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**Information technology — Digital
compression and coding of continuous-tone
still images: Requirements and guidelines**

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*Technologies de l'information — Compression numérique et codage des
images fixes de nature photographique: Prescriptions et lignes directrices*



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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 10918-1 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 the CCITT. The identical text is published as CCITT Recommendation T.81.

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, B, C, D, E, F, G, H and J form an integral part of this part of ISO/IEC 10918. Annexes K, L and M are for information only.

Patents

During the preparation of this part of ISO/IEC 10918, information was gathered on patents upon which application of the standard might depend. Relevant patents were identified as belonging to the patent holders listed in annex L. However, ISO/IEC cannot give authoritative or comprehensive information about evidence, validity or scope of patent and like rights. The patent holders have stated that licences will be granted under reasonable terms. Communications on this subject should be addressed to the patent holders (see annex L).

Introduction

This part of ISO/IEC 10918 was prepared by CCITT Study Group VIII and the Joint Photographic Experts Group (JPEG) of ISO/IEC JTC 1/SC 29/WG 10. This Experts Group was formed in 1986 to establish a standard for the sequential progressive encoding of continuous-tone grayscale and colour images.

This part of ISO/IEC 10918 sets out requirements and implementation guidelines for continuous-tone still image encoding and decoding processes, and for the coded representation of compressed image data for interchange between applications. 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. ISO/IEC 10918-2 sets out tests for determining whether implementations comply with the requirements for the various encoding and decoding processes specified in this part of ISO/IEC 10918.

The requirements which these processes must satisfy to be useful for specific image communications applications such as facsimile, Videotex and audiographic conferencing are defined in CCITT Recommendation T.80. The intent is that the generic processes of Recommendation T.80 will be incorporated into the various CCITT Recommendations for terminal equipment for these applications.

In addition to the applications addressed by the CCITT and ISO/IEC, the JPEG committee has developed a compression standard to meet the needs of other applications as well, including desktop publishing, graphic arts, medical imaging and scientific imaging.

This Specification aims to follow the guidelines of CCITT and ISO/IEC JTC 1 on *Rules for presentation of CCITT | ISO/IEC common text*.

INTERNATIONAL STANDARD

CCITT RECOMMENDATION

**INFORMATION TECHNOLOGY – DIGITAL COMPRESSION
AND CODING OF CONTINUOUS-TONE STILL IMAGES –
REQUIREMENTS AND GUIDELINES**

1 Scope

This CCITT Recommendation | International Standard is applicable to continuous-tone – grayscale or colour – digital still image data. It is applicable to a wide range of applications which require use of compressed images. It is not applicable to bi-level image data.

This Specification

- specifies processes for converting source image data to compressed image data;
- specifies processes for converting compressed image data to reconstructed image data;
- gives guidance on how to implement these processes in practice;
- specifies coded representations for compressed image data.

NOTE – This Specification does not specify a complete coded image representation. Such representations may include certain parameters, such as aspect ratio, component sample registration, and colour space designation, which are application-dependent.

2 Normative references

The following CCITT Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this CCITT 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 CCITT Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The CCITT Secretariat maintains a list of currently valid CCITT Recommendations.

- *CCITT Recommendation T.80 (1992), Common components for image compression and communication – Basic principles.*

3 Definitions, abbreviations and symbols**3.1 Definitions and abbreviations**

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

3.1.1 abbreviated format: A representation of compressed image data which is missing some or all of the table specifications required for decoding, or a representation of table-specification data without frame headers, scan headers, and entropy-coded segments.

3.1.2 AC coefficient: Any DCT coefficient for which the frequency is not zero in at least one dimension.

3.1.3 (adaptive) (binary) arithmetic decoding: An entropy decoding procedure which recovers the sequence of symbols from the sequence of bits produced by the arithmetic encoder.

3.1.4 (adaptive) (binary) arithmetic encoding: An entropy encoding procedure which codes by means of a recursive subdivision of the probability of the sequence of symbols coded up to that point.

