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PDF Georegistration Encoding Best Practice Version 2.2

Warning

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TerraGo Technologies, Inc

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Contents

i. Preface

This document contains the specification for the patented PDF geo-registration technique pioneered by TerraGo Technologies[1]. The intent of this specification is to codify existing practice and to insure that there is an official, stable best practice instance of PDF geo-registration that documents the format used in millions of existing GeoPDF® files (legacy protection). The intent is NOT to make this specification an OGC standard. Further, a Best Practice should not even be referred to as a standard. Any future work on PDF geo-registration in the OGC will be harmonized with the OGC and ISO standards baseline.

An OGC Best Practice is defined as:

"A best practice is a technique or methodology that, through experience and research, has proven to reliably lead to a desired result. A commitment to using the best practices in any field is a commitment to using all the knowledge and technology at one's disposal to ensure success."[2]

This document is not intended to contain an explanation of the mathematical formulas that a developer might need to implement software that is capable of performing coordinate system transformations.

Comments were received during the OGC review and voting process document that PDF geo-registration 2.2 is not completely aligned with the OGC Abstract Specification Topic 2 (ISO 19101) – Spatial Referencing By Coordinates. This means that PDF geo-registration 2.2 is not harmonized with the OGC Standards Baseline. However, PDF geo-registration 2.2 documents an existing, widely used storage format. Changing how CRS is specified would “break” compatibility of this document and the actual storage format and metadata in the existing PDF geo-registration 2.2. Future work activities for PDF geo-registration do include harmonization with the OGC Baseline.

Finally, the OGC recognizes that the specification of the datum, ellipsoid, and CRS codes as used in this document do not conform to the EPSG database, the current de-facto normative reference for CRS metadata. As this BP documents current existing practice, harmonizing with the EPSG codes is viewed as future work.

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[1] Submitted to the OGC on a royalty free, non-discriminatory basis (RAND-RF)

[2] OGC Technical Committee Policies and Procedures.

ii. Submitting organizations

The following organizations submitted this Best Practice to the Open Geospatial Consortium Inc.:

a.) TerraGo Technologies Inc.

iii. Submission contact points

All questions regarding this submission should be directed to the editor or the submitters:

CONTACT	COMPANY
George Demmy	TerraGo
Victor Minor	Blue Marble Geographics

iv. Revision history

Date	Release	Author	Paragraph modified	Description
8/19/08	0.1.0	Carl Reed	Not applicable	First version in OGC template format
11/18/08	0.1.1	Victor Minor	Not applicable	Updated language to more closely match Topic 2.
1/23/09	0.1.2	Carl Reed	Various	Incorporate comments from Doug Nebert, Steven Keenes and others
7/26/2010		George Demmy and Carl Reed	Various	Insert proper language as to PDF Registration. Prepare for publication as revision to BP

v. Changes to the OGC® Abstract Specification

The OGC® Abstract Specification does not require changes to accommodate this OGC® standard.

vi. Patent Information

The general technique of PDF geo-registration was patented by TerraGo technologies in the course of developing software to produce and leverage GeoPDF products. GeoPDF is a registered trademark of TerraGo Technologies and may only be applied to products created under license from TerraGo. GeoPDF products use the PDF geo-registration technique as described by this specification, but also may use other geo-registration encoding techniques, optimizations, and methods beyond the scope of this specification.

In general, creating a PDF file with a geo-registration that conforms to this specification does not create a GeoPDF product. Conformance to this specification conveys no rights for trademark usage, license to TerraGo software, or any other rights or license not specifically listed in this document.

This specification is being provided by TerraGo on a reasonable and non-discriminatory, royalty free basis (RAND-RF).

Foreword

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights (see above patent statement). Open Geospatial Consortium Inc. shall not be held responsible for identifying any or all such patent rights. However, to date, no such rights have been claimed or identified.

Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the Best Practice set forth in this document, and to provide supporting documentation.

Introduction

The PDF geo-registration encoding specified by this document is an extension to the Adobe® Portable Document Format, as described in *PDF Reference (*see the Bibliography). PDF geo-registration 2.2 allows association of an arbitrary coordinate reference system to a PDF illustration. Supporting software can then perform bidirectional coordinate conversions between the coordinate reference system and the PDF coordinate system.

These illustrations are frequently *maps*, representations of an area on the surface of the earth. Maps are frequently constructed to be more than aesthetically pleasing. They are made to allow tasks such as retrieving coordinates or compass bearings and measuring distances or areas. However, because a map is a two-dimensional representation of a three-dimensional sphere – surface of the earth – there is inherent distortion in making a map. There is also the problem that the earth is not a perfect sphere. To be useful for such tasks the map must be created so as to minimize distortion and make what distortion cannot be avoided predictable. There is both art and science to this. The science is composed of standardized mathematical methods, *map projections*, and idealized models of the earth, *ellipsoidal coordinate system*. A map projection is a mechanism for rigorously converting from an ellipsoidal coordinate system to a two-dimensional plane, or projected coordinate reference system. Every map projection's preservations and distortions make it more useful for some tasks and less for others. For each coordinate reference system, a datum is selected that best aligns with the portion of the earth's surface to be mapped. To learn more, see *Map Projections – A Working Manual* (in the Bibliography).

