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TIFF-FX Extensions 1

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A version of this draft document is intended for submission to the RFC editor as a Proposed Standard for the Internet Community. Discussion and suggestions for improvement are requested.

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Abstract

This document is an Internet draft for extensions to TIFF-FX [RFC XXXX], extension set 1.

This draft describes extensions to RFC XXXX to enable new features or conditions to TIFF-FX. The features are described by a set of guidelines for all TIFF-FX extensions, and a set of 5 extension types which enable: increased resolutions and image widths, expanding Profile M from 3 layers to N layers, the use of shared data as a general mechanism for sharing data across images and pages, a binary profile for JBIG2 coding, and an extension to Profile M for JBIG2 and "colour tag" coding. These extensions do not required modification of existing TIFF-FX implementations.

Table of Contents

E1.1. Introduction

This document describes extensions to RFC XXXX [RFCXXXX], titled "File Format for Internet Fax", also known as TIFF-FX, to augment the features and capabilities for the data content and structure generated by the current suite of ITU-T Recommendations for Group 3 facsimile.

These Recommendations and the TIFF fields described here support the following new facsimile profile:

Profile T: TIFF-FX Extension 4: Black-and-White JBIG2 Extension - a JBIG2 profile for binary only T.88|ISO/IEC 14492 [T.88] coded data, built upon Profile M and the Shared Data extension to Profile M (TIFF-FX Extension 5).

and create new extensions for the following new features:

- TIFF-FX Extension 1 (E1): Resolution and ImageWidth Extensions - extends the resolutions and image widths available for all Profiles, with the exception of Profile S
- TIFF-FX Extension 2 (E2): N-Layer Profile M Extension - extends the 3-layer model into N layers
- TIFF-FX Extension 3 (E3): Shared Data Extension to Profile M - enables data to be shared among different images and pages; an enabler for compression gains by using JBIG2 encoding
- TIFF-FX Extension 5 (E5): JBIG2 Color Extension of Profile M - the binary and color extension to Profile M which enables JBIG2 coding using T.88 (JBIG2,binary) and T.45 [T.45] "Run-length Colour Encoding", required for colour tag extensions to JBIG2.

This extension specification of TIFF-FX for facsimile is known as TIFF-FX Extensions 1.

E1.1.1 Scope

This document defines extensions to RFC XXXX, titled "File Format for Internet Fax", known as TIFF-FX. These extensions add new functionality to the profiles of TIFF-FX, with the exception of Profile S, which is highly constrained. Most of these extensions can be independently used; although some extensions may rely on others.

Unless otherwise noted, the primary reference is [RFC XXXX] "File Format for Internet Fax" (TIFF-FX), which references the following as it's primary references: the current TIFF specification [TIFF], selected TIFF Technical Notes [TTN1, TTN2] and [T.30].

E1.1.2 Overview of this draft

This Section gives an overview of TIFF-FX Extensions 1. Section E1.2 describes the requirements and recommendations associated with all TIFF-FX extensions defined within this document.
Sections E1.3 through E1.7 describe the five new extensions. One extension is a new profile, Profile T, and is located in Section E1.4. This section also specifies the ITU-T compatible field values (image parameters) for Profile T.

Throughout this document, Profiles, and section numbers without an "E1" prefix, refer to [RFC XXXX].

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", " NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [REQ].

E1.2. TIFF Fields Required or Recommended for All TIFF-FX Extensions

E1.2.1. Required Fields

E1.2.1.1. GlobalParametersIFD Field

Status of the GlobalParametersIFD (GPIFD) is being changed from Recommended to Required, for all extensions. This change is based on the fact that more than one required extension, such as SharedData and TIFF-FXExtensions, have global file implications (i.e. apply across multiple pages or Primary IFDs), warranting their location within the GPIFD. Accommodation of these required fields within the GPIFD then requires change in status of the GPIFD to Required.

E1.2.1.1.1 Instructions

Remove the GlobalParametersIFD field from Section 2.2.4 "New TIFF fields recommended for fax profiles" and append the following revised definition to Sections 4.2.3, 5.2.3, 6.2.3, 7.2.3 and 8.2.3 "New Fields":

GlobalParametersIFD (400) IFD or LONG

The GlobalParametersIFD, defined in Section 2.2.4, is an IFD containing global parameters. It SHALL be present for all TIFF-FX extensions. This reflects a modification to the Section 2.2.4 definition where GlobalParametersIFD is defined as a Recommended field. The RFC XXXX GlobalParametersIFD definition is further modified in that it is permitted to contain fields that are NOT permitted in any other IFD. The new SharedData field is one such field that is not permitted in any other IFD, see the Shared Data Extension to Profile M below.

It is recommended that a TIFF writer place this field in the first IFD, where a TIFF reader would find it quickly. If a conflict exists between fields in the GlobalParametersIFD and in the image IFDs, then the data in the image IFD SHALL prevail.

E1.2.1.2. TIFF-FXExtensions Field

The TIFF-FXExtensions field is introduced to be an identification mechanism for all TIFF-FX extensions and SHALL be present when an extension is used. The extensions are identified by bit value assignment, accommodating use of more than one extensions at the same time. The TIFF-FXExtensions field SHALL be placed within the GlobalParametersIFD.

E1.2.1.2.1 Instructions

Add the TIFF-FXExtensions field to Sections 4.2.3, 5.2.3, 6.2.3,

7.2.3 and 8.2.3 "New Fields", as defined below:

TIFF-FXExtensions (407) LONG

Count = 1

[[The 407 tag value is subject to change]]

This field identifies the RFC XXXX extension(s) that apply. The field accommodates the need to continually enhance the functionality of TIFF-FX. This field SHALL only appear in the GlobalParametersIFD, it is NOT permitted in any other IFD. It is required and SHALL be present with use of any TIFF-FX extension.

A value of 1 in a bit location indicates the corresponding TIFF-FX Extension is used. More than one bit set to 1 means more than one TIFF-FX extension is used.

Current TIFF-FX Extensions:

Bit number	Extension number	Meaning
0	1	Resolution and ImageWidth Extensions If bit 0 is 1, then any of the X and YResolutions from 300 x 600 to 1200 x 1200 pixels per resolution unit, and the corresponding ImageWidths MAY be used.
1	2	N-Layer Profile M Extension If bit 1 is 1, then the provision for more than three MRC layers is used.
2	3	Shared Data Extension to Profile M If bit 2 is 1, then Profile M and Shared Data provisions are used.
3	4	Profile T - Black-and-White JBIG2 Extension If bit 3 is 1, then Black-and-White JBIG2 coding is used (i.e. Compression = 12, TIFF-FXExtensions bit 2 is set and bi-level constrained MRC model is applied).
4	5	JBIG2 Extension of Profile M If bit 4 is 1, JBIG2 is used for Mask layer coding and colour tags may be used for foreground layers (i.e. Compression = 12 and TIFF-FXExtensions bit 2 is set).

Default = 0, no extensions being used.

E1.2.2. Recommended Fields

E1.2.2.1. FaxProfile Field

The FaxProfile field is revised for two reasons: 1) acknowledge the new MultiProfiles field, specified below, and make provisions for association of the two fields. 2) update the current profile list to include the new Profile T, specified later in this document.

E1.2.2.1.1 Instructions

Replace the existing FaxProfile field in Section 2.2.4 "New TIFF fields recommended for fax profiles" with the following:

FaxProfile(402) = 0 - 7, 255. BYTE

The profile that applies to this file; a profile is a subset of the full set of permitted fields and field values of TIFF-FX and it's extensions.

This field is used to indicate the profile used within the file when only one profile is used. The MultiProfiles field is used when a TIFF-FX extension or more than one profile is used within the file. A FaxProfile value of 255 (X'FF') indicates that the MultiProfiles field is used.

The currently defined FaxProfile values associated with a profile are:

0: does not conform to a profile defined for TIFF for facsimile
1: minimal black & white lossless, Profile S
2: extended black & white lossless, Profile F
3: lossless JBIG black & white, Profile J
4: lossy color and grayscale, Profile C
5: lossless color and grayscale, Profile L
6: Mixed Raster Content, Profile M
7: lossy and lossless JBIG2 black & white, Profile T
255: MultiProfiles field, indicates the profiles and/or profile(s) plus extension(s) used in the file

E1.2.2.2. MultiProfiles Field

This field is used to indicate when extension(s) or two or more different profiles are used within a single file. RFC XXXX makes no statement with regard to the appropriateness of using encodings of two or more different profiles within a file. There is no question as to the value of such a provision. This is illustrated by an example where the first ten black-and-white text pages of a fifteen page document are processed using Profile F MMR (G4) encoding while the last five color pages are processed using Profile C JPEG encoding. The existing FaxProfile field is used within the file to signal one encoding profile. In response to requests received from implementors,

this extension introduces the MultiProfiles field, to be used when and extended profile or more than one profile is used within a file.

Files containing extension(s) or more that one profile SHOULD contain the MultiProfiles field, identifying the profiles or extension(s) present. When present, the MultiProfiles field SHALL reside within the GlobalParameterIFD. The number of profiles present within a file is ambiguous without the MultiProfiles or FaxProfile field. It is highly likely that readers of files without the MultiProfiles or FaxProfile will assume that only one profile is present, the profile that is consistent with the Compression type and other relevant values that are present within the first IFD. Such readers may experience difficulty if different Compression types and/or other relevant parameters are encountered in subsequent IFDs within the file.

E1.2.2.2.1 Instructions

a) Append the new MultiProfiles field, specified below, to Section 2.2.4 "New TIFF fields recommended for fax profiles" following the ModeNumber field:

MultiProfiles(406) LONG
Count = N
[[The 406 tag value is subject to change]]

The extended profile (i.e. profile plus extension) or more than one profiles that apply to this file; a profile is a subset of the full set of permitted fields and field values of TIFF for facsimile. This field is used when an extended profile or more than one profiles are used within the file. This field SHALL only be present when the FaxProfile field is absent or has a value of 255 (X'FF'). A value of 1 in more than one bit location indicates the Corresponding profiles or profile(s) plus extension(s) that are used. The currently defined bits are:

MultiProfiles[0]:
Bit 0: minimal black & white lossless, Profile S
Bit 1: extended black & white lossless, Profile F
Bit 2: lossless JBIG black & white, Profile J
Bit 3: lossy color and grayscale, Profile C
Bit 4: lossless color and grayscale, Profile L
Bit 5: Mixed Raster Content, Profile M
Bit 6: lossy and lossless JBIG2 black & white, Profile T
Bit 7: Extension 1 (E1), resolution and imagewidth extensions
Bit 8: Extension 2 (E2), N-Layer Profile M extension
Bit 9: Extension 3 (E3), shared data extension to Profile M
Bit 10: Extension 5 (E5), JBIG2 extension of Profile M
Bits 11-31: reserved for future use.

WARNING: Files containing extensions or more that one profile

"SHOULD" contain the MultiProfiles field, identifying the profiles

present. See the description from the second paragraph of Section E1.2.2.2.

NOTE: count (N) > 1 should be used to accommodate future expansion beyond 32 bits.

b) Append the new 4.5.7 "Multiple Profiles within a file" section, specified below, to Section 4.5 "Implementation Warnings" following Section 4.5.6:

4.5.7 Multiple Profiles within a file

Files containing more that one profile "SHOULD" contain the MultiProfiles field, identifying the profiles present. The number of profiles present within a file is ambiguous without the MultiProfiles or FaxProfile field. It is highly likely that readers of files without the MultiProfiles or FaxProfile will assume that only one profile is present, the profile that is consistent with the Compression type and other relevant values that are present within the first IFD. Such readers may experience difficulty if different Compression types and/or other relevant parameters are encountered in subsequent IFDs within the file.

E1.3. TIFF-FX Extension 1 (E1): Resolution and ImageWidth Extensions

The ITU-T has approved a new set of X and YResolutions, along with corresponding image widths (i.e. page widths). This extension makes provisions for using these extended resolutions.

The TIFF-FXExtensions field, below, SHALL be present when this extension is used.

TIFF-FXExtensions (407) bit 0 is 1 LONG
See Section E1.2.1.2.