3.1.5 application environment: The standards for data representation, communication, or storage which have been established for a particular application.

- 3.1.6 arithmetic decoder:** An embodiment of arithmetic decoding procedure.
- 3.1.7 arithmetic encoder:** An embodiment of arithmetic encoding procedure.
- 3.1.8 baseline (sequential):** A particular sequential DCT-based encoding and decoding process specified in this Specification, and which is required for all DCT-based decoding processes.
- 3.1.9 binary decision:** Choice between two alternatives.
- 3.1.10 bit stream:** Partially encoded or decoded sequence of bits comprising an entropy-coded segment.
- 3.1.11 block:** An 8×8 array of samples or an 8×8 array of DCT coefficient values of one component.
- 3.1.12 block-row:** A sequence of eight contiguous component lines which are partitioned into 8×8 blocks.
- 3.1.13 byte:** A group of 8 bits.
- 3.1.14 byte stuffing:** A procedure in which either the Huffman coder or the arithmetic coder inserts a zero byte into the entropy-coded segment following the generation of an encoded hexadecimal X'FF' byte.
- 3.1.15 carry bit:** A bit in the arithmetic encoder code register which is set if a carry-over in the code register overflows the eight bits reserved for the output byte.
- 3.1.16 ceiling function:** The mathematical procedure in which the greatest integer value of a real number is obtained by selecting the smallest integer value which is greater than or equal to the real number.
- 3.1.17 class (of coding process):** Lossy or lossless coding processes.
- 3.1.18 code register:** The arithmetic encoder register containing the least significant bits of the partially completed entropy-coded segment. Alternatively, the arithmetic decoder register containing the most significant bits of a partially decoded entropy-coded segment.
- 3.1.19 coder:** An embodiment of a coding process.
- 3.1.20 coding:** Encoding or decoding.
- 3.1.21 coding model:** A procedure used to convert input data into symbols to be coded.
- 3.1.22 (coding) process:** A general term for referring to an encoding process, a decoding process, or both.
- 3.1.23 colour image:** A continuous-tone image that has more than one component.
- 3.1.24 columns:** Samples per line in a component.
- 3.1.25 component:** One of the two-dimensional arrays which comprise an image.
- 3.1.26 compressed data:** Either compressed image data or table specification data or both.
- 3.1.27 compressed image data:** A coded representation of an image, as specified in this Specification.
- 3.1.28 compression:** Reduction in the number of bits used to represent source image data.
- 3.1.29 conditional exchange:** The interchange of MPS and LPS probability intervals whenever the size of the LPS interval is greater than the size of the MPS interval (in arithmetic coding).
- 3.1.30 (conditional) probability estimate:** The probability value assigned to the LPS by the probability estimation state machine (in arithmetic coding).
- 3.1.31 conditioning table:** The set of parameters which select one of the defined relationships between prior coding decisions and the conditional probability estimates used in arithmetic coding.
- 3.1.32 context:** The set of previously coded binary decisions which is used to create the index to the probability estimation state machine (in arithmetic coding).
- 3.1.33 continuous-tone image:** An image whose components have more than one bit per sample.
- 3.1.34 data unit:** An 8×8 block of samples of one component in DCT-based processes; a sample in lossless processes.