To fully support maps, PDF geo-registration 2.2 provides for up to three coordinate systems. These will generally be referred to as: PDF, projected and *geodetic*. The geodetic coordinate system is a fully defined ellipsoidal coordinate system based on the geodetic datum used to create the map. Coordinate tuples for the geodetic system are commonly expressed as geodetic longitude and latitude. The projected coordinate system is a complete projected coordinate reference system derived from the PDF geo-registration 2.2's two-dimensional geodetic coordinate reference system by the application of a fully defined map projection. The coordinate tuples for this reference system may be expressed in any linear unit, but common units are feet, meters, miles and kilometers. The PDF coordinate system is the result of scaling, translating and rotating the projected coordinate tuples to make them fit on a reasonably sized PDF page in a desired orientation. The native PDF unit is points. PDF georegistration 2.2 preserves enough information so that software can freely translate between all three.

GeoPDF Encoding Best Practice

1 Scope

The intended audience of this document is a developer of software for creating and consuming geo=registered PDF documents that conform to PDF geo-registration 2.2. It specifies how to create the necessary PDF objects that identify a region of the PDF page as a map and describe the map's coordinate systems. Map creation and rendering to a PDF page are not addressed. The underlying PDF file format is not addressed. The file format is specified in *PDF Reference*[1] .

The reader will need knowledge of PDF objects and document structure. An understanding of cartographic projections and datums will also be helpful. Information about these can be found in *Map Projections – A Working Manual*[2] .

Though written with the PDF 1.7 file format in mind, this Best Practice is believed to be valid for all versions of the PDF file specification prior to PDF 1.7.

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2 Conformance

Not required.

3 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this OGC Best Practice. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of OGC document 08-139 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

Information about map projections:

Map Projections – A Working Manual
John P. Snyder
United States Government Printing Office, Washington, DC, 1987

Information about standards referred to in this Best Practice:

PDF Reference, sixth edition: Adobe Portable Document Format, Version 1.7
2006
Adobe Systems Incorporated
http://www.adobe.com/devnet/acrobat/pdfs/pdf_reference.pdf

IEEE Standard for Binary Floating-Point Arithmetic (IEEE 754-1985)
1985
Institute of Electrical and Electronics Engineers
http://grouper.ieee.org/groups/754/

4 Terms and definitions

For the purposes of this document, the following terms and definitions apply. These terms are further extended in ISO 19111[3] and ISO 19112[4].

4.1
coordinate
one of a sequence of *n* numbers designating the position of a point in *n*-dimensional space**.**

Note In a coordinate reference system, the coordinate numbers are qualified by units.

4.2
coordinate reference system
coordinate system that is related to an object by a datum

4.3
coordinate set
Collection of **coordinate tuples** related to the same **coordinate reference system.**

4.4
coordinate tuple
tuple composed of a sequence of **coordinates**

4.5
datum
parameter or set of parameters that define the position of the origin, the scale, and the orientation of a **coordinate system**

4.6
coordinate conversion
coordinate operation in which both **coordinate reference systems** are based on the same **datum**

EXAMPLE Conversion from an ellipsoidal coordinate system to projected coordinate reference system is accomplished by applying a map projection.

NOTE A coordinate conversion uses parameters which have specified values that are not determined empirically.

4.7
map projection
coordinate conversion from an **ellipsoidal coordinate system** to a plane

4.8
ellipsoid
surface formed by the rotation of an ellipse about a main axis

NOTE In this International Standard, ellipsoids are always oblate, meaning that the axis of rotation is always the minor axis.

4.9
ellipsoidal coordinate system
geodetic coordinate system
coordinate system in which position is specified by **geodetic latitude**, **geodetic longitude** and (in the three-dimensional case) **ellipsoidal height**

4.10
map frame
a section of the PDF geo-registration 2.2 document that is defined by a specific **neatline,** and a specific coordinate reference system.

4.11
neatline
A series of PDF points defining the boundary of the map frame, in clockwise order.

5 Conventions

5.1 Symbols (and abbreviated terms)

API	Application Program Interface
CAD	Computer Aided Design
COTS	Commercial Off The Shelf
IEEE	Institute of Electrical and Electronics Engineers, Inc
ISO	International Organization for Standardization

LGI	Layton Graphics Inc.
OGC	Open Geospatial Consortium
PDF	Portable Document Format
UML	Unified Modeling Language
XML	eXtensible Markup Language
1D	One Dimensional
2D	Two Dimensional
3D	Three Dimensional

5.2 UML Notation

Not Applicable

6 Overview

Conceptually, PDF geo-registration 2.2 specifies *map frames* associated with a PDF page. A minimal map frame describes a coordinate reference system that is associated with the entire document page. This association provides a collection of tuples that map the page (PDF) coordinate system to the known coordinate reference system. Optionally a *neatline* specifies the geometric region of the page that is associated with the foreign coordinate system. There may be multiple map frames on a given page. Map frames may overlap or be inset. The coordinate reference system of a map frame is independent of any other map frame.

Map frames are associated with their parent PDF page object. Table 1 describes PDF geo-registration 2.2 additions to the standard PDF page object.

Table 1 details the entries the PDF geo-registration 2.2 Best Practice adds to a PDF page object.

TABLE 1 PDF geo-registration 2.2 entries in a page object

KEY	TYPE	VALUE
LGIDict	array or dictionary	Required if there is one or more map frames associated with this page object. The value may be either a single map frame or an array of map frames. If an array, the order of map frames in the array is front to back (top to bottom). This may be significant if map frames overlap or are inset.

