large and very visible mismatches between the state of the encoder and decoder occur.

with the following:

NOTE 2 – Warning – Small non-zero inputs to the IDCT may result in all-zero output for some IDCT approximations that conform to the requirements specified in Annex A. If this occurs in an encoder, a mismatch may occur in decoders that use a different conforming IDCT approximation than the approximation used in modelling the decoding process within the encoder. An encoder should avoid this problem and may do so by checking the output of its own IDCT approximation. It should ensure that it never inserts any non-zero coefficients into the bitstream when the block in question reconstructs to zero through the encoder's own IDCT function approximation. If this action is not taken by the encoder, situations can arise where large and very visible mismatches between the state of the encoder and decoder occur.

5) Subclause 7.5 "Inverse DCT"

Replace subclause 7.5, which states as follows:

7.5 Inverse DCT

Once the DCT coefficients, F[v][u] are reconstructed, an IDCT transform that conforms to the specifications of Annex A shall be applied to obtain the inverse transformed values f[y][x].

with the following:

7.5 Inverse DCT

Once the DCT coefficients, F[v][u] are reconstructed, an IDCT function that conforms to the accuracy requirements specified in Annex A shall be applied to obtain the integer inverse transformed values f[y][x].

6) Subclause 7.6 "Motion compensation"

In subclause 7.6, third paragraph, make the following changes:

Replace the sentence stating "The saturation shown in Figure 7-5 is still required in order to remove negative values from f[y][x]" *with* "The saturation shown in Figure 7-5 is still required in order to remove negative values and values in excess of 255 (if present) from f[y][x]".

Insert the following additional paragraphs:

For establishing a requirement of bitstream conformance, for each macroblock in a P-picture, a prediction count increment value shall be derived as follows. If a macroblock in the current picture is skipped, its prediction count increment value shall be equal to 0. Otherwise, its prediction count increment value shall be equal to 1.

For establishing a requirement of bitstream conformance, for each macroblock in each I-picture and P-picture, a prediction count shall be derived as follows. If a macroblock is an intra coded macroblock, its prediction count shall be equal to 0. Otherwise, if the current picture is a field picture and the most recently reconstructed reference picture is also a field picture or if the current picture is a frame picture and the most recently reconstructed reference picture is also a frame picture, the prediction count for a macroblock in the current picture shall be equal to the prediction count increment value plus the value of the prediction count for the macroblock in the most recently reconstructed reference picture that corresponds to the position of the selected macroblock in the current picture. Otherwise, the prediction count for a macroblock in the current picture shall be equal to the prediction count increment value plus the maximum of the values of the two prediction counts for the two macroblocks in the area of the most recently reconstructed reference picture that corresponds to the position of the selected macroblock in the current picture.

It is a requirement of bitstream conformance that for each macroblock in a P-picture, the value of the resulting prediction count shall be less than 132.

7) Annex A "Inverse discrete transform"

Replace Annex A, which states as follows:

Annex A

Inverse discrete transform

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

The N × N two dimensional DCT is defined as:

$$F(u,v) = \frac{2}{N} C(u)C(v) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x,y) \cos\frac{(2x+1)u\pi}{2N} \cos\frac{(2y+1)v\pi}{2N}$$

with u, v, x, y = 0, 1, 2, ... N – 1

where x, y are spatial coordinates in the sample domain

u, v are coordinates in the transform domain

$$C(u), C(v) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for } u\ v = 0 \\ 1 & \text{otherwise} \end{cases}$$

The definition of the DCT (also called forward DCT) is purely informative. Forward DCT is not used by the decoding process described by this Specification.

The mathematical real-number IDCT is defined as:

$$f(x,y) = \frac{2}{N} \sum_{u=0}^{N-1} \sum_{v=0}^{N-1} C(u)C(v)F(u,v) \cos\frac{(2x+1)u\pi}{2N} \cos\frac{(2y+1)v\pi}{2N}$$

f (x, y) is a real number.

The mathematical integer-number IDCT is defined as:

$$f'(x, y) = \text{round}(f(x, y))$$

where round() is the rounding to the nearest integer, with half-integer values rounded away from zero. No clamping or saturation is performed.

The saturated mathematical integer-number IDCT is defined as:

$$f''(x, y) = \text{saturate}(f'(x, y))$$

where saturate() is the saturation in the range [–256, 255], defined as:

$$\text{saturate}(x) = \begin{cases} -256 & x < -256 \\ 255 & x > 255 \\ x & -256 \le x \le 255 \end{cases}$$

The IDCT function f[y][x] used in the decoding process may be any of several approximations of the saturated mathematical integer-number IDCT f "(x, y), provided that it meets all of the following requirements:

1) The IDCT function f[y][x] used in the decoding process shall have values always in the range [–256, 255].