- 3.1.35 DC coefficient:** The DCT coefficient for which the frequency is zero in both dimensions.
- 3.1.36 DC prediction:** The procedure used by DCT-based encoders whereby the quantized DC coefficient from the previously encoded 8×8 block of the same component is subtracted from the current quantized DC coefficient.
- 3.1.37 (DCT) coefficient:** The amplitude of a specific cosine basis function – may refer to an original DCT coefficient, to a quantized DCT coefficient, or to a dequantized DCT coefficient.
- 3.1.38 decoder:** An embodiment of a decoding process.
- 3.1.39 decoding process:** A process which takes as its input compressed image data and outputs a continuous-tone image.
- 3.1.40 default conditioning:** The values defined for the arithmetic coding conditioning tables at the beginning of coding of an image.
- 3.1.41 dequantization:** The inverse procedure to quantization by which the decoder recovers a representation of the DCT coefficients.
- 3.1.42 differential component:** The difference between an input component derived from the source image and the corresponding reference component derived from the preceding frame for that component (in hierarchical mode coding).
- 3.1.43 differential frame:** A frame in a hierarchical process in which differential components are either encoded or decoded.
- 3.1.44 (digital) reconstructed image (data):** A continuous-tone image which is the output of any decoder defined in this Specification.
- 3.1.45 (digital) source image (data):** A continuous-tone image used as input to any encoder defined in this Specification.
- 3.1.46 (digital) (still) image:** A set of two-dimensional arrays of integer data.
- 3.1.47 discrete cosine transform; DCT:** Either the forward discrete cosine transform or the inverse discrete cosine transform.
- 3.1.48 downsampling (filter):** A procedure by which the spatial resolution of an image is reduced (in hierarchical mode coding).
- 3.1.49 encoder:** An embodiment of an encoding process.
- 3.1.50 encoding process:** A process which takes as its input a continuous-tone image and outputs compressed image data.
- 3.1.51 entropy-coded (data) segment:** An independently decodable sequence of entropy encoded bytes of compressed image data.
- 3.1.52 (entropy-coded segment) pointer:** The variable which points to the most recently placed (or fetched) byte in the entropy encoded segment.
- 3.1.53 entropy decoder:** An embodiment of an entropy decoding procedure.
- 3.1.54 entropy decoding:** A lossless procedure which recovers the sequence of symbols from the sequence of bits produced by the entropy encoder.
- 3.1.55 entropy encoder:** An embodiment of an entropy encoding procedure.
- 3.1.56 entropy encoding:** A lossless procedure which converts a sequence of input symbols into a sequence of bits such that the average number of bits per symbol approaches the entropy of the input symbols.
- 3.1.57 extended (DCT-based) process:** A descriptive term for DCT-based encoding and decoding processes in which additional capabilities are added to the baseline sequential process.
- 3.1.58 forward discrete cosine transform; FDCT:** A mathematical transformation using cosine basis functions which converts a block of samples into a corresponding block of original DCT coefficients.

- 3.1.59 frame:** A group of one or more scans (all using the same DCT-based or lossless process) through the data of one or more of the components in an image.
- 3.1.60 frame header:** A marker segment that contains a start-of-frame marker and associated frame parameters that are coded at the beginning of a frame.
- 3.1.61 frequency:** A two-dimensional index into the two-dimensional array of DCT coefficients.
- 3.1.62 (frequency) band:** A contiguous group of coefficients from the zig-zag sequence (in progressive mode coding).
- 3.1.63 full progression:** A process which uses both spectral selection and successive approximation (in progressive mode coding).
- 3.1.64 grayscale image:** A continuous-tone image that has only one component.
- 3.1.65 hierarchical:** A mode of operation for coding an image in which the first frame for a given component is followed by frames which code the differences between the source data and the reconstructed data from the previous frame for that component. Resolution changes are allowed between frames.
- 3.1.66 hierarchical decoder:** A sequence of decoder processes in which the first frame for each component is followed by frames which decode an array of differences for each component and adds it to the reconstructed data from the preceding frame for that component.
- 3.1.67 hierarchical encoder:** The mode of operation in which the first frame for each component is followed by frames which encode the array of differences between the source data and the reconstructed data from the preceding frame for that component.
- 3.1.68 horizontal sampling factor:** The relative number of horizontal data units of a particular component with respect to the number of horizontal data units in the other components.
- 3.1.69 Huffman decoder:** An embodiment of a Huffman decoding procedure.
- 3.1.70 Huffman decoding:** An entropy decoding procedure which recovers the symbol from each variable length code produced by the Huffman encoder.
- 3.1.71 Huffman encoder:** An embodiment of a Huffman encoding procedure.
- 3.1.72 Huffman encoding:** An entropy encoding procedure which assigns a variable length code to each input symbol.
- 3.1.73 Huffman table:** The set of variable length codes required in a Huffman encoder and Huffman decoder.
- 3.1.74 image data:** Either source image data or reconstructed image data.
- 3.1.75 interchange format:** The representation of compressed image data for exchange between application environments.
- 3.1.76 interleaved:** The descriptive term applied to the repetitive multiplexing of small groups of data units from each component in a scan in a specific order.
- 3.1.77 inverse discrete cosine transform; IDCT:** A mathematical transformation using cosine basis functions which converts a block of dequantized DCT coefficients into a corresponding block of samples.
- 3.1.78 Joint Photographic Experts Group; JPEG:** The informal name of the committee which created this Specification. The "joint" comes from the CCITT and ISO/IEC collaboration.
- 3.1.79 latent output:** Output of the arithmetic encoder which is held, pending resolution of carry-over (in arithmetic coding).
- 3.1.80 less probable symbol; LPS:** For a binary decision, the decision value which has the smaller probability.
- 3.1.81 level shift:** A procedure used by DCT-based encoders and decoders whereby each input sample is either converted from an unsigned representation to a two's complement representation or from a two's complement representation to an unsigned representation.