6.1 Map Frames

The map frame describes the relationship between a coordinate reference system and an area on the PDF page. Three types of coordinate reference systems are supported: geodetic, projected and unregistered Cartesian (Engineering). In each case, the coordinate reference system is transformed into the PDF coordinate system with a coordinate transformation matrix as discussed in section 4.2.3 of *PDF Reference*[1] . The map frame contains PDF dictionary entries that describe the coordinate transformation matrix, all parameters required for a map projection (if used), the reference ellipsoid and geodetic datum. More than one map frame may be present on a single PDF page.

For simplicity, the map frame follows certain conventions. All angular values are in degrees. When angular coordinates are needed in a context where Cartesian *x* and *y* coordinate values would normally be expected, use the longitudinal values as *x* values and the latitudinal values as *y* values.

Due to limitations in Acrobat® internal numeric representations, PDF geo-registration 2.2 allows an alternate representation of numbers. Any number within a map frame may be expressed as a PDF string. The value of the string is a printed representation of the number. MAP2PDF® performs coordinate transformations using IEEE double-precision floating-point numbers as described in *IEEE Standard for Binary Floating-Point Arithmetic* (see the Bibliography). Acrobat® 6, 7 and 8 use IEEE single-precision floating-point numbers. Earlier versions used a 32-bit fixed-point numbers. Use of string representation for projection parameter values and transformation matrix members is highly recommended. Numbers not expressed as a PDF string will be subject to the limitations of Acrobat numeric representations.

Table 2 details the content of a map frame.

TABLE 2 Entries in a map frame

KEY	TYPE	VALUE
Type	name	*(Required)* The type of object that this dictionary describes; must be **LGIDict** for a map frame.
Version	string	*(Optional)* A string identifying the version of the *PDF geo-registration 2.2 Specification* this map frame conforms to. For this Best Practice the value should be **2.1**.

CTM	array	*(Required if registration points are not present)* The Coordinate Transformation Matrix mapping from the PDF coordinate system to the projected or geodetic coordinate system. A transformation matrix takes precedence over registration points when both are present. This array follows the same convention as the array parameter to the PDF coordinate transformation operator, **cm**, with the exception of allowing string representations.
Registration	array	*(Required if a transformation matrix is not present)* A series of registration point pairs. A transformation matrix takes precedence over registration points when both are present. Each point pair is given as an array of four values: a PDF *x* value, a PDF *y* value, a map *x* value, and a map *y* value.
Projection	dictionary	*(Required if a geodetic or projected coordinate system)* A projection dictionary (see "Projection and Display Dictionaries," below).
Display	dictionary	*(Optional)* A display dictionary (see "Projection and Display Dictionaries," below).
Neatline	array	*(Required if multiple map frames are present; otherwise optional)* A series of PDF points defining the boundary of the map frame, in clockwise order. The values in this array are interpreted as *x* and *y* values specifying PDF page points. The minimum number of points is two, which will be interpreted as a diagonal describing a rectangular bounding box.

Note: If ***Projection*** is not present, the value is assumed to be ***NONE*** (see Appendix B).

6.2 Projection and Display Dictionaries

The projection dictionary describes the algorithm and parameters required to define the coordinate reference system used in each map frame of the PDF geo-registration 2.2 document. Each map projection algorithm has a series of required parameters (see Appendix B). The parameter values vary with the geographic center and possibly the range of the data to be projected. The geodetic datum and map projection parameters are preserved in the projection dictionary. Supported geodetic datums and their associated PDF geo-registration 2.2 codes are listed in Appendix A. Supported map projections and associated PDF geo-registration 2.2 codes are listed in Appendix B. Appendix B includes the parameters required by and notes pertinent to each projection.

Note: The PDF geo-registration 2.2 notion of projection is more general than the typical cartographic usage. It includes some grid systems, such as Universal Transverse Mercator, which combine a projection algorithm with a system of standardized projection parameters.

Projection parameters are of a number of types. Most are either linear or angular. Linear values should always be expressed in meters, regardless of the native linear unit of the projection coordinate reference system. Angular values should always be given in degrees. Most angular values are either used in to define specific geodetic longitude or latitude values. Longitude values are relative to the Greenwich prime meridian, positive values being to the east and negative to the west. The supported range for longitudes is -180° to 180°. Latitude values are relative to the equator, positive values being to the north and negative values to the south. The supported range is -90° to 90°. Latitude and longitude are typically represented in PDF geo-registration 2.2 as decimal degrees. However, PDF geo-registration 2.2 files have been created using degrees decimal-minutes and degrees, minutes, and decimal-seconds. Consuming applications should be prepared to read such files.

A display dictionary is used to specify the coordinate system a consuming application should use to display non-PDF coordinate reference values.

Table 2 details the contents of a projection or display dictionary.

TABLE 2 Entries in a projection or display dictionary

KEY	TYPE	VALUE
Type	name	*(Required)* The type of object that this dictionary describes; must be **Projection** for a projection dictionary or **Display** for a display dictionary.
Units	string	*(Optional)* A label to be used in displaying linear measures in the projected coordinate system. This is nonsensical in the case of the **GEOGRAPHIC** where coordinates are angular.
Datum	string or dictionary	*(Optional)* The source geodetic coordinate system. This may be either a PDF geo-registration 2.2 code for a predefined datum, or a custom datum definition.
ProjectionType	string	*(Required)* The projection algorithm used to project geodetic coordinates into Cartesian coordinates. The value is a PDF geo-registration 2.2 code for