2) The IDCT function f[y][x] used in the decoding process shall conform to the IEEE Standard Specification for the implementation of 8 by 8 Inverse Discrete Cosine Transform, IEEE Std. 1180-1990, 6 December 1990.

3) This item applies only when input blocks of DCT coefficients cause all the 64 values output of the mathematical integer-number IDCT f '(x, y) to be in the range [–384, 383]. When f '(x, y) > 256, f[y][x] shall be equal to 255 and when f '(x, y) < –257, f[y][x] shall be equal to –256. For all values of f '(x, y) in the range [–257, 256] the absolute difference between f[y][x] and f "(x, y) shall not be larger than 2.

4) Let F be the set of 4096 blocks Bi[y][x] (i = 0 … 4095) defined as follows:

   a) Bi[0][0] = i – 2048.

   b) Bi[7][7] = 1 if Bi[0][0] is even, Bi[7][7] = 0 if Bi[0][0] is odd.

   c) All other coefficients Bi[y][x] other than Bi[0][0] and Bi[7][7] are equal to 0.

   For each block Bi[y][x] that belongs to set F defined above, an IDCT that conforms to this specification (see Annex A) shall output a block f[y][x] that has a peak error of 1 or less compared to the reference saturated mathematical integer-number IDCT f "(x, y). In other words, | f[y][x] –f "(x, y) | shall be < = 1 for all x and y.

In addition to these requirements, the following is a recommendation on the accuracy of the IDCT function f[y][x].

5) When item 3) does not apply, i.e., for input blocks of DCT coefficients causing the output of the mathematical integer-number IDCT f '(x, y) to contain one or more values out of the range [–384, 383], it is desirable that f[y][x] be as close as possible to f "(x, y) for all bitstreams produced by reasonably well-designed encoders.

NOTE – Clause 2.3 IEEE Standard 1180-1990 "Considerations of Specifying IDCT Mismatch Errors" requires the specification of periodic intra-picture coding in order to control the accumulation of mismatch errors. Every macroblock is required to be refreshed before it is coded 132 times as predictive macroblocks. Macroblocks in B-pictures (and skipped macroblocks in P-pictures) are excluded from the counting because they do not lead to the accumulation of mismatch errors. This requirement is the same as indicated in 1180-1990 for visual telephony according to Recommendation H.261.

with the following.

Annex A

Inverse discrete cosine transform

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

The N × N two-dimensional mathematical real-number IDCT is defined as:

$$f(x, y) = \frac{2}{N}\sum_{u=0}^{N-1}\sum_{v=0}^{N-1} C(u)C(v)F(u,\ v)\cos\frac{(2x+1)u\pi}{2N}\cos\frac{(2y+1)v\pi}{2N}$$

with u, v, x, y = 0, 1, 2, … N – 1

where x, y are spatial coordinates in the sample domain

u, v are coordinates in the transform domain

f(x, y) and F(u, v) are real numbers for each pair of values (x, y) and (u, v)

π is Archimedes' constant 3,141 592 653 589 793 238 462 643 ...

$$C(u),\ C(v) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for u v} = 0 \\ 1 & \text{otherwise} \end{cases}$$

The N × N two-dimensional mathematical real-number DCT is defined as:

$$F(u,v) = \frac{2}{N} C(u)C(v) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x,y) \cos\frac{(2x+1)u\pi}{2N} \cos\frac{(2y+1)v\pi}{2N}$$

where x, y, u, v, f (x, y) and F(u, v) are defined as given above for the IDCT definition.

The definition of the DCT (also called forward DCT) is purely informative. The forward DCT is not used by the decoding process specified in this Recommendation | International Standard.

For purposes of this Recommendation | International Standard, the value of N shall be considered equal to 8.

The mathematical integer-number IDCT is defined as:

$$f'(x, y) = \text{round}(f(x, y))$$

with f(x, y) produced by the mathematical real-number IDCT as specified above for each value of x and y, where round() denotes rounding to the nearest integer, with half-integer values rounded away from zero. No clamping or saturation is performed.

The IDCT function used in the decoding process for computation of the integer values f[y][x] may use any method of integer approximation of the mathematical integer-number IDCT results f '(x, y), provided that it conforms to all requirements specified in ISO/IEC 23002-1 and its Annexes A and B and has sufficient precision so that significant errors do not occur in the final integer values.

NOTE – In addition to the above requirement, it is desirable that the integer output of the IDCT function f[y][x] used in the decoding process additionally produces output that is as close as feasible to the result of the mathematical integer-number IDCT f '(x, y) for input values causing one or more elements f '(x, y) of the output of the mathematical integer-number IDCT to somewhat exceed the range of [–384, 383].

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	**Audiovisual and multimedia systems**
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects and next-generation networks
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2006