- 3.1.82 lossless:** A descriptive term for encoding and decoding processes and procedures in which the output of the decoding procedure(s) is identical to the input to the encoding procedure(s).
- 3.1.83 lossless coding:** The mode of operation which refers to any one of the coding processes defined in this Specification in which all of the procedures are lossless (see Annex H).
- 3.1.84 lossy:** A descriptive term for encoding and decoding processes which are not lossless.
- 3.1.85 marker:** A two-byte code in which the first byte is hexadecimal FF (X'FF') and the second byte is a value between 1 and hexadecimal FE (X'FE').
- 3.1.86 marker segment:** A marker and associated set of parameters.
- 3.1.87 MCU-row:** The smallest sequence of MCU which contains at least one line of samples or one block-row from every component in the scan.
- 3.1.88 minimum coded unit; MCU:** The smallest group of data units that is coded.
- 3.1.89 modes (of operation):** The four main categories of image coding processes defined in this Specification.
- 3.1.90 more probable symbol; MPS:** For a binary decision, the decision value which has the larger probability.
- 3.1.91 non-differential frame:** The first frame for any components in a hierarchical encoder or decoder. The components are encoded or decoded without subtraction from reference components. The term refers also to any frame in modes other than the hierarchical mode.
- 3.1.92 non-interleaved:** The descriptive term applied to the data unit processing sequence when the scan has only one component.
- 3.1.93 parameters:** Fixed length integers 4, 8 or 16 bits in length, used in the compressed data formats.
- 3.1.94 point transform:** Scaling of a sample or DCT coefficient.
- 3.1.95 precision:** Number of bits allocated to a particular sample or DCT coefficient.
- 3.1.96 predictor:** A linear combination of previously reconstructed values (in lossless mode coding).
- 3.1.97 probability estimation state machine:** An interlinked table of probability values and indices which is used to estimate the probability of the LPS (in arithmetic coding).
- 3.1.98 probability interval:** The probability of a particular sequence of binary decisions within the ordered set of all possible sequences (in arithmetic coding).
- 3.1.99 (probability) sub-interval:** A portion of a probability interval allocated to either of the two possible binary decision values (in arithmetic coding).
- 3.1.100 procedure:** A set of steps which accomplishes one of the tasks which comprise an encoding or decoding process.
- 3.1.101 process:** See coding process.
- 3.1.102 progressive (coding):** One of the DCT-based processes defined in this Specification in which each scan typically improves the quality of the reconstructed image.
- 3.1.103 progressive DCT-based:** The mode of operation which refers to any one of the processes defined in Annex G.
- 3.1.104 quantization table:** The set of 64 quantization values used to quantize the DCT coefficients.
- 3.1.105 quantization value:** An integer value used in the quantization procedure.
- 3.1.106 quantize:** The act of performing the quantization procedure for a DCT coefficient.
- 3.1.107 reference (reconstructed) component:** Reconstructed component data which is used in a subsequent frame of a hierarchical encoder or decoder process (in hierarchical mode coding).