		a predefined projection.
CentralMeridian	number	*(Optional)* A projection parameter. This is a longitude value.
FalseEasting	number	*(Optional)* A projection parameter. This is a linear value.
FalseNorthing	number	*(Optional)* A projection parameter. This is a linear value.
Height	number	*(Optional)* A projection parameter (see Appendix B). This is a linear value.
Hemisphere	string	*(Optional)* A projection parameter. Supported values are **N** or **S**, indicating the northern or southern hemisphere.
LatitudeOne	number	*(Optional)* A projection parameter. This is a latitude value.
LatitudeTwo	number	*(Optional)* A projection parameter. This is a latitude value.
LatitudeOfTrueScale	number	*(Optional)* A projection parameter. This is a latitude value.
LongitudeOne	number	*(Optional)* A projection parameter. This is a longitude value.
LongitudeTwo	number	*(Optional)* A projection parameter. This is a longitude value.
LongitudeDownFromPole	number	*(Optional)* A projection parameter. This is a longitude value.
Orientation	number	*(Optional)* A projection parameter. This is an angular offset.
OriginHeight	number	*(Optional)* A projection parameter. This is a linear value.
OriginLatitude	number	*(Optional)* A projection parameter. This is a longitude value.
OriginLongitude	number	*(Optional)* A projection parameter.

		This is a longitude value.
ScaleFactor	number	*(Optional)* A projection parameter. This is a scalar value.
StandardParallel	number	*(Optional)* A projection parameter. This is a latitude value.
StandardParallelOne	number	*(Optional)* A projection parameter. This is a latitude value.
StandardParallelTwo	number	*(Optional)* A projection parameter. This is a latitude value.
Zone	number	*(Optional)* A projection parameter. This is an integral value. The supported values are dependent on **ProjectionType**.

6.3 Datum Definitions

In addition to predefined geodetic datum codes, PDF geo-registration 2.2 supports custom geodetic datum definitions. A geodetic datum is comprised of an ellipsoid, a known origin point, and a prime meridian. In the case of PDF geo-registration 2.2 documents, a Greenwich prime meridian is assumed. Additionally, the dictionary description for a custom geodetic datum can contain a *shift*, a mathematical operation that converts (at least approximately) the geodetic datum's coordinates to the widely-used World Geodetic System 1984 geodetic datum (WGS84).

Table 3 details the contents of a custom datum definition.

TABLE 3 Entries in a custom geodetic datum definition

KEY	TYPE	VALUE
Ellipsoid	string or dictionary	*(Required)* An ellipsoid definition. The value may be an ellipsoid code (see Appendix C) or an ellipsoid definition.
Description	string	*(Optional)* A name assigned to this datum.
ToWGS84	string or dictionary	*(Optional)* A shift from this datum to the WGS84 datum. The value is either a shift code (see Appendix D) or a shift definition.

6.4 Ellipsoid Definitions

An ellipsoid is a surface formed by the rotation of an ellipse about a main axis. Along with a defined center point and prime meridian, it can be used as a model that approximates the surface of the earth. It is described by a *semi-major axis* and either a *semi-minor axis* or an *inverse flattening*. Table 4 details the contents of an ellipsoid definition.

TABLE 4 Entries in a custom ellipsoid definition

KEY	TYPE	VALUE
SemiMajorAxis	number	*(Required)* The length of the ellipsoid semi-major axis, i.e. the radius of the earth at its equator.
InvFlattening	number	*(Required if semi-minoraxis is not specified)* $1/f$, where $f = (a-b)/a$, and a is the semi-major axis and b is the semi-minor axis.
SemiMinorAxis	number	*(Required if inverse flattening is not specified)* The length of the ellipsoid semi-minor axis, i.e. half the distance from the north pole to the south pole.
Description	string	*(Optional)* A name assigned to this ellipsoid.

6.5 Shift Definitions

A shift definition specifies how to convert a map frames geodetic datum's coordinate values to equivalent ellipsoidal coordinates on a WGS84 geodetic datum. Table 5 details the content of a shift definition.

TABLE 5 Entries in a shift definition

KEY	TYPE	VALUE
dx	number	*(Optional)* This specifies translation on x.
dy	number	*(Optional)* This specifies translation on y.
dz	number	*(Optional)* This specifies translation on z.
rx	number	*(Optional)* This specifies rotation around the x axis.
ry	number	*(Optional)* This specifies rotation around the y axis.
rz	number	*(Optional)* This specifies rotation around the z axis.
sf	number	*(Optional)* This specifies a scale factor.
Description	string	*(Optional)* A name assigned to this shift.