E1.3.1 Instructions

a) Replace the 2nd sentence of Section 2.2.2 "Additional TIFF fields required for all fax profiles" XResolution field with the following:

The ITU-T Recommendations for facsimile specify a small number of horizontal resolutions: 100, 200, 300, 400, 600, 1200 pixels per inch, and 80, 160 pixels per centimeter (or 204, 408 pixels per inch).

b) Replace the 2nd sentence of Section 2.2.2 "Additional TIFF fields required for all fax profiles" YResolution field with the following:

The ITU-T Recommendations for facsimile specify a small number of vertical resolutions: 100, 200, 300, 400, 600, 800, 1200 pixels per inch, and 38.5, 77, 154 pixels per centimeter (or 98, 196, 391 pixels per inch).

c) Append the following five rows to the resolution table that follows the YResolution field in Section 2.2.2 "Additional TIFF fields required for all fax profiles":

300		600	
600		600	
400		800	
600		1200	
1200		1200	

d) Replace the ImageWidth field in Section 4.2.1. "Baseline fields" with the following:

ImageWidth(256) SHORT or LONG
RequiredByTIFFBaseline
This profile supports the following fixed page widths: 1728, 2592, 3456, 5184, 10368 (corresponding to North American Letter and Legal, ISO A4 paper sizes), 2048, 3072, 4096, 6144, 12288 (corresponding to ISO B4 paper size), and 2432, 3648, 4864, 7296, 14592 (corresponding to ISO A3 paper size).
No default; must be specified

NOTE: Historical TIFF-F did not include support for the following widths related to higher resolutions: 2592, 3072, 3648, 3456, 4096, 4864, 5184, 6144, 7296, 10368, 12288 and 14592. Historical TIFF-F documents also included the following values related to A5 and A6 widths: 816 and 1216. Per the most recent version of [T.4], A5 and A6 documents are no longer supported in Group 3 facsimile, so the related width values are now obsolete. See section 4.5.2 for more information on inch/metric equivalencies and other implementation details.

e) Replace the XResolution field in Section 4.2.1. "Baseline fields" with the following:

XResolution(282) = 200, 204, 300, 400, 408, 600, 1200 RATIONAL
RequiredByTIFFBaseline

The horizontal resolution of the image is expressed in pixels per

resolution unit. In pixels/inch, the allowed values are: 200, 204, 300, 400, 408, 600 and 1200. See Section 2.2.2 for inch-metric equivalency.
No default, must be specified

NOTE: The values of 200 and 408, 600 and 1200 have been added to the Historical TIFF-F values, for consistency with [T.30]. Some existing TIFF-F implementations may also support values of 80 pixels/cm, which is equivalent to 204 pixels per inch. See section 4.5.2 for information on implementation details.

f) Replace the YResolution field in Section 4.2.1. "Baseline fields" with the following:

YResolution(283) = 98, 100, 196, 200, 300, 391, 400, 600, 800 and 1200 RATIONAL

RequiredByTIFFBaseline
The vertical resolution of the image is expressed in pixels per resolution unit. In pixels/inch, the allowed values are: 98, 100, 196, 200, 300, 391, 400, 600, 800 and 1200 pixels/inch.
See Section 2.2.2 for inch-metric equivalency.
No default, must be specified

NOTE: The values of 100, 200, 391, 600, 800 and 1200 have been added to the historical TIFF-F values, for consistency with [T.30]. Some existing TIFF-F implementations may also support values of 77 and 38.5 (cm), which are equivalent to 196 and 98 pixels per inch respectively. See Section 4.5.2 for more information on implementation details.

NOTE: Not all combinations of XResolution, YResolution and ImageWidth are legal. The following table gives the legal combinations and corresponding paper size [T.30].

g) Replace the Resolution and ImageWidth table that follows YResolution in Section 4.2.1. "Baseline fields" with the following:

XResolution x YResolution	ImageWidth		
200x100, 204x98			
200x200, 204x196	1728	2048	2432
204x391			
300 x 300, 300 x 600	2592	3072	3648
408 x 391, 400 x 400	3456	4096	4864
400x800			

+---------------------------------+---------+--------+--------+

600 x 600, 600 x 1200	5184	6144	7296
1200 x 1200	10368	12288	14592
	Letter,A4 Legal	B4	A3
	Paper Size		

h) Replace the ImageWidth field in Section 6.2.1. "Baseline Fields" with the following:

ImageWidth(256). SHORT or LONG

This profile supports the following fixed page widths: 864, 1024, 1216, 1728, 2048, 2432, 2592, 3072, 3456, 3648, 4096, 4864, 5184, 6144, 7296, 10368, 12288, 14592.

i) Replace the XResolution and YResolution fields in Section 6.2.1. "Baseline Fields" with the following:

XResolution(282) = 100, 200, 300, 400, 600, 1200. RATIONAL
YResolution(283) = 100, 200, 300, 400, 600, 1200. RATIONAL

The resolution of the image is expressed in pixels per resolution unit. In pixels per inch, allowed XResolution values are: 100, 200, 300, 400, 600 and 1200. The base color fax profile requires the pixels to be square, hence YResolution SHALL equal XResolution. Base resolution is 200 pixels per inch and SHALL be supported by all implementations of this profile.

NOTE: The functional equivalence of inch-based and metric-based resolutions is maintained, per Annex E.6.5 in [T.4]. See table in Sec. 2.2.2.

NOTE: Not all combinations of XResolution, YResolution and ImageWidth are legal. The following table gives the legal combinations for inch-based resolutions and the corresponding paper sizes [T.30].

j) Replace the Resolution and ImageWidth table that follows YResolution in Section 6.2.1. "Baseline fields" with the following:

XResolution x YResolution	ImageWidth		
100 x 100	864	1024	1216
200 x 200	1728	2048	2432

300 x 300	2592	3072	3648
400 x 400	3456	4096	4864
600 x 600	5184	6144	7296
1200 x 1200	10368	12288	14592
	Letter,A4 Legal	B4	A3
	Paper Size		

k) Replace the XResolution and YResolution fields in Section 7.2.1. "Baseline Fields" with the following:

XResolution(282) = 100, 200, 300, 400, 600, 1200. RATIONAL
YResolution(283) = 100, 200, 300, 400, 600, 1200. RATIONAL

The resolution of the image is expressed in pixels per resolution unit. In pixels per inch, allowed XResolution values are: 100, 200, 300, 400, 600 and 1200. The lossless color fax profile requires the pixels to be square, hence YResolution SHALL equal XResolution. Base resolution is 200 pixels per inch.

E1.4. TIFF-FX Extension 2 (E2): N-Layer Profile M Extension

E1.4.1 Introduction

This section tracks [T.44] by defining the N-layer extension to the 3-layer Mixed Raster Content profile or Profile M of TIFF for facsimile. By applying the appropriate black-and-white, bi-level, constraints from Extension 4 (Section E1.6), the N-layer model and rules of this extension may also be applied to Profile T.

Often times, the contents of a page can be broken up into more components than a 3-layer representation would allow. For instance, a complex magazine article may do well to have:

- a low resolution background image, for a low variance picture. Let's say this is 100 dpi, and is color.
- a high resolution mask layer, for the large amount of text and lines. Let's say this is 400 dpi (and binary).
- a low resolution foreground image, for the text and line color. Let's say this is 100 dpi, and is color.
- several medium resolution, for the pictures that are scattered throughout the page. Let's say they are 200 dpi, and are

color. Of these, several may be odd shapes (non-rectangular), and would require a separate mask to select their regions.

Expanding the 3-layer MRC model to N-layers allows for greater complexity of a page content, with the same simplicity in the existing model.

This N-layer Profile M Extension is specified by defining specific modifications to the text of Profile M. As a result of the specification method, this extension should be read in conjunction with Profile M.

E1.4.2. Section 8.1. Overview

The objective is to change 3-layer to N-layer references.

2nd paragraph - replace the 3rd and 4th sentences with the following:

By itself, MRC does not define any new coding methods or resolutions. Instead it defines an N-layer (where N is a positive integer) image model for structuring and combining the scanned image data. The MRC N-layer model has been applied here using the TIFF format to yield a data structure which differs from [T.44] though it applies the same coding methods, uses the same compressed image data streams and is consistent with the TIFF principle of a single IFD per image.

E1.4.3. Section 8.1.1. MRC 3-layer model

The objective is to change 3-layer to N-layer references, specify the presence of multiple foreground and mask layers, distinguish role of Primary Mask relative to secondary mask layers and their interactions:

a) Title and 1st paragraph - replace the title and paragraph with the following:

8.1.1. MRC N-layer model

The N layers of the MRC model are Background (layer 1), Mask (even numbered layers such as 2, 4, 6,..., N-1, where N is odd) and Foreground (odd numbered layers such as 3, 5, 7,..., N, where N is odd) pairs. The Mask and Foreground layers occur in Mask and Foreground pairs (i.e. layers 2 & 3, 4 & 5, 6 & 7, ..., N-1 & N pairs, where N is odd). The odd numbered layers (Background and Foreground) are typically encoded with multi-level coders while the even numbered layers (Mask) are encoded with bi-level coders. Each layer may appear only once on a page and is coded independently of the other layers.

The final image is obtained by using the Mask layers to determine which of the Foreground layer pixels are rendered over the Background layer or composite of layers below the Mask. When the Mask layer pixel value is 1, the corresponding pixel from the corresponding Foreground layer is selected; when it is 0, the corresponding pixel from the Background layer or composite of layers below the Mask is selected.
Details are given in the Introduction of this section, and in Annex A of [T.44].

b) 4th paragraph - replace with the following:

Not all pages, and not all parts of a page, require 3 or more layers. If a page consists of only one layer, then that layer is the primary image whether it is a Background, Mask, or Foreground layer. If there is more than one layer, then the Primary Mask (layer 2) SHALL be one of the layers, in which case it is the primary image. In all cases, the primary image SHALL be page size.

c) 5th paragraph, 1st sentence - replace with the following:

MRC [T.44] allows a page to be transmitted as a series of stripes with each stripe consisting of 1, 2, 3 or N layers.

d) 6th paragraph - replace with the following:

Furthermore, color fax also requires the spatial resolutions of Background and Foreground images to be legal fax values that are also integer factors of the Primary Mask image resolution. For example, if the Primary Mask Layer resolution is 400 pixels per inch, then allowed resolutions for the Foreground, Background and secondary Mask (layers 4, 6, ..., N-1, where N is odd) layers are 100, 200 or 400 pixels per inch; if the Primary Mask is at 300 pixels per inch, then allowed values are 100 and 300. The Foreground, Background and secondary Mask layer resolutions can be set independent of each other.

E1.4.4. Section 8.1.2. A TIFF Representation for the MRC 3-layer model

The objective is to change 3-layer to N-layer references, specify multiple foreground and mask layers, define their IFD and SubIFD relationships and structural layout:

a) Title and 1st paragraph - replace the title and paragraph with the following:

8.1.2. A TIFF Representation for the MRC N-layer model

In the TIFF representation of the N-layer MRC model, each page is represented by a single IFD, called the Primary IFD. The nextIFD offset associated with a Primary IFD SHALL point to the Primary IFD of the next page. If the page consists of a single layer, then the Primary IFD represents that layer. If more than one layer is present, the Primary IFD represents the Primary Mask layer and the other layers are represented by a set of child IFDs that are referenced through the SubIFD extension field [TTN1] of the Primary IFD. To distinguish MRC-specific SubIFDs from other SubIFDs, the NewSubFileType field SHALL have Bit 4 ON, indicating an MRC-related IFD. A new ImageLayer field is also introduced that consists of two values that identify the layer (Background [layer 1], Mask [layer 2, 4, 6, ..., N-1, where N is odd], or Foreground [layer 3, 5, 7, ..., N, where N is odd]) and the order within the layer (first, second, ...image of the layer); see Section 8.2.3.

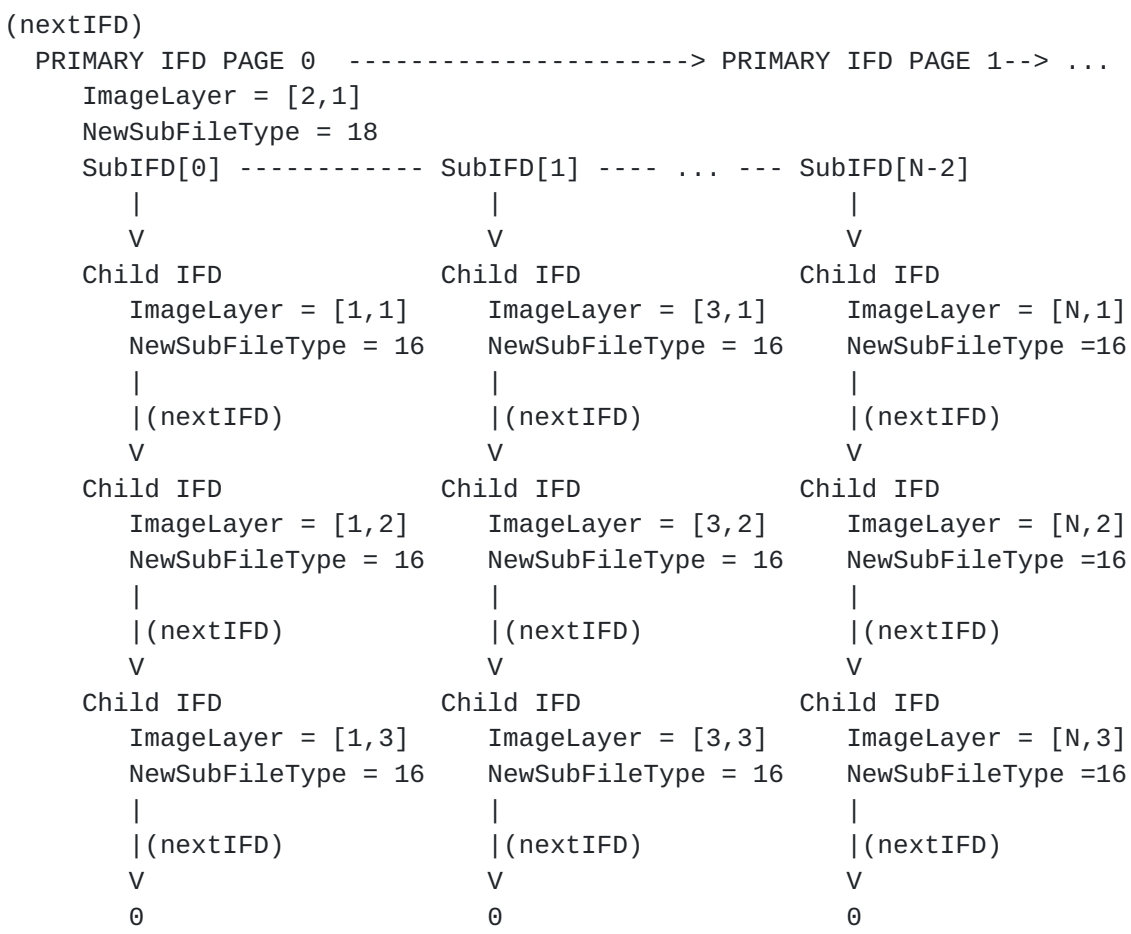
b) 5th paragraph, last sentence - replace the sentence with the following:

In all cases, if the Primary Mask layer exists, it SHALL be represented by a single IFD and a single set of coding parameters.

c) 6th paragraph, first 3 sentences - replace the sentences with the following:

The use of SubIFDs to store child IFDs is described in [TTN1]. When a Mask is the primary image, the Background and Foreground layer images are represented with child IFDs that are referenced by the SubIFDs field in the Primary IFD. There are many possible ways to represent the Background and Foreground layer images: (1) the SubIFD field of the Primary IFD is an array of pointers to all child image IFDs, one entry per child image; (2) the SubIFD field is a single pointer to a linked list of all child image IFDs; (3) the SubIFD field is an array of N-1 pointers, where the first pointer is to a linked list of all Background layer (layer 1) image IFDs, the second pointer is to a linked list of all the first Foreground layer (layer 3) image IFDs, the third pointer is to a linked list of all the second Mask layer (layer 4) IFDs, the N-1 pointer is to a linked list of all the Nth layer IFDs.

d) IFD - SubIFD tree diagram that follows the 6th paragraph - replace the tree diagram with the following:



e) Last paragraph, last sentence - replace the sentence with the following:

> If the image data is not ITU L*a*b*, the ImageBaseColor is interpreted as 8-bit ITU L*a*b*; see Section 8.2.3.

E1.4.5. Section 8.2.1. Baseline Fields

> The objective is to reflect presence of the multiple foreground and mask layers and the distinct Primary Mask layer in some fields and specify the impact of having no image data in the multiple mask and foreground layer pairs.

a) ImageWidth - replace with the following:

ImageWidth(256). SHORT or LONG

> Primary images define the page widths, which SHALL be limited to the same set of widths as defined in Profile C, the base color profile; see Section 6.2.1. In Profile M, the width of an image (i.e. Foreground, Background, or Mask layer) in the coded data stream may be less than the page width, unless the Background, Foreground or

Mask is the primary image (i.e. the Primary IFD), in which case the width of the coded data stream is the page width. The ImageWidth field SHALL always store the actual width of the coded data.

b) Compression - replace the first sentence with the following:

For Mask layers, see Sections 4.2.1 and 5.2.1

c) PhotometricInterpretation - replace with the following:

PhotometricInterpretation(262) = 0, 2, 5, 10. SHORT
For Mask layers, 0. For Foreground and Background layers, see Sections 6.2.1 and 7.2.1.

d) StripByteCounts - replace the field with the following:

StripByteCounts(279) SHORT or LONG
In Profile M, it is permissible for the StripByteCounts value for a given strip, other than one corresponding to a mask, to have a zero entry. This means there is no encoded image data corresponding to that strip. Instead, for the Foreground or Background layers the current default image color should be used for the strip. The standard default image colors are black for the Foreground layers and White for the Background layer. The ImageBaseColor field can be used to specify other default image colors, see 8.2.3.

e) YResolution - replace the last sentence with the following:

The resolution of Mask, Background and Foreground layers SHALL each be an integer factor of the Primary image, which is the Primary Mask layer, when it is present; see Section 8.4.

E1.4.6. Section 8.2.2. Extension Fields

The objective is to reflect presence of the multiple mask layers.

a) T6Options - replace the field with the following:

T6Options(293) = 0. SHORT
For Mask layers, see Section 4.2.2.

E1.4.7. Section 8.2.3. New Fields

The objective is to reflect presence of the multiple mask and foreground layers, their impact on the ImageLayer field and resulting extension of the ImageLayer[0] field values. The newly required TIFF-FXExtension field and minimal bit setting are specified.

a) T82Options - replace the field with the following:

T82Options(435) LONG
For Mask layers, see Section 5.2.3.

b) ImageLayer - replace the field, descriptive paragraph and ImageLayer[0]field with the following:

ImageLayer (34732). LONG
Count = 2
Image layers are defined such that layer 1 is the Background layer. Layers above layer 1 are arranged in mask (i.e. even numbered layers) and foreground (i.e. odd numbered layers) pairs. The mask selects pixels from the associated foreground that will be rendered on top of the Background or composite of layers below the mask. For example, layer 2 (i.e. the Primary Mask or first mask layer) selects pixels from layer 3 (i.e. the first foreground layer) that will be rendered on top of the Background. Layer 4 (i.e. the second mask layer) selects pixels from layer 5 (i.e. the second foreground layer) that will be rendered on top of the composite of layers 1through 3 below. The ImageLayer field contains two values, describing the layer to which the image belongs and the order in which it is imaged.

ImageLayer[0] = 1, 2, 3, ..., N.
1: Image is a Background image, i.e., the image that will appear whenever the Primary Mask contains a value of 0. Background images typically contain low-resolution, continuous-tone imagery.
2: Image is the Primary Mask layer. In MRC, if more than one layer is present then the Primary Mask layer (layer 2) is present, it SHALL be the Primary IFD and be full page in extent.
3: Image is the first Foreground image, i.e. the image that will be rendered on top of the lower layer (layer 1) whenever the Primary Mask contains a value of 1. The Foreground image generally defines the color of text or lines, but may also contain high-resolution imagery.
4: Image is the second Mask layer (layer 4).
5: Image is the second Foreground image (layer 5), i.e. the image that will be rendered on top of the composite of layers 1 through 3 below whenever the second Mask contains a value of 1.
N-1: If N is odd, then layer N-1 is the (N-1)/2-th Mask layer.
N: If N is odd, then layer N is the (N-1)/2-th Foreground image, i.e. the image that will be rendered on top of the composite of layers 1 through N-2 below whenever the (N-1)/2 Mask contains a value of 1.
If N is even, then layer N is the N/2-th Mask layer, which will
rendered as black on top of the composite layers of 1 through N-1, whenever the image contains a value of 1.

c) TIFF-FX extensions - append the following field at the end of the section:

TIFF-FXExtensions (407) bit 1 is 1 LONG
See Section E1.2.1.2.

E1.4.8. Section 8.4. Rules and Requirements for Images

The objective is to reflect presence and impact of the multiple mask and Foreground layers and the Primary IFD role in rules 1, 4, 8 and 9.

a) Replace the introductory sentence, along with rules 1, 4, 8 and 9 with the following:

Profile M defines a fundamental set of rules for images in the N-layer representation. These rules, with the appropriate black-and-white (bi-level) constraints, also apply to Profile T.

1. If more than one layer exists, then a binary Mask layer SHALL be present and the first mask layer SHALL be the primary image. Mask layers SHALL support the binary data representations defined in Section 3 and MAY support the binary data representations defined in Sections 4, 5 or E1.6. PhotometricInterpretation SHALL be set to "0". If only one layer exists, then the image corresponding to that layer is the primary image.

4. Images other than the Primary Image (i.e. Primary IFD) MAY optionally cover only a portion of the strip or page.

8. In MRC Internet Fax, each layer is transmitted as a sequence of strips. If the page consists of a single layer, then all strips SHALL be stored in the single Primary IFD. In this case, coding parameters SHALL NOT change between strips. If the page consists of more than one layer, then all strips of the Primary Mask layer SHALL be stored in the single Primary IFD. All strips of the Foreground/Background/secondary mask layers SHALL be stored in separate IFDs, referenced by the Primary IFD's SubIFD field, containing an ImageLayer field with ImageLayer[0] identifying Background (layer 1), Foreground layers (layer 3, 5, 7, ..., N, where N is odd) or mask layers (layer 2, 4, 6, ..., N-1, where N is odd), and Imagelayer[1] identifying order in which images within a single layer are to be imaged. The TIFF XPosition and Yposition fields are used to indicate the placement of these images with respect to the primary image.

9. When the Primary Mask image is present, the resolution of Background, Foreground and secondary mask images SHALL each be an integer factor of the Primary Mask image. For example, if the Primary Mask image is 400pixels/inch, then the Background, Foreground or secondary mask images may be at 400 pixels/inch (400/1), 200 pixels/inch (400/2) or 100 pixels/inch (400/4).

E1.4.9. Section 8.5. Profile M - MRC Fax Profile Summary

The objective is to identify the secondary mask layers as being among the data blocks pointed to by the SubIFD offsets, reflect the required status of the GlobalParametersIFD, append the required TIFF-FXExtensions field to the table and callout the need to activate the N-Layer Profile M Extension bit.

a) Revise the following Section 8.5 table entries to read as shown:

SubIFDs	<IFD>: byte offset to FG, BG, or secondary mask IFDs
GlobalParameters IFD**	IFD: global parameters IFD

b) Append the following to Section 8.5 table:

TIFF-FXExtensions **	n: extension(s) identification number, bit 1 for N-Layer Profile M Extension SHALL be among the set bits

E1.5. TIFF-FX Extension 3 (E3): Shared Data Extension to Profile M

This section defines the Shared Data extension to Profile M. Shared Data accommodate a single representation of reusable resources, such as image data or encoding tables, that appear or are used multiple times within a file. Most importantly, it provides a mechanism for access to the redundant resources by multiple components (i.e. sharing) within the encoding process. The sharing of resources is a new encoding provision defined in ITU-T Rec. T.44 Annex B [T.44Amd1]. Use of Shared Data is restricted to the MRC structure defined in Profile M or M with N layers, as defined in this document. Rational for Shared Data in Profile M only is traceable to T.44 Annex B [T.44Amd1].

E1.5.1. Overview

Many pages and/or documents have repeating components such as shapes or symbols, words, images and meta-data (i.e. Huffman Tables). This is especially true for images of text, where the repeating shapes are the characters themselves. The SharedData field is

defined below to leverage the redundancy of these repeating components by storing each component once, and then referring to each stored component as many times as possible. Reference to a resource must be made with an explicit and unique reference to the Shared Data, from within the data stream that uses it (the referencing data stream).

E1.5.2. Required TIFF Fields

This section describes the TIFF fields required, in addition to those in Section 8.2, to represent Shared Data.

E1.5.2.1. Baseline Fields

See Section 8.2.1.

E1.5.2.2. Extension Fields

See Section 8.2.2.

E1.5.2.3. New Fields

Append the following to the fields of 8.2.3:

GlobalParametersIFD (400) IFD or LONG
See Section E1.2.1

TIFF-FXExtensions (407) bit 2 SHALL be 1 LONG
See Section E1.2.1

SharedData (437) LONG
[[The 437 tag value is subject to change]]
See Section E1.5.4.

E1.5.3. Recommended TIFF Fields

See Sections 8.3, with exception of GlobalParametersIFD.

E1.5.4 Shared Data

The following new field is defined:

SharedData (437) LONG
Count = 1
[[The 437 tag value is subject to change]]

The SharedData field contains the file offset (E), in bytes, from the beginning of the file of the first Shared Data Table. Each Shared Data Table contains a count of the number of Shared Data Entries that physically exist in the table (whether filled with a shared data or not) , the Shared Data Entries themselves, and the file location of

the next Shared Data Table (if any).

There can be as many Shared Data Tables as necessary to describe the number of shared data items, but there SHALL be only one SharedData field in a file, and it SHALL be in the GlobalParametersIFD (recommended to be in the first IFD in the file). The SharedData field is required when sharing data and SHALL be present. A SharedData value of zero "0" means that there are no Shared Data Tables present and that no data is currently being shared.

Each Shared Data Table consists of a 2-byte count of the number of physical entries, a sequence of 16-byte shared data entries, and a 4-byte offset to the next Shared Data Table. The last shared data table has a "next table file offset" of 0.

NOTE: In all the tables shown below, all multi-byte quantities are written/read in the endianness convention established by the TIFF file ("II" or "MM").

Shared Data Table

Bytes	Byte offsets	Type	Description
2	E - E+1	SHORT	Items in table - (i) The number of shared data entries that are physically in this table, whether populated (non-zero byte entries) or not.
16	E+2 - E+17	-	Item 1 - First shared data entry.
16	E+18 - E+33	-	Item 2 - Second shared data entry.
. . .	. . . Etc.	-	Item i - i-th item entry. (i determined by "items in table" value above.)
4	N - N+3	LONG	Next table file offset: 4-byte file offset, in bytes from beginning of file, of the next Shared Data Table. Where i = shared data entries in this table (see "items in table", above), and each shared data item entry is 16 bytes, N = E+2+16*i.