- 3.1.108 renormalization:** The doubling of the probability interval and the code register value until the probability interval exceeds a fixed minimum value (in arithmetic coding).
- 3.1.109 restart interval:** The integer number of MCUs processed as an independent sequence within a scan.
- 3.1.110 restart marker:** The marker that separates two restart intervals in a scan.
- 3.1.111 run (length):** Number of consecutive symbols of the same value.
- 3.1.112 sample:** One element in the two-dimensional array which comprises a component.
- 3.1.113 sample-interleaved:** The descriptive term applied to the repetitive multiplexing of small groups of samples from each component in a scan in a specific order.
- 3.1.114 scan:** A single pass through the data for one or more of the components in an image.
- 3.1.115 scan header:** A marker segment that contains a start-of-scan marker and associated scan parameters that are coded at the beginning of a scan.
- 3.1.116 sequential (coding):** One of the lossless or DCT-based coding processes defined in this Specification in which each component of the image is encoded within a single scan.
- 3.1.117 sequential DCT-based:** The mode of operation which refers to any one of the processes defined in Annex F.
- 3.1.118 spectral selection:** A progressive coding process in which the zig-zag sequence is divided into bands of one or more contiguous coefficients, and each band is coded in one scan.
- 3.1.119 stack counter:** The count of X'FF' bytes which are held, pending resolution of carry-over in the arithmetic encoder.
- 3.1.120 statistical conditioning:** The selection, based on prior coding decisions, of one estimate out of a set of conditional probability estimates (in arithmetic coding).
- 3.1.121 statistical model:** The assignment of a particular conditional probability estimate to each of the binary arithmetic coding decisions.
- 3.1.122 statistics area:** The array of statistics bins required for a coding process which uses arithmetic coding.
- 3.1.123 statistics bin:** The storage location where an index is stored which identifies the value of the conditional probability estimate used for a particular arithmetic coding binary decision.
- 3.1.124 successive approximation:** A progressive coding process in which the coefficients are coded with reduced precision in the first scan, and precision is increased by one bit with each succeeding scan.
- 3.1.125 table specification data:** The coded representation from which the tables used in the encoder and decoder are generated and their destinations specified.
- 3.1.126 transcoder:** A procedure for converting compressed image data of one encoder process to compressed image data of another encoder process.
- 3.1.127 (uniform) quantization:** The procedure by which DCT coefficients are linearly scaled in order to achieve compression.
- 3.1.128 upsampling (filter):** A procedure by which the spatial resolution of an image is increased (in hierarchical mode coding).
- 3.1.129 vertical sampling factor:** The relative number of vertical data units of a particular component with respect to the number of vertical data units in the other components in the frame.
- 3.1.130 zero byte:** The X'00' byte.
- 3.1.131 zig-zag sequence:** A specific sequential ordering of the DCT coefficients from (approximately) lowest spatial frequency to highest.
- 3.1.132 3-sample predictor:** A linear combination of the three nearest neighbor reconstructed samples to the left and above (in lossless mode coding).

3.2 Symbols

The symbols used in this Specification are listed below.