7.0 Examples

Example 1: The following example illustrates a single map frame associated with a PDF page. The map frame has a projected coordinate reference system that uses an Albers Equal Area Conic map projection.

```
105 0 obj
<<
   /Type /Page
   /LGIDict 104 0 R
   % remainder of the PDF Page dictionary not reproduced in this
example
>>
endobj
104 0 obj
<<
   /Type /LGIDict
   /Version (2.1)
   /CTM
   [
      (3524.5004673001) (0.0000000000)
           (0.0000000000) (3524.5004673001)
           (-2493370.4940219196) (-1538087.6795059151)
   ]
   /Projection
   <<
      /Type /Projection
      /ProjectionType (AC)
      /StandardParallelOne (20.00000)
      /StandardParallelTwo (60.00000)
      /FalseNorthing (0.00000)
      /Datum (NAR)
      /OriginLatitude (40.00000)
      /CentralMeridian (-96.00000)     /FalseEasting (0.00000)
   >>
   /Display
   <<
      /Type /Projection
      /ProjectionType (AC)
      /StandardParallelOne (20.00000)
      /StandardParallelTwo (60.00000)
      /FalseNorthing (0.00000)
      /OriginLatitude (40.00000)
      /CentralMeridian (-96.00000)
      /Units (M)
      /FalseEasting (0.00000)
      /Datum (NAR)
   >>
   /Description (Southwestern United States)
   /Registration% two points, describing a rectangle
   [[
      (53.5103998492) (124.5528002880)           % PDF
      (-2304773.0647479948) (-1099101.2766873206)% map
    ]
    [
      (725.0183996828) (560.4984001800)        % PDF
      (61957.1944612906) (437389.1938494640)     % map
   ]]
   /Neatline % must be in PDF coordinate system
   [
      (53.5103998492) (124.5528002880)
```

```
        (53.5103998492) (560.4984001800)
        (725.0183996828) (560.4984001800)
        (725.0183996828)(124.5528002880)
    ]
>>
endobj
```

Example 2: The next example illustrates two map frames associated with a single PDF page. The first map frame has a geodetic coordinate reference system and the second an arbitrary Cartesian (Engineering) coordinate reference system.

```
187 0 obj
<<
    /Type /Page
    /LGIDict [ 188 0 R 189 0 R ]
    % remainder of the PDF Page dictionary not reproduced in this
example
>>
endobj
188 0 obj

<<
    /Type /LGIDict
    /Version (2.1)
    /CTM
    [
        (0.5367729901) (-0.3099060303)
        (0.3099060303) (0.5367729901)
        (-1134.6947857129) (346.9822048049)

    ]
    /Description (Map 1)
    /Display
    <<
        /Type /Projection
        /ProjectionType (GEODETIC)
        /Datum (WE)   /Neatline

    >>

    /Neatline
    [
        (1513.0683996836) (64.1739002400)
        (1513.0683996836) (834.8877001440)
        (2213.0683995964) (834.8877001440)
        (2213.0683995964) (64.1739002400)

    ]

    /Projection
    <<
        /Type /Projection
        /ProjectionType (GEOGRAPHIC)
        /Datum (WE)
    >>
>>

endobj
```

```
189 0 obj

<<
    /Type /LGIDict
    /Version (2.1)
    /CTM
    [
        (0.0900555640) (-0.0519936041)
        (0.0519936041) (0.0900555640)
        (-62.2728952159) (-0.9403414838)
    ]
    /Description (Map 2)
    /Neatline
    [
        (351.4285240577) (64.1739002400)
        (351.4285240577) (834.8877001440)
        (1051.4284747903) (834.8877001440)
        (1051.4284747903) (64.1739002400)
    ]
    /Projection

    <<
        /Type /Projection
        /ProjectionType (NONE)
    >>
>>
endobj
```

Annex A: Predefined Datums
(Informative)

Table 6 below lists the predefined datums supported in PDF geo-registration 2.2 at the time of publication of this Best Practice. Datum names are those used by the U.S. National Geospatial-Intelligence Agency's GEOTRANS software (see the Bibliography).

TABLE 6 Datum Code Values

DATUM NAME	DATUM CODE
ADINDAN, Burkina Faso	ADI-E
ADINDAN, Cameroon	ADI-F
ADINDAN, Ethiopia	ADI-A
ADINDAN, Mali	ADI-C
ADINDAN, Mean	ADI-M
ADINDAN, Senegal	ADI-D
ADINDAN, Sudan	ADI-B
AFGOOYE, Somalia	AFG
AIN EL ABD 1970, Bahrain	AIN-A
AIN EL ABD 1970, Saudi Arabia	AIN-B
AMERICAN SAMOA 1962	AMA
ANNA 1 ASTRO 1965, Cocos Is.	ANO
ANTIGUA ISLAND ASTRO 1943	AIA
ARC 1950, Botswana	ARF-A
ARC 1950, Burundi	ARF-H
ARC 1950, Lesotho	ARF-B
ARC 1950, Malawi	ARF-C
ARC 1950, Mean	ARF-M
ARC 1950, Swaziland	ARF-D
ARC 1950, Zaire	ARF-E
ARC 1950, Zambia	ARF-F
ARC 1950, Zimbabwe	ARF-G
ARC 1960, Kenya	ARS-A

ARC 1960, Kenya & Tanzania	ARS-M
ARC 1960, Tanzania	ARS-B
ASCENSION ISLAND 1958	ASC
ASTRO BEACON E 1945, Iwo Jima	ATF
ASTRO DOS 71/4, St. Helena Is.	SHB
ASTRO STATION 1952, Marcus Is.	ASQ
ASTRO TERN ISLAND (FRIG) 1961	TRN
AUSTRALIAN GEODETIC 1966	AUA
AUSTRALIAN GEODETIC 1984	AUG
AYABELLE LIGHTHOUSE, Djibouti	PHA
BELLEVUE (IGN), Efate Is.	IBE
BERMUDA 1957, Bermuda Islands	BER
BISSAU, Guinea-Bissau	BID
BOGOTA OBSERVATORY, Columbia	BOO
BUKIT RIMPAH, Banka & Belitung	BUR
CAMP AREA ASTRO, Camp McMurdo	CAZ
CAMPO INCHAUSPE 1969, Arg.	CAI
CANTON ASTRO 1966, Phoenix Is.	CAO
CAPE CANAVERAL, Fla & Bahamas	CAC
CAPE, South Africa	CAP
CARTHAGE, Tunisia	CGE
CHATHAM ISLAND ASTRO 1971, NZ	CHI
CHUA ASTRO, Paraguay	CHU
CORREGO ALEGRE, Brazil	COA
DABOLA, Guinea	DAL
DECEPTION ISLAND	DID
DJAKARTA, INDONESIA	BAT
DOS 1968, Gizo Island	GIZ
EASTER ISLAND 1967	EAS
ESTONIA, 1937	EST
EUROPEAN 1950, Cyprus	EUR-E
EUROPEAN 1950, Egypt	EUR-F
EUROPEAN 1950, England, Channel	EUR-G