Shared Data Entries

Bytes	Byte offsets	Type	Description
4	Y - Y+3	LONG	Shared Data bytes - Size of the shared data data block, in bytes.
4	Y+4 - Y+7	LONG	Shared Data file offset - File offset of this shared data data block, in bytes, from beginning of file.
2	Y+8 - Y+9	SHORT	SharedDataType - The type of data being represented as a shared data. The table below contains the type of shared data currently defined.
2	Y+10 - Y+11	SHORT	Last page used - The page (primary IFD) ordinal (1, 2, ...) of the last page that references this shared data. A value of 0 indicates that the last page to use the shared data is not known. The page ordinal SHOULD be based on the order within the primary IFD chain.
4	Y+12 - Y+15	LONG	SharedDataMemory - the number of bytes required by the referencing data stream to hold this shared data. If the shared data is encoded then the memory required SHOULD be consistent with the decoded form of the shared data. A value of 0 indicates that the SharedDataMemory is not known, or this field is not applicable. When defining a shared data and SharedDataMemory is applicable, a formula for computing the SharedDataMemory SHALL be given within the definition of the referencing data stream. An example of such a formula may be found in Section E1.6.4.2 for JBIG2.

Current SharedDataTypes:

SharedDataType Value	Description
0	undefined
1	JBIG2 Shared Data (i.e. JBIG2 symbol dictionaries, pattern dictionaries, Huffman tables, etc)

Shared Data ID:

The reference to a shared data entry SHALL be by a unique ID, which SHALL be the offset of the entry in the list described by the Shared Data Tables; the first shared data entry SHALL have ID 0. Note that the "list" of shared data entries is what the series of Shared Data Tables SHALL contain, when collected together. The order of the shared data tables SHALL determine the order of the shared data IDs. For example, if the first three tables (A, B and C) have 3, 1 and 2 shared data respectively; then table A will contain shared data with IDs 0, 1, and 2; table B will contain the shared data with ID 3; and table C will contain shared data with IDs 4 and 5. Note that if copying shared data from one file to another, the shared data ID will likely need revision to be brought in alignment with the destination table; additionally, any copied data that refers to the copied shared data will require a change in the reference to the new ID.

E1.5.4.1 SharedDataList

The data stream that requires inclusion of one or more Shared Data (i.e. the reference data stream) may include a list of IDs in a SharedDataList. For instance, an image strip that requires a shared data in order to be a complete compressed data stream, will include a SharedDataList. It is up to the interpretation of the reference data type (i.e. Compression type) as to how the shared data will be used.

A SharedDataList, located at file offset P, in bytes, from the beginning of the file, SHALL contain a 2-byte count of the number of IDs (i) in the list, followed by i 4-byte IDs.

SharedDataList Structure

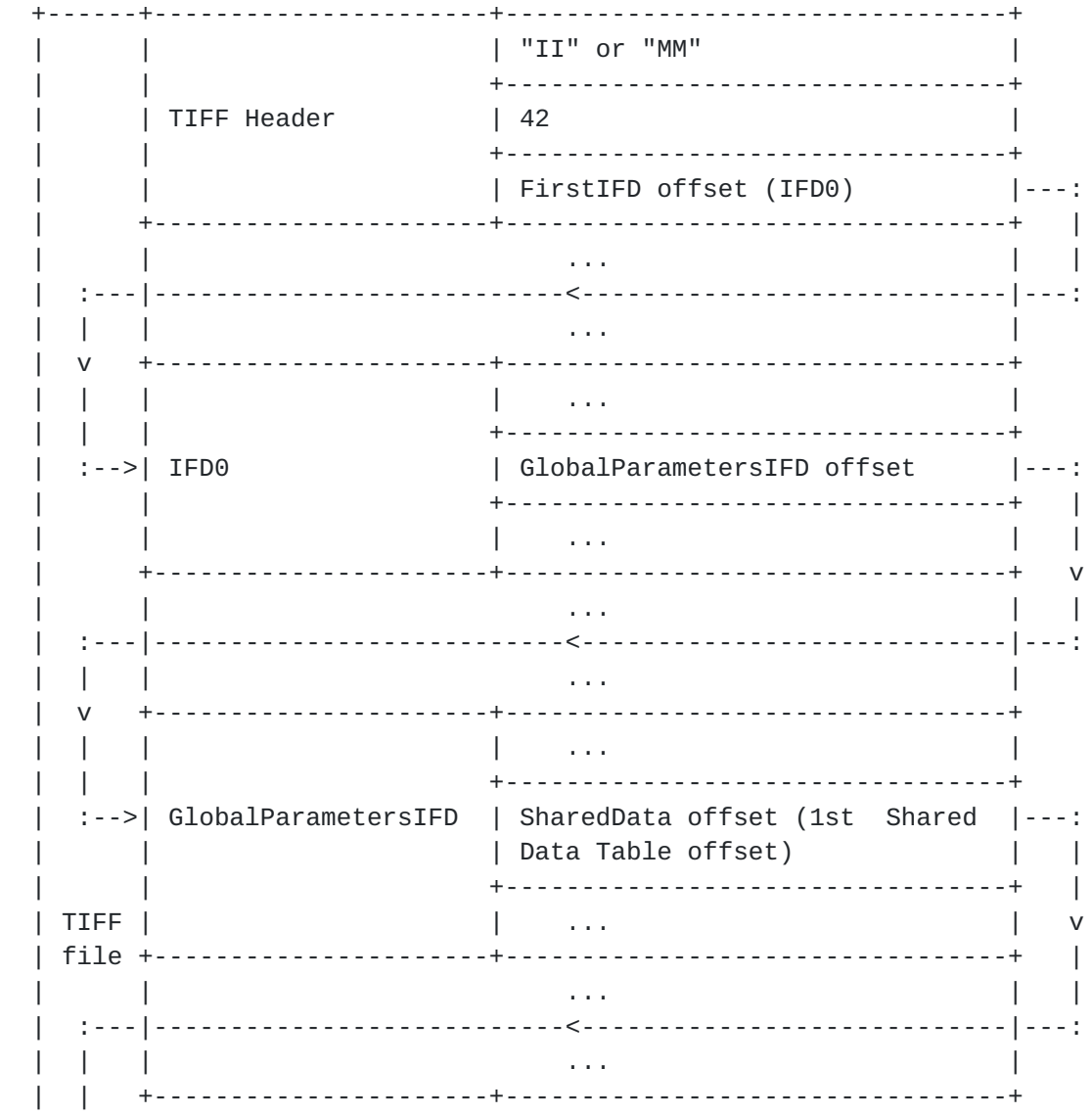
Bytes	Byte offsets	Type	Description
2	P - P+1	SHORT	The number of shared data IDs (i)
4	P+2 - P+5	LONG	First shared data ID

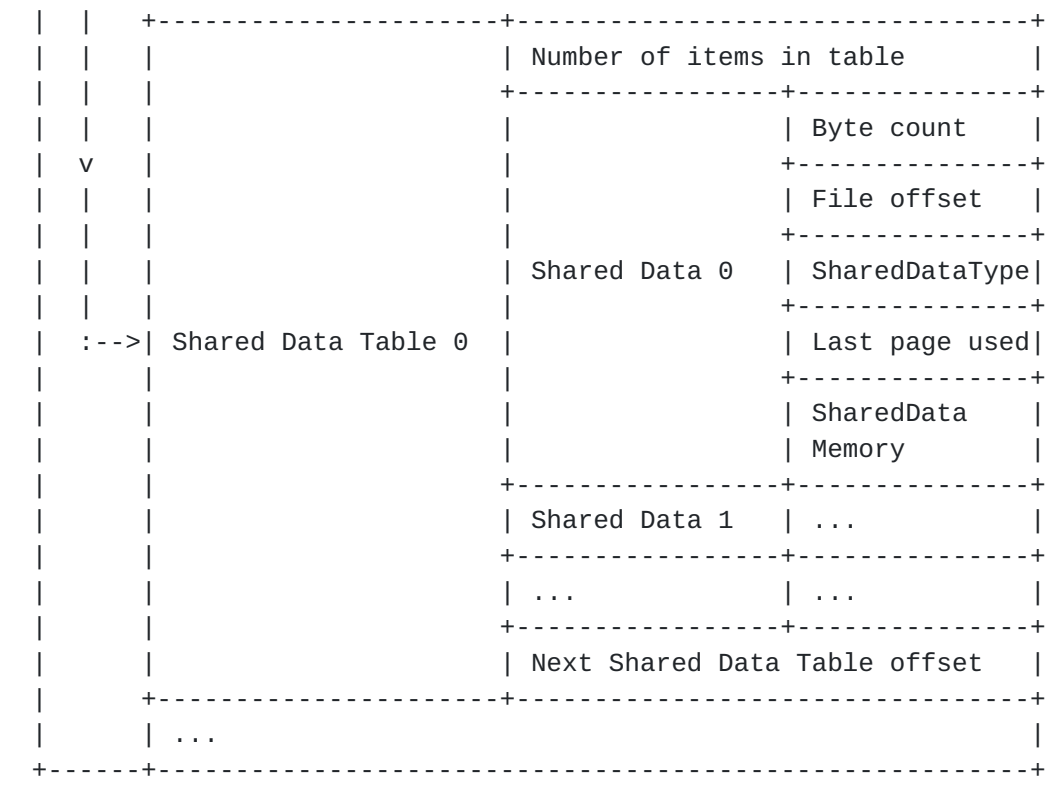
+-----+---------------+-----+--+

4	...	LONG	...
4	P+2+(i-1)*4 - P+5+(i-1)*4	LONG	i-th shared data ID

E1.5.4.2 Representation of Shared Data in TIFF

The representation of Shared Data in a TIFF file is shown below:





E1.6. TIFF-FX Extension 4 (E4): Profile T - Lossy and Lossless JBIG2 Black-and-White Fax profile

This section defines the lossy and lossless JBIG2 black-and-white profile or Profile T of TIFF for facsimile. JBIG2, ITU-T Rec. T.88 / ISO-IEC 14492 [T.88], is frequently referenced as symbol or token-based compression because it makes use of repeating shapes. The Profile T designation is representative of the term token-based compression. It must be noted that there are modes of JBIG2 that do not make use of repeating shapes, such as generic region coding. All profile T readers and writers SHALL also be able to read and write Profile S, since Profile S is the minimal binary TIFF-FX profile.

E1.6.1. Overview

This section describes a black-and-white profile that uses JBIG2 compression. The ITU-T has approved the lossy and lossless modes of JBIG2 for Group 3 facsimile. JBIG2 compression is typically used in accordance with the application rules given in ITU-T Rec. T.89 [T.89].

This profile is essentially a JBIG2 encoded black-and-white constrained profile of Profile M plus the Profile M Shared Data

extension. The MRC 3-layer model and TIFF representation, defined in

Section 8.1 and constrained to a single image layer (i.e. only one layer with image data), SHALL be used.

The behavior and structure of this profile is that of a plain single-layer image, similar to that of Profiles S, F and J, with some added structure to accommodate JBIG2's meta-data. Within this context, bit 4 of the NewSubFileType field SHALL be set, indicating the MRC imaging model with multiple layers. It must be noted, however, that the SubIFDs SHOULD consist of only even-numbered layers. In other words, only even-numbered values of the ImageLayer[0] field, representing mask layers, SHOULD be present. Additionally the SharedData field SHALL be used to store JBIG2 Shared Data, such as symbol or pattern dictionaries, and the Compression type SHALL be set to 12 (JBIG2 Compression). These requirements are consistent with ITU-T's definitions in Rec. T.4 Annex H [T.4Amd1] and Rec. T.44 Annex B [T.44 Ammd1].

JBIG2 compression utilizes the fact that many images have repeating shapes or symbols. This is especially true for images of text, where the repeating shapes are the characters themselves. Symbol or token-based compression makes use of these repeating shapes, by storing a set of images for the symbols once, and then referring to the symbol images as many times as possible.

In a multi-page document, the same shape can occur on multiple pages. In fact, this is quite common: any shape occurring on the first page, is likely to show up on other pages as well. JBIG2 compression is improved by collecting all the repeating shapes from multiple pages, and allowing this collection to be referred to by more than one page. This collection of symbol images is referred to as a symbol dictionary. A document can contain more than one symbol dictionary. For example, one symbol dictionary might contain all the symbols that occurred on more than one page; each page then might have its own symbol dictionary, containing all the symbols that occurred only on that page.

There are two typical ways of compressing symbols on a page using (or generating) a symbol dictionary. One is by finding an exact match (lossless), and the other is by allowing a small amount of discrepancy between the symbol candidate, and the matching symbol in the symbol dictionary (lossy). The mode used can be distinguished by the value of the "Lossless" bit in the T88Options[0] field, which is defined below.

The representation of a symbol-compressed image consists of a shared data list, which identifies which "JBIG2 Shared Data" are used, and a "JBIG2-coded position block". A JBIG2 Shared Data is used to represent a variety of JBIG2 shared entities (i.e. JBIG2 resources)

such as symbol dictionaries, pattern dictionaries, which are used in

halftone coding, and Huffman tables. The symbol dictionaries are typically contained within one or more JBIG2 Shared Data, represented within the Shared Data provisions of the Shared Data Extension of Profile M. The JBIG2-coded position block consists of a series of symbol X and Y-Position coordinates, plus the IDs of the symbols located by the coordinates. The symbol bitmaps are stored in the referenced symbol dictionaries.

Each TIFF strip in an IFD whose Compression is equal to 12 (the TIFF Compression value defined for JBIG2 below) SHALL be formatted as described in Section E1.6.5 (The JBIG2 Image Strip).