A	probability interval
AC	AC DCT coefficient
AC _{ji}	AC coefficient predicted from DC values
A _h	successive approximation bit position, high
A _l	successive approximation bit position, low
A _{p_i}	<i>i</i> th 8-bit parameter in APP _n segment
APP _n	marker reserved for application segments
B	current byte in compressed data
B2	next byte in compressed data when B = X'FF'
BE	counter for buffered correction bits for Huffman coding in the successive approximation process
BITS	16-byte list containing number of Huffman codes of each length
BP	pointer to compressed data
BPST	pointer to byte before start of entropy-coded segment
BR	counter for buffered correction bits for Huffman coding in the successive approximation process
B _x	byte modified by a carry-over
C	value of bit stream in code register
C _i	component identifier for frame
C _u	horizontal frequency dependent scaling factor in DCT
C _v	vertical frequency dependent scaling factor in DCT
CE	conditional exchange
C-low	low order 16 bits of the arithmetic decoder code register
C _{m_i}	<i>i</i> th 8-bit parameter in COM segment
CNT	bit counter in NEXTBYTE procedure
CODE	Huffman code value
CODESIZE(V)	code size for symbol V
COM	comment marker
C _s	conditioning table value
C _{s_i}	component identifier for scan
CT	renormalization shift counter
C _x	high order 16 bits of arithmetic decoder code register
CX	conditional exchange
d _{ji}	data unit from horizontal position <i>i</i> , vertical position <i>j</i>
d _{ji^k}	d _{ji} for component <i>k</i>
D	decision decoded

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Da	in DC coding, the DC difference coded for the previous block from the same component; in lossless coding, the difference coded for the sample immediately to the left
DAC	define-arithmetic-coding-conditioning marker
Db	the difference coded for the sample immediately above
DC	DC DCT coefficient
DC _i	DC coefficient for <i>i</i> th block in component
DC _k	<i>k</i> th DC value used in prediction of AC coefficients
DHP	define hierarchical progression marker
DHT	define-Huffman-tables marker
DIFF	difference between quantized DC and prediction
DNL	define-number-of-lines marker
DQT	define-quantization-tables marker
DRI	define restart interval marker
E	exponent in magnitude category upper bound
EC	event counter
ECS	entropy-coded segment
ECS _i	<i>i</i> th entropy-coded segment
Eh	horizontal expansion parameter in EXP segment
EHUFCO	Huffman code table for encoder
EHUFSI	encoder table of Huffman code sizes
EOB	end-of-block for sequential; end-of-band for progressive
EOB _n	run length category for EOB runs
EOB _x	position of EOB in previous successive approximation scan
EOB ₀ , EOB ₁ , ..., EOB ₁₄	run length categories for EOB runs
EOI	end-of-image marker
Ev	vertical expansion parameter in EXP segment
EXP	expand reference components marker
FREQ(V)	frequency of occurrence of symbol V
H _i	horizontal sampling factor for <i>i</i> th component
H _{max}	largest horizontal sampling factor
HUFFCODE	list of Huffman codes corresponding to lengths in HUFFSIZE
HUFFSIZE	list of code lengths
HUFFVAL	list of values assigned to each Huffman code
i	subscript index
I	integer variable
Index(S)	index to probability estimation state machine table for context index S
j	subscript index
J	integer variable

JPG	marker reserved for JPEG extensions
JPG _n	marker reserved for JPEG extensions
k	subscript index
K	integer variable
Kmin	index of 1st AC coefficient in band (1 for sequential DCT)
Kx	conditioning parameter for AC arithmetic coding model
L	DC and lossless coding conditioning lower bound parameter
L _i	element in BITS list in DHT segment
L _i (t)	element in BITS list in the DHT segment for Huffman table t
La	length of parameters in APP _n segment
LASTK	largest value of K
Lc	length of parameters in COM segment
Ld	length of parameters in DNL segment
Le	length of parameters in EXP segment
Lf	length of frame header parameters
Lh	length of parameters in DHT segment
Lp	length of parameters in DAC segment
LPS	less probable symbol (in arithmetic coding)
Lq	length of parameters in DQT segment
Lr	length of parameters in DRI segment
Ls	length of scan header parameters
LSB	least significant bit
m	modulo 8 counter for RST _m marker
m _t	number of V _{i,j} parameters for Huffman table t
M	bit mask used in coding magnitude of V
Mn	n th statistics bin for coding magnitude bit pattern category
MAXCODE	table with maximum value of Huffman code for each code length
MCU	minimum coded unit
MCU _i	i th MCU
MCUR	number of MCU required to make up one MCU-row
MINCODE	table with minimum value of Huffman code for each code length
MPS	more probable symbol (in arithmetic coding)
MPS(S)	more probable symbol for context-index S
MSB	most significant bit
M2, M3, M4, ... , M15	designation of context-indices for coding of magnitude bits in the arithmetic coding models
n	integer variable
N	data unit counter for MCU coding
N/A	not applicable