EUROPEAN 1950, England, Ireland	EUR-K
EUROPEAN 1950, Greece	EUR-B
EUROPEAN 1950, Iran	EUR-H
EUROPEAN 1950, Iraq, Israel	EUR-S
EUROPEAN 1950, Malta	EUR-L
EUROPEAN 1950, Mean (3 Param)	EUR-M
EUROPEAN 1950, Mean (7 Param)	EUR-7
EUROPEAN 1950, Norway & Finland	EUR-C
EUROPEAN 1950, Portugal & Spain	EUR-D
EUROPEAN 1950, Sardinia(Italy)	EUR-I
EUROPEAN 1950, Sicily(Italy)	EUR-J
EUROPEAN 1950, Tunisia	EUR-T
EUROPEAN 1950, Western Europe	EUR-A
EUROPEAN 1979	EUS
FORT THOMAS 1955, Leeward Is.	FOT
GAN 1970, Rep. of Maldives	GAA
Geocentric Datum of Australia	GDS
GEODETIC DATUM 1949, NZ	GEO
GRACIOSA BASE SW 1948, Azores	GRA
GUAM 1963	GUA
GUNUNG SEGARA, Indonesia	GSE
GUX 1 ASTRO, Guadalcanal Is.	DOB
HERAT NORTH, Afghanistan	HEN
HERMANNSKOGEL, old Yugoslavia	HER
HJORSEY 1955, Iceland	HJO
HONG KONG 1963	HKD
HR1901G Croatia (Helmert)	HRG-7
HU-TZU-SHAN, Taiwan	HTN
INDIAN 1954, Thailand	INF-A
INDIAN 1960, Con Son Island	ING-B
INDIAN 1960, Vietnam 16N	ING-A
INDIAN 1975, Thailand	INH-A
INDIAN 1975, Thailand	INH-A1

INDIAN, Bangladesh	IND-B
INDIAN, India & Nepal	IND-I
INDIAN, Pakistan	IND-P
INDONESIAN 1974	IDN
IRELAND 1965	IRL
ISTS 061 ASTRO 1968, S Georgia	ISG
ISTS 073 ASTRO 1969, Diego Garc	IST
JOHNSTON ISLAND 1961	JOH
KANDAWALA, Sri Lanka	KAN
KERGUELEN ISLAND 1949	KEG
KERTAU 1948, W Malaysia & Sing.	KEA
KOREAN GEO DATUM 1995, S Korea	KGS
KUSAIE ASTRO 1951, Caroline Is.	KUS
L.C. 5 ASTRO 1961, Cayman Brac	LCF
LEIGON, Ghana	LEH
LIBERIA 1964	LIB
LUZON, Mindanao Island	LUZ-B
LUZON, Phillipines	LUZ-A
MAHE 1971, Mahe Is.	MIK
MASSAWA, Ethiopia	MAS
MERCHICH, Morocco	MER
MIDWAY ASTRO 1961, Midway Is.	MID
MINNA, Cameroon	MIN-A
MINNA, Nigeria	MIN-B
MONTSERRAT ISLAND ASTRO 1958	ASM
M'PORALOKO, Gabon	MPO
NAHRWAN, Masirah Island (Oman)	NAH-A
NAHRWAN, Saudi Arabia	NAH-C
NAHRWAN, United Arab Emirates	NAH-B
NAPARIMA, Trinidad & Tobago	NAP
NORTH AMERICAN 1927, Alaska	NAS-D
NORTH AMERICAN 1927, Alberta/BC	NAS-F
NORTH AMERICAN 1927, Aleutian E	NAS-V

NORTH AMERICAN 1927, Aleutian W	NAS-W
NORTH AMERICAN 1927, Bahamas	NAS-Q
NORTH AMERICAN 1927, C. America	NAS-N
NORTH AMERICAN 1927, Canada	NAS-E
NORTH AMERICAN 1927, Canal Zone	NAS-O
NORTH AMERICAN 1927, Caribbean	NAS-P
NORTH AMERICAN 1927, CONUS	NAS-C
NORTH AMERICAN 1927, Cuba	NAS-T
NORTH AMERICAN 1927, E. Canada	NAS-G
NORTH AMERICAN 1927, Eastern US	NAS-A
NORTH AMERICAN 1927, Greenland	NAS-U
NORTH AMERICAN 1927, Man/Ont	NAS-H
NORTH AMERICAN 1927, Mexico	NAS-L
NORTH AMERICAN 1927, Michigan	NAS-M
NORTH AMERICAN 1927, NW Terr.	NAS-I
NORTH AMERICAN 1927, San Salv.	NAS-R
NORTH AMERICAN 1927, Western US	NAS-B
NORTH AMERICAN 1927, Yukon	NAS-J
NORTH AMERICAN 1983, Alaska	NAR-A
NORTH AMERICAN 1983, Aleutian	NAR-E
NORTH AMERICAN 1983, Canada	NAR-B
NORTH AMERICAN 1983, CONUS	NAR-C
NORTH AMERICAN 1983, Hawaii	NAR-H
NORTH AMERICAN 1983, Mexico	NAR-D
NORTH SAHARA 1959, Algeria	NSD
OBSERVATORIO MET. 1939, Flores	FLO
OLD EGYPTIAN 1907	OEG
OLD HAWAIIAN (CC), Hawaii	OHA-A
OLD HAWAIIAN (CC), Kauai	OHA-B
OLD HAWAIIAN (CC), Maui	OHA-C
OLD HAWAIIAN (CC), Mean	OHA-M
OLD HAWAIIAN (CC), Oahu	OHA-D
OLD HAWAIIAN (IN), Hawaii	OHI-A