E1.6.1.1 Why Use JBIG2

The symbol-based compression model is incorporated in the JBIG2 standard. This standard boosts compression of text-like documents by retaining similar shapes across multiple images. In the case of text, the shapes are the character symbols, and for multi-page documents, the set of unique character symbols may be fairly small, especially when the same font is used on each page.

A typical image of binary text, at 300 dpi might take about 80 kilobytes to store using T.6 compression; a similar JBIG2 file might only require around 20 kilobytes to store. The compression gain can be up to a factor of two for multi-page files. Sharing dictionaries between multiple pages makes this high compression possible, but requires some way to refer to the dictionaries used by more than one page. This is the reason for using Profile M and its Shared Data provisions.

E1.6.2. Required TIFF Fields

This section describes the TIFF fields required, in addition to those in Sections 8.2 and E1.5.2, for Profile T. Additionally it describes those not required in Section 8.2 and constrained differently from those in Section 8.2.

Note that these fields are defined under the premise that all odd-numbered layers are omitted, in conformance to the Profile T black-and-white constraint. However, there are application conditions that could benefit from inclusion of these odd-numbered layers and setting the associated StripByteCounts to 0. This may be true when an application wishes to represent a reverse video image (i.e. a white image on a black background). Under these conditions the list of required fields and/or values will be modified per the StripByteCounts field below.

E1.6.2.1. Baseline Fields

ImageWidth(256). SHORT or LONG
Same page widths as Profile F, the extended black-and-white profile, and the ImageWidth extensions available to Profile F; see Section 4.2.1 and E1.3.
The change in ImageWidth reference, to those of Profile F rather than Profile C, is consistent with the black-and-white constraint of this profile.
Note that for layers other than layer 2, the ImageWidth could be a fragment of the page width, as when the XPosition is greater than 0.

BitsPerSample (258) = 1. SHORT
Constraint is consistent with the black-and-white constraint.

SamplesPerPixel (277) = 1. SHORT
Constraint is consistent with the black-and-white constraint.

Compression(259) = 12. SHORT
[[The compression value of 12 is subject to change]]

12 = JBIG2 coding, ITU-T Rec. T.88 / ISO-IEC 14492 (Lossy/Lossless coding of Bi-level Images, frequently referenced as symbol-based compression), T88Options field may be present when using JBIG2.
The format of the data pointed to by the StripByteOffsets when Compresstion=12 is described later.

FillOrder (266) = 1, 2. SHORT
See Section 8.2.1

PhotometricInterpretation(262) = 0. SHORT
The '0' constraint is consistent with the black-and-white constraint of Section E1.6.1 and the MRC mask layer PhotometricInterpretation constraint defined in Section 8.2.1.

ResolutionUnit (296) = 2. SHORT
See Section 8.2.1.

StripByteCounts(279) SHORT or LONG
In the event that SubIFDs consists of odd-numbered layers, then the value of the StripByteCounts for all odd-numbered values of the ImageLayer[0] field SHALL be fixed to zero "0". In Profile M, it is permissible for the StripByteCounts value for a given odd-numbered layer strip to have a zero entry. This means there is no encoded image data corresponding to that strip. Instead, the current default image color should be used for the strip. The standard default image colors are white for the Background layer and black for the Foreground layer(s).

It would be efficient to omit all odd numbered layers for Profile T. However, it may be useful to identify portions of a background and/or foreground image where the default color should be reversed; namely where a background image portion is all black, or where reverse video appears.

To define a child IFD specifying an odd-numbered layer (i.e. foreground or background) but containing no encoded image data, create an IFD with the following settings:

ImageLayer[0]:	specified odd numbered layer
ImageLayer[1]:	specified order
RowsPerStrip:	strip height
ImageLength:	image height
ImageWidth:	specified value, often the Primary IFD width
BitsPerSample:	8
PhotometricInterpretation:	10
SamplesPerPixel:	3
Compression:	1 (none)
XPosition:	specified value, frequently 0
YPosition:	specified value, frequently to top of strip
XResolution:	that of the Primary IFD
YResolution:	that of the Primary IFD
StripByteCounts:	single 0 value
StripOffsets:	single 0 entry
NewSubFileType:	bit 4 set to 1 (MRC)
ImageBaseColor:	default is white and black for background and foreground layers respectively, the reverse may be specified, no other colors SHALL be specified

XResolution(282) RATIONAL

Same XResolution as Profile F, the extended black-and-white profile, and the XResolution extensions available to Profile F; see Section 4.2.1 and E1.3.

The change in XResolution reference, to those of Profile F rather than Profile M, is consistent with the black-and-white constraint of this profile.

YResolution(283) RATIONAL

Same YResolution as Profile F, the extended black-and-white profile, and the YResolution extensions available to Profile F; see Section 4.2.1 and E1.3.

The change in YResolution reference, to those of Profile F rather than Profile M, is consistent with the black-and-white constraint of this profile.

Note that unlike Profile M, Profile F and Profile T may both have non-square resolutions (i.e. different X and YResolution values).

E1.6.2.2. Extension Fields

These fields SHALL NOT be present:
ChromaSubSampling(530)
ChromaPositioning(531)
Indexed(346)
T4Options(292)
T6Options(293)

These fields are as described in Section 8.2.2:
SubIFDs(330).
XPosition(286).
YPosition(287).

E1.6.2.3. New Fields

These Section 8.2.3 fields SHALL NOT be present:
Decode(433).
T82Options(435)

This Section 8.2.3 field SHOULD NOT be present:
ImageBaseColor(434). The field SHOULD be omitted and the default color of black and white SHALL be applied to foreground and background layers respectively. When present, the default Background or Foreground colors are typicallytypicallyty revised to black or white respectively, see StripByteCounts above.

These fields, described in Section 8.2.3 SHALL be present:
StripRowCounts(559).
ImageLayer (34732).

The fields described in E1.5.2.3 SHALL be present.
GlobalParametersIFD (400)
SharedData (437)
TIFF-FXExtensions (407)
Bits 2 and 3 of the TIFF-FXExtensions field SHALL be set to 1.

E1.6.3. Recommended TIFF Fields

See Sections 8.3, with exception of GlobalParametersIFD and append the Following:

T88Options (436). LONG
Count = 1 or 2
[[The 436 tag value is subject to change]]

The T88Options field contains one or two values, describing options applied to the encoded data stream and any application profile to which the encoded data stream may conform. It SHALL only be present when the IFD's Compression field is equal to 12 (JBIG2). The content provides an aid to TIFF readers, in that they describe JBIG2 options that may or may not be handled by a specific JBIG2 decoder. None of the values in the field are required for correct decoding, and the field may be ignored. In the event that this field is omitted, a reader SHALL assume that the data stream is encoded per the ITU-T T.89 Base profile (i.e. profile identification number 0x00000101), see T88Options[1] below.

T88Options[0] = 1, 2, ..., 7.
This value represents options that are being applied to the encoded data stream.

NOTE: In all the tables shown below, all multi-byte quantities are written/read in the endianness convention established by the TIFF file ("II" or "MM").

The following options are defined:

Bit number	Meaning
0	HuffmanCodingNotPresent If bit 0 is 1, then the JBIG2-compressed data in this IFD SHALL NOT use Huffman or MMR (T.6) coding.
1	ArithmeticCodingPresent If bit 1 is 1, then the JBIG2-compressed data in this IFD MAY contain segments that contain arithmetic (MQ) coding.
2	Lossless If bit 2 is 1, then the JBIG2-compressed data in this IFD SHALL be a lossless representation of the original image.
3	SingleStriped If bit 3 is 1, then each TIFF strip SHALL contain a JBIG2 Position Block that has only one JBIG2 stripe (not the same as a TIFF strip). Note: There is a limit of 32767 lines per JBIG2 stripe in the event that multi-stripe mode is used.

	4	TextStripesMixed If bit 4 is 1, then some JBIG2-compressed stripes that have text region segment(s) MAY also have region segments with other data types (e.g. generic or halftone region segment).
	5	ColourTagsFollow If bit 5 is 1, then this IFD SHALL be in a mask layer whose corresponding foreground layer SHALL be coded with JBIG2 (Compression = 12) and the JBIG2-data SHALL be augmented with ITU-T Rec. T.45 (Run-length colour encoding) [T.45] coded colour tags.
	6	ColourTagsPresent If bit 6 is 1, then this IFD SHALL be in a foreground layer, which SHALL be coded with JBIG2 (Compression = 12) and the JBIG2-data SHALL be augmented with T.45-coded colour tags.
	7	HalftoneRegionPresent If bit 7 is 1, then the JBIG2-compressed data in this IFD SHALL contain halftone region segment(s).

Note: Bits 5 or 6 SHALL be 0 within Profile T, which is constrained to black-and-white images.

T88Options[1] = 0x00000101, 0x00000102, 0x00000103.
This value represents the JBIG2 profile identification number. This value may be omitted.
Default = 0x00000101.

The profile identification number of the T88Options identifies a subset of the full set of permitted parameters and parameter values that the JBIG2 coded data stream is in compliance with. None of the values of the T88Options field is required for correct decoding of a JBIG2 coded data stream and may be ignored. It allows a decoder to find out quickly which of the set of JBIG2 parameters and parameter values may be required to decode a given data stream.

The four-byte profile identification numbers 0x00000000 through 0xFFFFFFFF are administered by ISO/IEC JTC1 SC29. ISO/IEC JTC1 SC29 has reserved profile identification numbers 0x00000100 through 0x00000FFF for ITU-T disposition. Interpretation of profiles 0x00000100 through 0x00000FFF is documented in ITU-T Rec. T.89, while interpretation of profiles 0x00000000 through 0x000000FF is documented in ISO/IEC 14492 | ITU-T T.88.

Current profiles:

JBIG2 Profile ID	Description
0x00000101	ITU-T T.89 Base (minimal Fax Application Profile) - MMR and Huffman coding, minimum of two stripes per page, stripes containing text region segment(s) SHALL NOT contain other region segments
0x00000102	ITU-T T.89 Upper MMR - MMR and Huffman coding, minimum of two stripes per page, accommodates halftone and colour tags
0x00000103	ITU-T T.89 Lower Arithmetic - Arithmetic coding, minimum of two stripes per page, stripes containing text region segment(s) SHALL NOT contain other region segments

NOTE: In this table, the term "stripe" means JBIG2 stripe (i.e. a stripe within a JBIG2 Position Block), not a TIFF strip, nor a TIFF-FX stripe.

E1.6.4 JBIG2 Shared Data

For JBIG2 Shared Data, the SharedDataType value in the Shared Data Entry SHALL have a value of 1.

E1.6.4.1 The JBIG2 Shared Data

The JBIG2 Shared Data stored in a TIFF file contains three pieces:

1. A JBIG2 Shared Data version
2. A JBIG2-coded shared data block
3. Extensions to the JBIG2 Shared Data (these extensions contain data that are outside the scope of T.88-JBIG2)

The JBIG2-coded shared data block can have a series of JBIG2 segments. The following segment types may occur:

- Symbol dictionary segment
- Pattern dictionary segment
- Extension segment (future extensions to be defined within the T.88 JBIG2 standard)
- Supported profiles segment
- Table segment

Each segment in a JBIG2-coded shared data block SHALL be associated with no page (i.e., SHALL have a page association field value of 0,

as described in T.88 - JBIG2 Section 7.2.6).

To put it into perspective, when sharing data is required, a file contains one SharedData field, which is located in the GlobalParametersIFD. The SharedData field contains the file offset of the first Shared Data Table. Each Shared Data Table contains a count of the number of Shared Data Entries (i.e. JBIG2 Shared Data) that physically exist in the table , the location and size of the JBIG2 Shared Data themselves, and the file location of the next Shared Data Table (if any). There can be as many Shared Data Tables as necessary to describe the number of JBIG2 Shared Data items.

The JBIG2 image strip (i.e. the reference data stream), described in the next section, that requires inclusion of one or more JBIG2 Shared Data SHALL include a list of JBIG2 Shared Data IDs in a SharedDataList.

E1.6.4.1.1 JBIG2 Shared Data Format

The JBIG2 Shared Data format consists of a version number, which identifies the version of the format that follows, followed by the size of the JBIG2 data block, then the data block itself, followed by any extensions. The start of the JBIG2 Shared Data is located at file offset T, in bytes, from the beginning of the file.