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Nb	number of data units in MCU
Next_Index_LPS	new value of Index(S) after a LPS renormalization
Next_Index_MPS	new value of Index(S) after a MPS renormalization
Nf	number of components in frame
NL	number of lines defined in DNL segment
Ns	number of components in scan
OTHERS(V)	index to next symbol in chain
P	sample precision
Pq	quantizer precision parameter in DQT segment
Pq(t)	quantizer precision parameter in DQT segment for quantization table t
PRED	quantized DC coefficient from the most recently coded block of the component
Pt	point transform parameter
Px	calculated value of sample
Q _{ji}	quantizer value for coefficient AC _{ji}
Q _{vu}	quantization value for DCT coefficient S _{vu}
Q ₀₀	quantizer value for DC coefficient
QAC _{ji}	quantized AC coefficient predicted from DC values
QDC _k	kth quantized DC value used in prediction of AC coefficients
Qe	LPS probability estimate 10918-1:1994
Qe(S)	LPS probability estimate for context index S https://standards.iteh.ai/catalog/standards/sis/5c83e61e92a401fb706-7ea38aea991f/iso-iec-10918-1-1994
Qk	kth element of 64 quantization elements in DQT segment
r _{vu}	reconstructed image sample
R	length of run of zero amplitude AC coefficients
R _{vu}	dequantized DCT coefficient
Ra	reconstructed sample value
Rb	reconstructed sample value
Rc	reconstructed sample value
Rd	rounding in prediction calculation
RES	reserved markers
Ri	restart interval in DRI segment
RRRR	4-bit value of run length of zero AC coefficients
RS	composite value used in Huffman coding of AC coefficients
RST _m	restart marker number m
S _{yx}	reconstructed value from IDCT
S	context index
S _{vu}	DCT coefficient at horizontal frequency u, vertical frequency v

SC	context-index for coding of correction bit in successive approximation coding
Se	end of spectral selection band in zig-zag sequence
SE	context-index for coding of end-of-block or end-of-band
SI	Huffman code size
SIGN	1 if decoded sense of sign is negative and 0 if decoded sense of sign is positive
SIZE	length of a Huffman code
SLL	shift left logical operation
SLL α β	logical shift left of α by β bits
SN	context-index for coding of first magnitude category when V is negative
SOF ₀	baseline DCT process frame marker
SOF ₁	extended sequential DCT frame marker, Huffman coding
SOF ₂	progressive DCT frame marker, Huffman coding
SOF ₃	lossless process frame marker, Huffman coding
SOF ₅	differential sequential DCT frame marker, Huffman coding
SOF ₆	differential progressive DCT frame marker, Huffman coding
SOF ₇	differential lossless process frame marker, Huffman coding
SOF ₉	sequential DCT frame marker, arithmetic coding
SOF ₁₀	progressive DCT frame marker, arithmetic coding
SOF ₁₁	lossless process frame marker, arithmetic coding
SOF ₁₃	differential sequential DCT frame marker, arithmetic coding
SOF ₁₄	differential progressive DCT frame marker, arithmetic coding
SOF ₁₅	differential lossless process frame marker, arithmetic coding
SOI	start-of-image marker
SOS	start-of-scan marker
SP	context-index for coding of first magnitude category when V is positive
Sq _{vu}	quantized DCT coefficient
SRL	shift right logical operation
SRL α β	logical shift right of α by β bits
Ss	start of spectral selection band in zig-zag sequence
SS	context-index for coding of sign decision
SSSS	4-bit size category of DC difference or AC coefficient amplitude
ST	stack counter
Switch_MPS	parameter controlling inversion of sense of MPS
Sz	parameter used in coding magnitude of V
S0	context-index for coding of V = 0 decision
t	summation index for parameter limits computation
T	temporary variable