OLD HAWAIIAN (IN), Kauai	OHI-B
OLD HAWAIIAN (IN), Maui	OHI-C
OLD HAWAIIAN (IN), Mean	OHI-M
OLD HAWAIIAN (IN), Oahu	OHI-D
OMAN	FAH
ORDNANCE GB 1936, Eng., Wales	OGB-B
ORDNANCE GB 1936, England	OGB-A
ORDNANCE GB 1936, Mean (3 Para)	OGB-M
ORDNANCE GB 1936, Mean (7 Para)	OGB-7
ORDNANCE GB 1936, Scotland	OGB-C
ORDNANCE GB 1936, Wales	OGB-D
PICO DE LAS NIEVES, Canary Is.	PLN
PITCAIRN ASTRO 1967	PIT
POINT 58, Burkina Faso & Niger	PTB
POINT NOIRE 1948, Congo	PTN
PORTO SANTO 1936, Madeira Is.	POS
PROV. S AMERICAN 1956, Bolivia	PRP-A
PROV. S AMERICAN 1956, Colombia	PRP-D
PROV. S AMERICAN 1956, Ecuador	PRP-E
PROV. S AMERICAN 1956, Guyana	PRP-F
PROV. S AMERICAN 1956, Mean	PRP-M
PROV. S AMERICAN 1956, N Chile	PRP-B
PROV. S AMERICAN 1956, Peru	PRP-G
PROV. S AMERICAN 1956, S Chile	PRP-C
PROV. S AMERICAN 1956, Venez	PRP-H
PROVISIONAL SOUTH CHILEAN 1963	HIT
PUERTO RICO & Virgin Is.	PUR
PULKOVO 1942, Russia	PUK
QATAR NATIONAL	QAT
QORNOQ, South Greenland	QUO
REUNION, Mascarene Is.	REU
ROME 1940, Sardinia	MOD
S-42 (PK 1942), Kazakhstan	SPK-E

S-42 (PK42) Former Czechoslov.	SPK-C
S-42 (PULKOVO 1942), Albania	SPK-F
S-42 (PULKOVO 1942), Hungary	SPK-A
S-42 (PULKOVO 1942), Latvia	SPK-D
S-42 (PULKOVO 1942), Poland	SPK-B
S-42 (PULKOVO 1942), Romania	SPK-G
SANTO (DOS) 1965	SAE
SAO BRAZ, Santa Maria Is.	SAO
SAPPER HILL 1943, E Falkland Is	SAP
SCHWARZECK, Namibia	SCK
SELVAGEM GRANDE 1938, Salvage Is	SGM
SIERRA LEONE 1960	SRL
SIRGAS, South America	SIR
S-JTSK, Czech Republic	CCD
SOUTH AMERICAN 1969, Argentina	SAN-A
SOUTH AMERICAN 1969, Baltra	SAN-J
SOUTH AMERICAN 1969, Bolivia	SAN-B
SOUTH AMERICAN 1969, Brazil	SAN-C
SOUTH AMERICAN 1969, Chile	SAN-D
SOUTH AMERICAN 1969, Colombia	SAN-E
SOUTH AMERICAN 1969, Ecuador	SAN-F
SOUTH AMERICAN 1969, Guyana	SAN-G
SOUTH AMERICAN 1969, Mean	SAN-M
SOUTH AMERICAN 1969, Paraguay	SAN-H
SOUTH AMERICAN 1969, Peru	SAN-I
SOUTH AMERICAN 1969, Trinidad	SAN-K
SOUTH AMERICAN 1969, Venezuela	SAN-L
SOUTH ASIA, Singapore	SOA
TANANARIVE OBSERVATORY 1925	TAN
TIMBALAI 1948, Brunei & E Malay	TIL
TOKYO, Japan	TOY-A
TOKYO, Mean	TOY-M
TOKYO, Okinawa	TOY-C

TOKYO, South Korea	TOY-B
TOKYO, South Korea	TOY-B1
TRISTAN ASTRO 1968	TDC
VITI LEVU 1916, Viti Levu Is.	MVS
VOIROL 1874, Algeria	VOI
VOIROL 1960, Algeria	VOR
WAKE ISLAND ASTRO 1952	WAK
WAKE-ENIWETOK 1960	ENW
YACARE, Uruguay	YAC
ZANDERIJ, Suriname	ZAN

Annex B: Predefined Projections (Informative)

This Annex lists the predefined coordinate reference systems supported by PDF georegistration 2.2 at the time of publication of this Best Practice. Also included are the names of required projection parameters and pertinent notes. The table shows three coordinate reference system cases, an arbitrary Cartesian (Engineering) system (NONE), a geodetic (ellipsoidal) system (GEODETIC), and various projected systems.