The JBIG2 Shared Data has the following format:

Bytes	Byte offsets	Type	Description
1	T	BYTE	The JBIG2 Shared Data version number, which is currently 0.
4	T+1 - T+4	LONG	Size of JBIG2-coded shared data block (not including extensions) = Y.
Y	T+5 - T+4+Y	BYTE	The JBIG2-coded shared data block.
2	. . . .	SHORT	Extension type for first extension (these extensions contain data that are outside the scope of T.88-JBIG2)
4	. . . .	LONG	Size of first extension=Z1
Z1	. . . .	BYTE	Data for first extension
2	. . . .	SHORT	Extension type for second extension
4	. . . .	LONG	Size of second extension=Z2
Z2	. . . .	BYTE	Data for second extension

```
   +-----+--------------+-----+----------------------------------------+
```

E1.6.4.2 JBIG2 SharedDataMemory

For JBIG2 dictionary Shared Data the SharedDataMemory requirement is represented by the total amount of decoded symbol dictionary information a decoder will accommodate in memory at one time to decode a file. This SharedDataMemory requirement is referenced as the decoder memory. If decoder memory is specified (non-zero value), then it follows the formula described in [T.89]. Namely, the decoder memory, composed of two components (a fixed and per-symbol component), is a measure of how much memory is required to hold a decoded dictionary. The fixed component does not depend on the number of symbols, while the per-symbol component does depend on the number of symbols. The decoder memory algorithm does have dependence on whether Huffman (see note 1) or Arithmetic (see note 2) coding is used and whether the dictionaries contain symbols or halftone patterns (see note 3).

decoder memory = fixed component + per-symbol component

fixed component = 2^{direct coding template size}
+ 2^{refinement coding template size} + 8K

per-symbol component = SUM (32 + (round32(Wi) (Hi) / 8) over i,
i= 1 to N

where:
i = ith symbol in the dictionary
N = the number of symbols in the dictionary
32 = a fixed per-symbol overhead required to represent:
- width of symbol
- height of symbol
- symbol ID Huffman code
- length of symbol ID Huffman code
- pointer to memory where symbol bitmap resides
round32 = is a rounding up to the next multiple of 32 bits (e.g., 33 rounds to 64, 128 rounds to 128)
Wi = width of the ith symbol
Hi = height of the ith symbol

This means that for each symbol there are 32 bytes overhead, plus Hi rows of bitmap data, each of which is round32(Wi)/8 bytes.

Note:
1) For Huffman coding there are no templates, so the fixed component is about 8K bytes. The fixed component can in fact be zero if

custom Huffman tables are not used.

2) For Arithmetic coding the per-symbol component is the same. The amount of memory needed to store the decoded dictionary bitmaps (that's the (round32(Wi) * Hi) / 8 component) is unchanged. Differences occur in the 32 bytes per-symbol overhead component. The width, height and pointer fractions of the overhead still apply, however the Huffman code parts do not apply. There are, however, context tables for symbol ID probability modeling that take the place of the Huffman code parts. Bottom line, 32 bytes is also a reasonable per-symbol overhead for Arithmetic coding. The template options documented in [T.89] range from a 10 pixels direct bitmap template with no refinement bitmap coding to a 16 pixels direct bitmap template with a 13 pixels refinement bitmap template. Given this range of templates, the fixed component will range from 9K to 80K bytes.
3) The same expression holds for pattern dictionaries of halftone image regions, since pattern dictionaries are similar to symbol dictionaries but contain halftone patterns. In this context, the references to symbol above should be taken to include patterns stored in pattern dictionaries. The pattern dictionaries, however, tend to be small relative to symbol dictionaries, since the pattern count is frequently low. This isThis only a few K of memory. It is the space required by a decoder to hold the halftone bit-planes that is of significance and determines the SharedDataMemory. This memory requirement is document in [T.89] to be typically 110% of the resolution dependent page buffer size (i.e. 1.0 Mbytes at 300 dpi and 2.0 Mbytes at 400 dpi).

E1.6.5 The JBIG2 Image Strip

The JBIG2 image stored in a TIFF file will have components that require a TIFF reader to parse through its strip content. This is due to the fact that JBIG2 is represented by two types of data:

1. shared components: namely the symbol or pattern bitmaps that are associated with multiple images, which are compressed into dictionaries and stored in one or more JBIG2 Resources.
2. image specific components: data that is specific to one image only, that with the aid of the shared components, will allow the image to be decoded.

To couple these two component sets together, each JBIG2 Image Strip within an IFD has a corresponding list of shared data IDs in the SharedDataList section of each image strip. The concatenation of the shared data and the JBIG2 position block will comprise a decodable JBIG2 stream for the image described by the IFD for that strip.

A position block is the JBIG2 encoding of the binary image code

stream. Included in the position block are the encoded positions and

IDs of the symbols within the dictionaries, which may lie within the position block, and/or outside of it (as JBIG2 Shared Data). Within the position block, the following segment types may occur:

1. Page information segment
   - Exactly one page information segment SHALL be present, and it SHALL be the first segment in the JBIG2-coded position block
2. End of page segment
   - Exactly one end of page segment SHALL be present, and it SHALL be the last segment in the JBIG2-coded position block
3. End of stripe segment
4. Symbol dictionary segment
5. Pattern dictionary segment
6. Generic region segment
7. Generic refinement region segment
8. Text region segment
9. Halftone region segment
10. Extension segment (future extensions to be defined within the T.88 JBIG2 standard)
11. Supported profiles segment
12. Table segment.

Each segment in a JBIG2-coded position block SHALL be associated with the page defined by the page information segment.

The TIFF JBIG2 Image Strip SHALL consist of four pieces:

1. A JBIG2 Image Strip version
2. A SharedDataList: list of JBIG2 Shared Data IDs
3. The JBIG2-coded position block
4. Extensions to the image strip (these extensions contain data that are outside the scope of JBIG2, such as colour tags, which are defined within the JBIG2 Extension of Profile M. Colour tags are not permitted within this profile, Profile T).

If the JBIG2 Image Strip contains extensions, each extension is preceded by a two-byte type giving its extension type, and a 4-byte count of its length in bytes. Other data that could possibly be stored in an extension includes ASCII text, hyperlinks, and so on. The current image strip extensions and the data that may be stored in them are defined in Section E1.6.5.1. If a TIFF reader is not able to interpret an extension (if it does not recognize the extension type), then it SHOULD ignore that extension, but may skip over it to find further extensions that it can interpret.

To decode a JBIG2-coded image strip, follow these steps:

1. Retrieve the list of shared data IDs from the SharedDataList.
2. Search the collection of JBIG2 Shared Data for all the JBIG2 Shared Data, such as dictionaries, whose IDs are given in the SharedDataList.

From each one, extract its JBIG2-coded shared data block.

3. Concatenate those JBIG2-coded shared data blocks, in the order in which their IDs are given in the SharedDataList, followed by the JBIG2-coded position block.
4. This concatenated data stream can then be decoded as a JBIG2 data stream. This SHALL be a valid JBIG2 data stream containing a single page: no segment numbers may be duplicated, and so on.

As an optimization, you won't actually concatenate and decode the JBIG2-coded shared data block(s) for every position block that uses them, as that is quite inefficient. Instead, the JBIG2-coded shared data block(s) can be decoded and kept in an intermediate format, designed so that the effect of logical concatenation can be simulated.

E1.6.5.1 Image Strip Format

The image strip has the following format, which includes a ResourceList, delimited by "====":

Bytes	Byte offsets	Type	Description
1	P	BYTE	Strip format version number, which is currently 0.
2	P+1 - P+2	SHORT	Number of resource IDs = X (i.e. JBIG2 Shared Data)
X*4	P+3 - P+2 +(X*4)	LONG	The sequence of shared data IDs of the JBIG2 Shared Data required by this JBIG2-coded position block. The JBIG2 Shared Data (e.g. dictionaries) will be prepended in the order specified by this sequence of IDs, to construct the array of symbols that will be used to decode the JBIG2-coded position block.
4	P+3+(X*4) - P+6+(X*4)	LONG	Size of JBIG2-coded position block not including extensions = Y
Y	. . . .	BYTE	The JBIG2-coded Position Block.
2	. . . .	SHORT	Extension type for first extension (these extensions contain data that are outside the scope of T.88-JBIG2, such as colour tags)

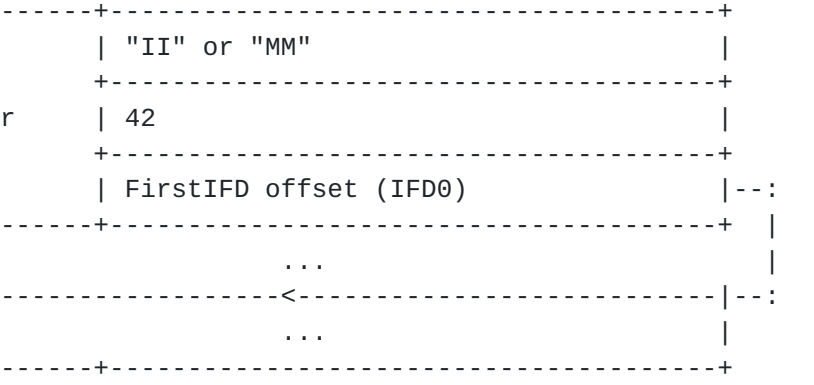
4	. . . .	LONG	Size of first extension=Z1
Z1	. . . .	BYTE	Data for first extension
2	. . . .	SHORT	Extension type for second extension
4	. . . .	LONG	Size of second extension=Z2
Z2	. . . .	BYTE	Data for second extension
...	. . . .	....	Further extensions

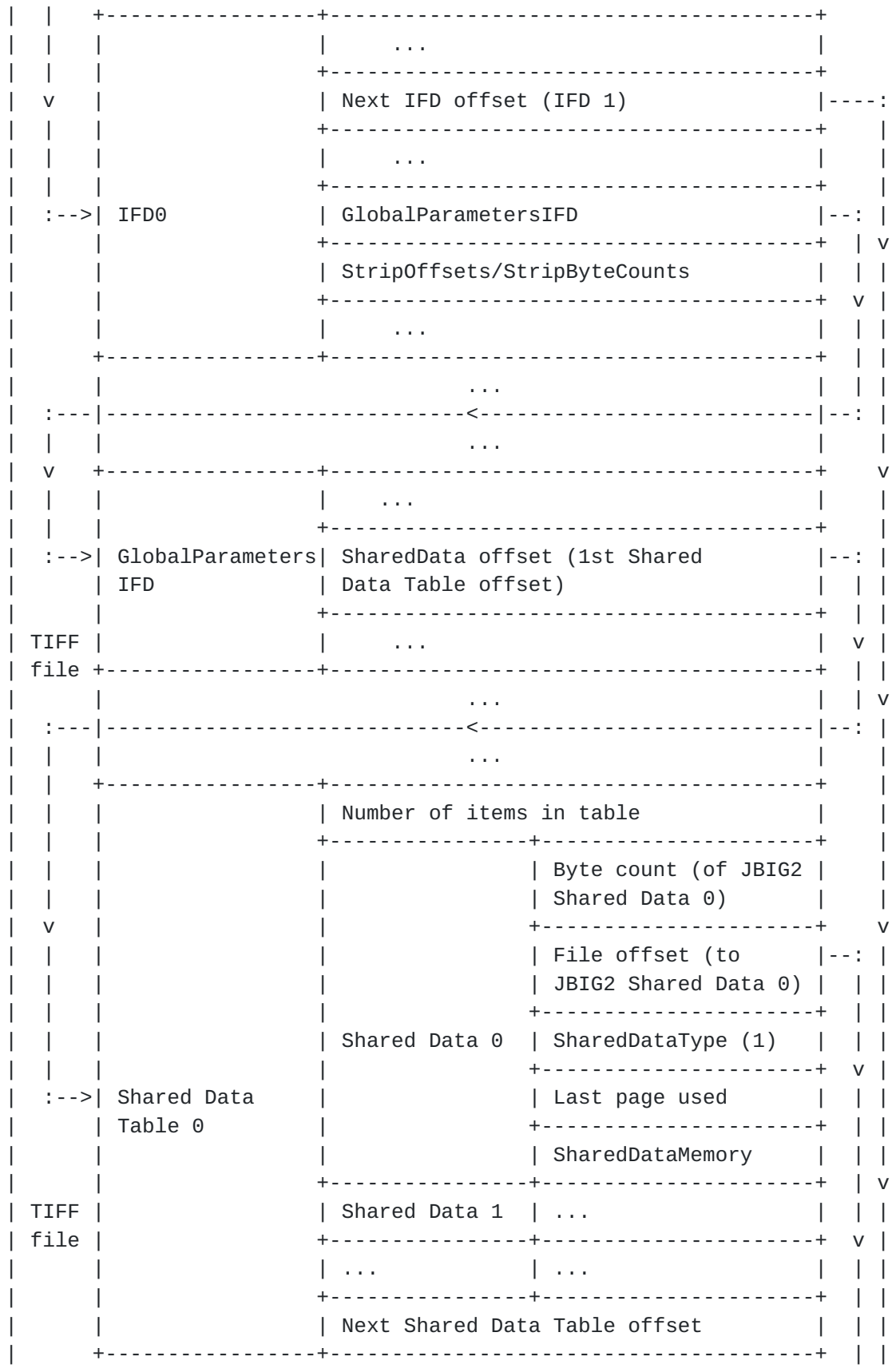
Current JBIG2 Image Strip Extension Types:

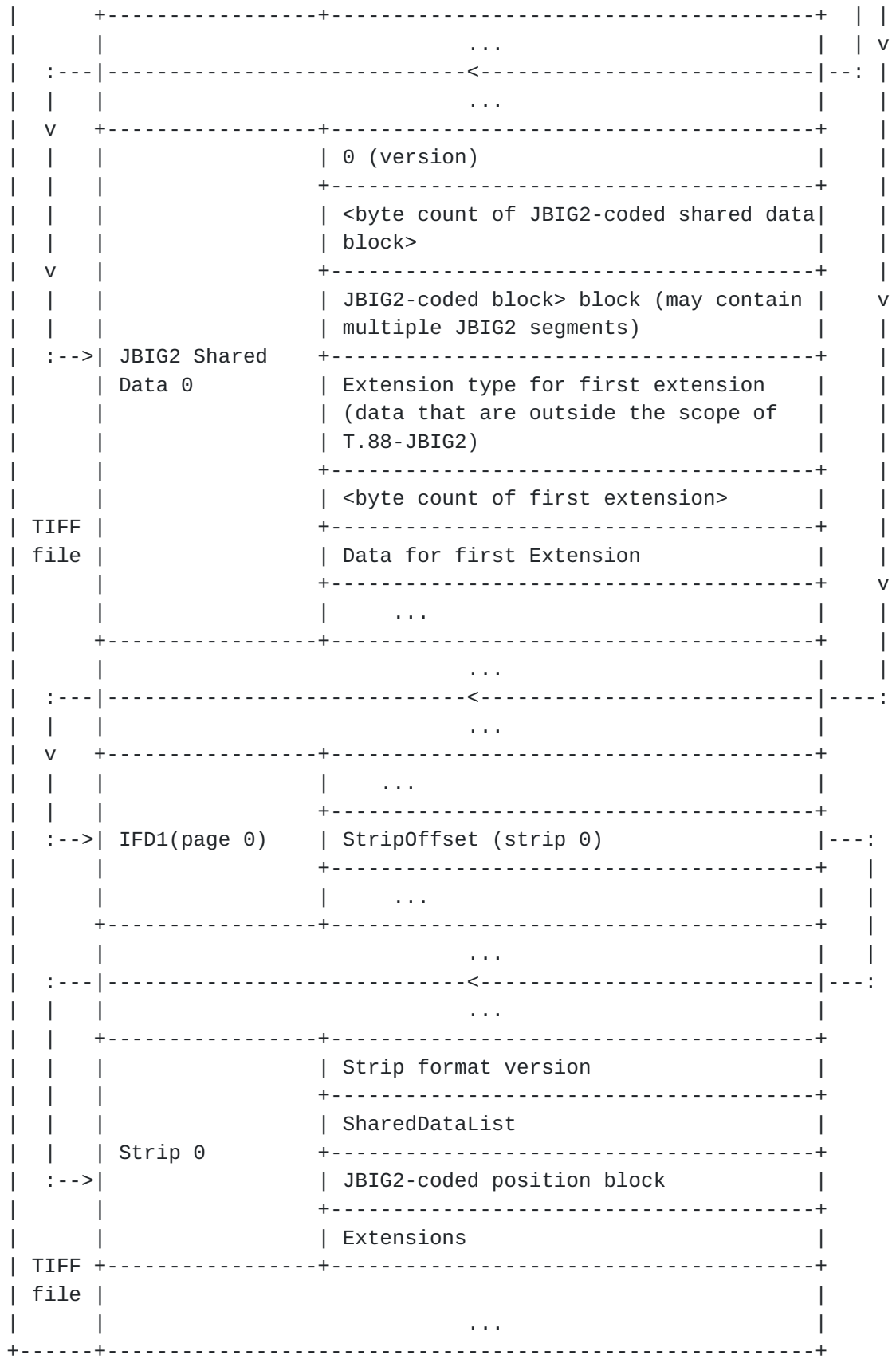
Extension Type	Meaning
0	Undefined
1	Colour tags This extension contains colour tag data, T.45 encoded. This value SHALL NOT be used when using Profile T

E1.6.6 Representation of JBIG2 data in TIFF

The embedding of JBIG2 data in TIFF then takes the following form:




IFD0
GlobalParametersIFD
StripOffsets/StripByteCounts
GlobalParameters IFD
SharedData offset (1st Shared Data Table offset)
Number of items in table
Byte count (of JBIG2 Shared Data 0)
File offset (to JBIG2 Shared Data 0)
Shared Data 0
SharedDataType (1)
Shared Data Table 0
Last page used
SharedDataMemory
Shared Data 1
Next Shared Data Table offset
Next IFD offset (IFD 1)
TIFF file


JBIG2 Shared Data 0
0 (version)
<byte count of JBIG2-coded shared data block>
JBIG2-coded block> block (may contain multiple JBIG2 segments)
Extension type for first extension (data that are outside the scope of T.88-JBIG2)
<byte count of first extension>
Data for first Extension
IFD1(page 0)
StripOffset (strip 0)
Strip format version
SharedDataList
Strip 0
JBIG2-coded position block
Extensions
TIFF file
TIFF file

E1.6.7 Rules and Requirements for Images

Profile T defines a fundamental set of rules for images in the 3-layer representation.

1. Typically, only ONE layer with image data SHALL exist and it SHALL be the binary Mask layer, which SHALL be the Primary IFD. Compression 12 SHALL be used in this layer and the PhotometricInterpretation SHALL be 0.

2. A Foreground and/or Background layer without image data (i.e. IFD with StripByteCounts = 0) MAY be present. If present, then only black and white colors SHALL be used. The Foreground and Background defaults for ImageBaseColor SHALL be black and white respectively.

3. The Primary IFD defines and extends to the entire page boundary; all attached SubIFD images cannot extend beyond the Primary image. Resolution differences may cause some pixels to "hang over" the page boundary, but no new pixels should exist completely beyond the page extent.

4. Images other than the Primary Image (i.e. Primary IFD) MAY optionally cover only a portion of the strip or page.

5. Each Primary IFD and each MRC-specific SubIFD SHALL have an ImageLayer field to specify which layer the IFD belongs to, and the imaging order of that IFD within the layer.

6. Each Primary IFD SHALL have a NewSubFileType field value set to 18, indicating a single page of a multi-page document (bit 1) and MRC (bit 4).

7. Each MRC-specific child IFD SHALL have a NewSubFileType field value set to 16, indicating MRC (bit 4).

8. In MRC Internet Fax, each layer is transmitted as a sequence of strips. If the page consists of a single layer, then all strips SHALL be stored in the single Primary IFD. In this case, coding parameters cannot change between strips. If the page consists of more than one layer, then all strips of the Primary Mask layer SHALL be stored in the single Primary IFD. Should Foreground /Background layers be present, the StripByteCounts SHALL be set to "0". Each strip of the Foreground/Background layers SHALL be stored in one IFD, referenced by the Primary IFD's SubIFD field, containing an ImageLayer field with ImageLayer[0] identifying Background (layer 1) or Foreground layer (layer 3), and Imagelayer[1] identifying order in which images within a single layer are to be rendered. The TIFF XPosition and YPosition fields

are used to indicate the placement of these images with respect to the primary image.

9. If Background and/or Foreground images are present, their resolution SHALL be that of the Primary Mask image.

E1.6.8. Profile T - Lossy and Lossless JBIG2 Black-and-White Fax profile Summary

Recommended fields are shown with an asterisk *

Required fields or values are shown with a double asterisk **. If the double asterisk is on the field name, then all the listed values are required of implementations; if the double asterisks are in the Values column, then only the values suffixed with a double asterisk are required of implementations.

Baseline Fields	Values
BitsPerSample	1**: binary mask
Compression	1: None (ImageBaseColor IFD only) 12**: JBIG2
DateTime*	{ASCII): date/time in the 24-hour format "YYYY:MM:DD HH:MM:SS"
FillOrder**	1: Most significant bit first 2: Least significant bit first
ImageDescription*	{ASCII}: A string describing the contents of the image.
ImageWidth	1728**, 2048, 2432, 2592, 3072, 3456, 3648, 4096, 4864
ImageLength**	n: total number of scanlines in image
NewSubFileType**	16, 18: Bit 1 indicates single page of a multi-page document on Primary IFD Bit 4 indicates MRC model
Orientation	1**-8, Default 1
PhotometricInterpretation	0**: WhiteIsZero (Mask Layer)

+------------------+--+

ResolutionUnit**	2: inch
RowsPerStrip	n: number or scanlines per strip
SamplesPerPixel	1**, 3 (ImageBaseColor IFD only)
Software*	{ASCII}: name & release number of creator software
StripByteCounts**	<n>: number or bytes in each strip, fixed to "0" for FG/BG (when present)
StripOffsets**	<n>: offset from beginning of file to each TIFF strip
XResolution	200**, 204**, 300, 400, 408 (written in pixels/inch)
YResolution	98**, 196**, 100**, 200**, 300, 391, 400 (written in pixels/inch)
Extension Fields	
DocumentName*	{ASCII}: name of scanned document
PageNumber**	n, m: page number followed by total page count
SubIFDs	<IFD>: byte offset to FG/BG IFDs
XPosition	horizontal offset in primary IFD resolution units
YPosition	vertical offset in primary IFD resolution units
New Fields	
StripRowCounts	<n>: number of scanlines in each strip
ImageLayer	n, m: layer number, imaging sequence (e.g., strip number)
GlobalParameters IFD**	IFD: global parameters IFD
ProfileType*	n: type of data stored in TIFF file

+------------------+--+

FaxProfile*	n: ITU-T compatible fax profile
CodingMethods*	n: compression algorithms used in file
VersionYear*	byte sequence: year of ITU-T standard
ModeNumber*	n: mode (i.e. functional level) of T.44 standard
TIFF-FXExtensions **	n: extension(s) identification number, bits 2 and 3 for SharedData and Profile T SHALL be among the set bits
T88Options*	n, m: option numbers, profile number
SharedData**	<n>: offset from beginning of file to the first Shared Data

E1.7. TIFF-FX Extension 5 (E5): JBIG2 Color Extension of Profile M

This section defines extensions to Profile M that augment the pool of coders and encoding mechanisms available for use in the mask and foreground layers when encoding documents with color. The JBIG2, ITU-T Rec. T.88 / ISO-IEC 14492, bi-level coder is made available for use in both mask and foreground layer(s). It must be noted that simple JBIG2 symbol-based compression is limited to matching symbols in a binary image, but ITU-T Rec. T.44 Annex B [T.44Amd1] expands this to include single-color images, such as colored text. The T.44 defined mechanism, referenced as "colour tag" encoding, is only available for use in foreground layers that are associated with JBIG2 coded mask layers. The more conventional multi-level color coders, such JPEG, are also available for use in the encoding of foreground layer colors when JBIG2 is used in the mask layer(s).

E1.7.1. Overview

Use of JBIG2 in Profile M effectively amounts to application of Profile T (i.e. Section E.2) to the mask layer(s), without imposition of the Profile T black-and-white constraints that prohibit the presence of background and/or foreground image data (i.e. if present StripByteCounts = 0). This translates to augmenting the MRC 3-layer model and TIFF representation, defined in Profile M, with the Shared Data extension E1 (Extension 1), and using JBIG2 coding (i.e. Compression =12) in the mask layer. The N-layer model and TIFF representation, defined in extension E2 (Section E1.4) MAY also be

used if the corresponding TIFF-FXExtensions bit is set.

Use of JBIG2 and "colour tagging" to encode the colors of the foreground layer(s) translates to attaching discrete color values to the JBIG2 coded symbols (shapes) that are represented in the associated mask layer.

E1.7.2. Required TIFF Fields

This section describes the TIFF fields required, in addition to those in Sections 8.2, E1.4 and E1.5.2.3.

E1.7.2.1. Baseline Fields

Augment the Section 8.2.1 compression field with JBIG2 (i.e. value = 12) as below:

Compression(259) = 1, 3, 4, 7, 9, 10, 12. SHORT

For Mask layer, see Sections 4.2.1, 5.2.1 and E1.6.2.1.
For Foreground and Background layers, see Sections 6.2.1, 7.2.1 and E1.6.2.1. Compression=1 is not used by previous profiles. An IFD used only to specify the default image color for a layer SHALL not have any encoded image data associated with it, i.e., the StripByteCounts field SHALL contain a 0. Since no image data exists in the IFD, the Compression field SHALL be set to 1 indicating no compression. A Compression field value of 1 is not allowed for any other IFDs.

E1.7.2.2. Extension Fields

See Section 8.2.2.

E1.7.2.3. New Fields

Augment Section 8.2.3 with the fields from E1.5.2.3.

Bits 2 and 4 of the TIFF-FXExtensions field SHALL be set to 1.

E1.7.3. Recommended TIFF Fields

See Section E1.6.3.

The note that appears at the end of the T88Options[0] table, prohibiting activation of bits 5 or 6 (i.e. ColourTagsFollow or ColourTagsPresent respectively) for Profile T SHALL be disregarded.

If the IFD's T88Options[0] field has the ColourTagsFollow or ColourTagsPresent bits set, then the following segment types SHALL NOT occur in the JBIG2-coded position block:

- Pattern dictionary
- Halftone region
- Generic region
- Generic refinement region segment

E1.7.4 JBIG2 Shared Data
See Section E1.6.4.

E1.7.5 The Image Strip
See Section E1.6.5.

E1.7.6 Representation of JBIG2 data in TIFF
See Section E1.6.6.

E1.7.7 Colour Tag (Color Symbol) Compression

E1.7.7.1 Why Use Colour Tag Compression

Another opportunity that is afforded by JBIG2 is improved compression of the foreground layer for documents containing colored text. In most cases, if a document contains text, each individual text character is a single, flat, color (e.g., black or red), and the number of such colors is limited. The foreground layer in this case looks like a number of colored blobs, one for each character, each one having the shape of the corresponding character. This foreground layer can be compressed using a new method that takes advantage of the JBIG2 structure. If the mask layer is compressed using JBIG2 symbols, then decoding it essentially yields a sequence of (XPosition, YPosition, Symbol ID) triples. Each triple indicates that the symbol (from some dictionary) specified by "Symbol ID" SHOULD be drawn at the location "(X, Y)". Simply augmenting a text region triple with a fourth component, the color of that individual character (the symbols "colour tag"), allows storage of the foreground layer in a very small amount of space, using run-length coding on those colors. The total space taken by the foreground layer can be small in comparison to an encoded contone image.

E1.7.7.2 Colour Tag Terms of Use in TIFF

Colour tags are one of the JBIG2 image strip extensions referenced in Section E1.6.5 (The JBIG2 Image Strip). Their Representation within the image strip is expressed within Section E1.6.5.1 (Image Strip Format). Stepping back and considering the MRC (Mixed Raster Content) mask (bi-level data) and foreground (color data) layer pairs, we arrive at the following terms of use to be applied when colour tagging is used in foreground representation:

1. the (JBIG2-compressed) bi-level data (position block) SHALL be followed immediately (in the file) by the colour tags. The colour tags SHALL appear as an extension in the JBIG2 image strip, with the image strip extension type = 1 (colour tags, as

defined in Section E1.6.5.1). The colour tags SHALL be compressed using ITU-T Rec. T.45.

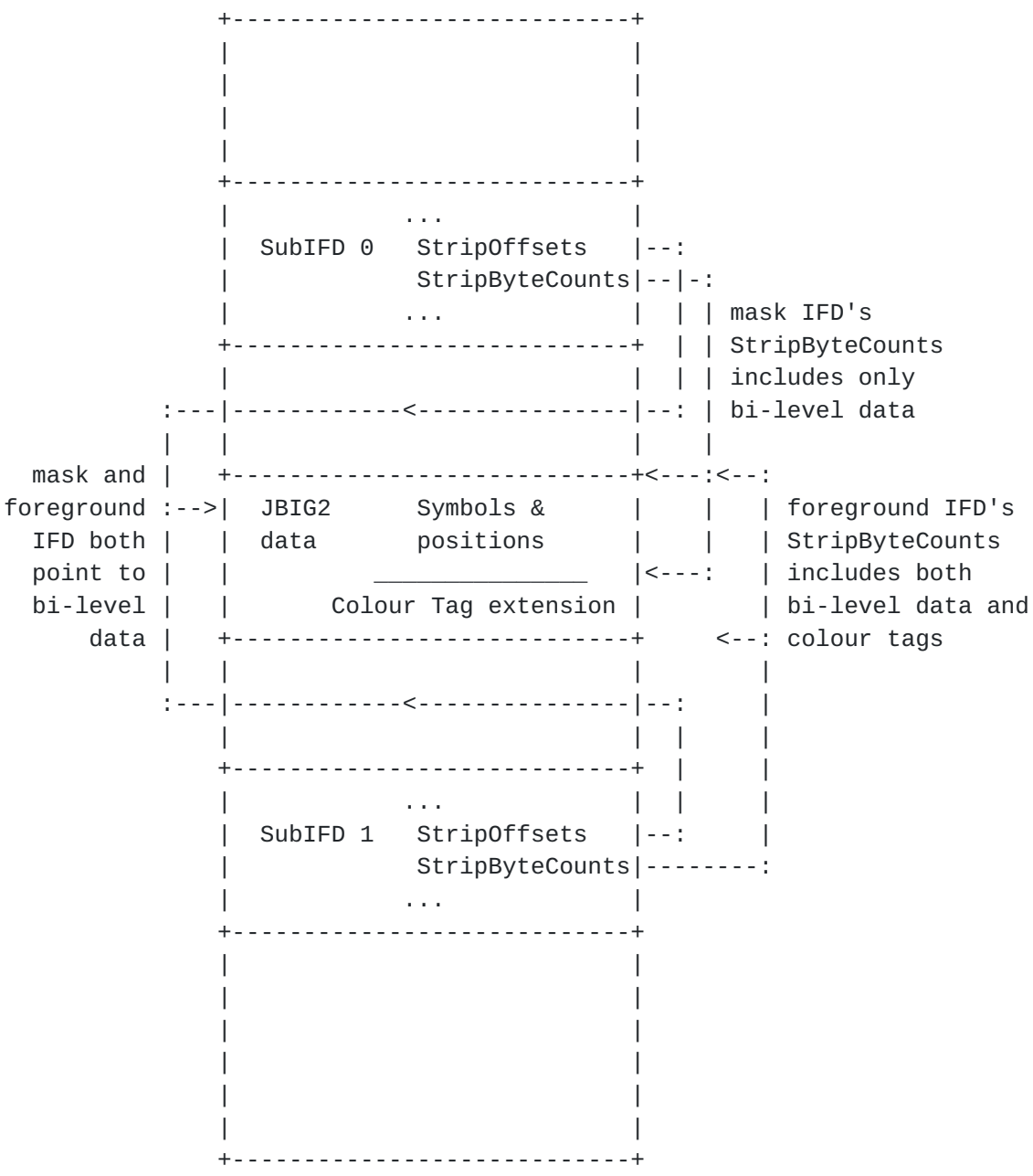
2. the mask IFD points to the start of the bi-level data, and the associated byte count SHALL include ONLY the bi-level data (the position block, but not the colour tags). The IFD's Compression field SHALL be set to 12 (JBIG2). If present, the T88Options[0] field SHOULD have bit 5 set to 1 (ColourTagsFollow).
3. the foreground IFD points to the bi-level data, and the associated byte count SHALL include BOTH the bi-level data and the colour tag extension. The IFD's Compression field SHALL be set to 12 (JBIG2). The IFD's PhotometricInterpretation SHALL indicate the color space used to interpret the colors found in the colour tag data. If present, the T88Options[0] field SHOULD have bit 6 set to 1 (ColourTagsPresent).
4. in the event that two symbol instances overlap, the reconstructed image SHOULD be the one obtained by drawing each JBIG2 symbol with the appropriate color, where the drawing SHALL be done in the order that the JBIG2 symbols appear in the encoded JBIG2 image strip.

Thus, the foreground IFD completely describes an image: it points to enough data to reconstruct a colored image that contains the right color at each pixel selected by the mask. It is reasonable that a decoder will recognize that both a mask IFD and a foreground IFD point to the same JBIG2 data, and decode the JBIG2 data only once (not once for the mask, and again for the foreground). The T88Options[0] bits "ColourTagsFollow" and "ColourTagsPresent" are designed to make the decoder's job easier: if it sees ColourTagsFollow in the T88Options[0] field of a mask IFD, it knows it should defer decoding it until it decodes the corresponding foreground IFD.

Similarly, if it sees ColourTagsPresent in a foreground IFD, then it can optimize the drawing/decoding operations.

Note: This representation has two pointers to the same part of the TIFF-FX file, which is a violation of a TIFF guideline, and could conceivably cause problems in some unsuspecting TIFF editors. However, these unsuspecting TIFF editors would probably not be able to decode the JBIG2 data anyway. The shared pointers occur only in a restricted case.

The nature of the two pointers is illustrated below:



E1.7.8 Rules and Requirements for Images

Revise the identified Profile M Section 8.4 Rules and Requirements for Images as follows:

a. Revise Rule 1 to read:

1. If more than one layer exists, then the binary Mask layer SHALL be present and be the primary image. The Mask layer SHALL support the binary data representations defined in Section 3 and MAY support the binary data representations defined in Sections 4, 5 and E1.6, with the exception that PhotometricInterpretation SHALL be 0. If only one layer exists,

then the image corresponding to that layer is the primary image.

b. Revise Rule 3 to read:

3. The Background and Foreground images SHALL support the color representations defined in Section 6 and MAY support the color representations defined in Sections 7 or E1.7.

E1.7.9. JBIG2 Extension of Profile M Summary

Recommended fields are shown with an asterisk *

Required fields or values are shown with a double asterisk **. If the double asterisk is on the field name, then all the listed values are required of implementations; if the double asterisks are in the Values column, then only the values suffixed with a double asterisk are required of implementations.

Baseline Fields	Values
BitsPerSample	1**: binary mask 2-8**: bits per color sample for FG/BG 9-16: optional 12 bits/sample
Compression	1: None (ImageBaseColor IFD only) 3**: Modified Huffman and Modified Read (mask layer) 4: Modified Modified Read 7**: JPEG (FG/BG layers) 9: JBIG, per T.85 10: JBIG, per T.43 12**: JBIG2, per T.88 (Note that T.45 Run-length Colour Encoding is also required for FG/BG layers)
DateTime*	{ASCII): date/time in the 24-hour format "YYYY:MM:DD HH:MM:SS"
FillOrder**	1: Most significant bit first 2: Least significant bit first
ImageDescription*	{ASCII}: A string describing the contents of the image.
ImageWidth	864, 1024, 1216, 1728**, 2048, 2432, 2592, 3072, 3456, 3648, 4096, 4864
ImageLength**	n: total number of scanlines in image

NewSubFileType**	16, 18: Bit 1 indicates single page of a multi-page document on Primary IFD Bit 4 indicates MRC model
Orientation	1**-8, Default 1
PhotometricInterpretation	0**: WhiteIsZero (Mask layer) 2: RGB 5: CMYK 10**: ITULAB (FG/BG layers)
ResolutionUnit**	2: inch
RowsPerStrip	n: number or scanlines per strip
SamplesPerPixel	1**: L* (lightness) 3: RGB, LAB, CMY 4: CMYK
Software*	{ASCII}: name & release number of creator software
StripByteCounts**	<n>: number or bytes in each strip
StripOffsets**	<n>: offset from beginning of file to each TIFF strip
XResolution	100, 200**, 300, 400 (written in pixels/inch)
YResolution	equal to XResolution (pixels SHALL be square)
Extension Fields	
T4Options	0**: required if Compression is Modified Huffman, EOLs not byte aligned 1: required if Compression 2D Modified Read, EOLs are not byte aligned 4**: required if Compression Modified Huffman, EOLs byte aligned 5: required if Compression 2D Modified Read, EOLs are byte aligned
T6Options	0: required if Compression is 2D Modified Modified Read

DocumentName*	{ASCII}: name of scanned document
PageNumber**	n, m: page number followed by total page count
ChromaSubSampling	(1,1), (2, 2)** (1, 1): equal numbers of lightness and chroma samples horizontally & vertically (2, 2): twice as many lightness samples as chroma horizontally and vertically
ChromaPositioning	1: centered
Indexed	0: not a palette-color image 1: palette-color image
SubIFDs	<IFD>: byte offset to FG/BG IFDs
XPosition	horizontal offset in primary IFD resolution units
YPosition	vertical offset in primary IFD resolution units
New Fields	
Decode	minL, maxL, mina, maxa, minb, maxb: minimum and maximum values for L*a*b*
ImageBaseColor	a, b, c: background color in ITULAB
StripRowCounts	<n>: number of scanlines in each strip
ImageLayer	n, m: layer number, imaging sequence (e.g., strip number)
T82Options	0: T.85 profile of T.82 coding
GlobalParameters IFD**	IFD: global parameters IFD
ProfileType*	n: type of data stored in TIFF file
FaxProfile*	n: ITU-T compatible fax profile
CodingMethods*	n: compression algorithms used in file

VersionYear*	byte sequence: year of ITU-T standard
ModeNumber*	n: mode of T.44 standard
TIFF-FXExtensions **	n: extension(s) identification number, bits 2 and 4 for SharedData and Profile M SHALL be among the set bits
T88Options*	n, m: option numbers, profile number - if colour tag is used then bit 1 of n SHALL NOT be set - if bit 5 is set then IFD is in mask layer with colour tag augmented JBIG2 coded corresponding foreground layer - if bit 6 is set then IFD is in foreground layer with colour tag augmented JBIG2 coding
SharedData**	<n>: offset from beginning of file to the first Shared Data

E1.8. Security Considerations

This document describes a file format for Internet fax, which is a series of profiles of TIFF for facsimile. As such, it does not create any security issues not already identified in [TIFF-REG], in its use of fields as defined in [TIFF]. There is also new TIFF fields defined within this specification, but they are of a purely descriptive nature, so that no new security risks are incurred.

Further, the encoding specified in this document does not in any way preclude the use of any Internet security protocol to encrypt, authenticate, or non-repudiate TIFF-encoded facsimile messages.

E1.9. References

The following references are appended to the list in Section 11 of RFC XXXX.

[RFC XXXX] RFC XXXX, Draft Standard "File Format for Internet Fax", known as TIFF-FX (pending issue)

[T.4 Amd1] Amendment 1 to ITU-T Recommendation T.4, Standardization of group 3 facsimile apparatus for document transmission, March 2000

[T.44Amd1] Amendment 1 to ITU-T Recommendation T.44, Mixed Raster Content (MRC), March 2000.

[T.45] ITU-T Recommendation T.45, Run-length Colour Encoding, March 2000.

[T.88] ITU-T Recommendation T.88|ISO/IEC 14492:2000, Information technology - Lossy/Lossless coding of Bi-level Images. (Commonly referred to as JBIG2 standard.)

[T.89] ITU-T Draft Recommendation T.89, Application Profiles for Recommendation T.88 - Lossy/Lossless Coding of Bi-level Images (JBIG2) for Facsimile, November 2000.

E1.10 Authors' Addresses

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