Projection, Codes and Parameters

PROJECTION NAME	PROJECTION CODE	REQUIRED PARAMETERS	NOTES
Plant (Ungeoregistered Cartesian)	NONE		Cartesian to Cartesian mapping.
Geodetic	GEODETIC		Direct geodetic to Cartesian mapping. For use only in projection dictionaries.
Geographic	GEOGRAPHIC		For use only in display dictionaries. Signifies display of geodetic coordinates.
Local Cartesian	LOCAL CARTESIAN	OriginLatitude OriginLongitude OriginHeight Orientation	A pseudo-projection.
Military Grid Reference System (MGRS)	MG		For use only in display dictionaries. Signifies display of MGRS coordinates.
Universal Transverse Mercator (UTM)	UT	Zone Hemisphere	
Universal Polar Stereographic (UPS)	UP	Hemisphere	
State Plane 1927	SPCS	Zone	The value expected for

Zone is the Federal Information Processing Standards (FIPS) code.

The value expected for **Zone** is the FIPS code.

State Plane 1983	SPCS	Zone
Albers Equal Area Conic	AC	OriginLatitude CentralMeridian StandardParallelOne StandardParallelTwo FalseEasting FalseNorthing
Azimuthal Equidistant**	AL	OriginLatitude CentralMeridian FalseEasting FalseNorthing
Bonne	BF	OriginLatitude CentralMeridian FalseEasting FalseNorthing
Cassini	CS	OriginLatitude CentralMeridian FalseEasting FalseNorthing
Cylindrical Equal Area	LI	OriginLatitude CentralMeridian FalseEasting FalseNorthing
Eckert IV*	EF	CentralMeridian FalseEasting FalseNorthing
Eckert VI*	ED	CentralMeridian FalseEasting FalseNorthing
Equidistant Cylindrical*	CP	StandardParallel CentralMeridian FalseEasting FalseNorthing
Gnomonic*	GN	OriginLatitude CentralMeridian FalseEasting FalseNorthing
Lambert	LE	OriginLatitude

Conformal Conic		CentralMeridian StandardParallelOne StandardParallelTwo FalseEasting FalseNorthing
Mercator	MC	OriginLatitude CentralMeridian ScaleFactor FalseEasting FalseNorthing
Miller Cylindrical*	MH	CentralMeridian FalseEasting FalseNorthing
Mollweide*	MP	CentralMeridian FalseEasting FalseNorthing
Ney's (Modified Lambert Conformal Conic)	NY	OriginLatitude CentralMeridian StandardParallelOne FalseEasting FalseNorthing
New Zealand Map Grid	NT	
Oblique Mercator	OC	OriginLatitude LatitudeOne LongitudeOne LatitudeTwo LongitudeTwo ScaleFactor FalseEasting FalseNorthing
Orthographic*	OD	OriginLatitude CentralMeridian FalseEasting FalseNorthing
Polar Stereographic	PG	LatitudeTrueScale LongitudeDownFromPole FalseEasting FalseNorthing
Polyconic	PH	OriginLatitude CentralMeridian FalseEasting FalseNorthing

Sinusoidal	SA	CentralMeridian FalseEasting FalseNorthing
Stereographic	SD	OriginLatitude CentralMeridian FalseEasting FalseNorthing
Transverse Mercator	TC	OriginLatitude CentralMeridian ScaleFactor FalseEasting FalseNorthing
Transverse Cylindrical Equal Area	TX	OriginLatitude CentralMeridian ScaleFactor FalseEasting FalseNorthing
Van der Grinten	VA	CentralMeridian FalseEasting FalseNorthing

* This projection is only supported for the spherical case.

Annex C: Ellipsoids

Table 8 below lists the predefined ellipsoids supported by PDF geo-registration 2.2 at the time of publication of this Best Practice. Ellipsoid names are those used by the U.S. National Geospatial-Intelligence Agency's GEOTRANS software (see the Bibliography).

TABLE 8 Ellipsoid Codes

ELLIPSOID NAME	ELLIPSOID CODE
Airy 1830	AA
Modified Airy	AM
Australian National	AN
Bessel 1841(Namibia)	BN
Bessel 1841	BR
Clarke 1866	CC
Clarke 1866 (Michigan)	CM
Clarke 1880	CD
Everest (India 1830)	EA
Everest (E. Malasia, Brunei)	EB
Everest 1956 (India)	EC
Everest 1969 (West Malasia)	ED
Everest 1948(W.Mals. & Sing.)	EE
Everest (Pakistan)	EF
Mod. Fischer 1960(South Asia)	FA
Helmert 1906	HE
Hough 1960	HO
Indonesian 1974	ID
International 1924	IN
Krassovsky 1940	KA
GRS 80	RF
South American 1969	SA
WGS 72	WD

WGS 84	WE

Annex D

There are no predefined shift codes supported by PDF geo-registration 2.2 as of the publication of this Best Practice.

Bibliography

[1] PDF REFERENCE, SIXTH EDITION: ADOBE PORTABLE DOCUMENT FORMAT, VERSION 1.7, 2006, ADOBE SYSTEMS INCORPORATED, (HTTP://WWW.ADOBE.COM/DEVNET/ACROBAT/PDFS/PDF_REFERENCE.PDF)

[2] SNYDER, JOHN P. *Map Projections: A Working Manual*, USGS Professional Paper 1395, 1987

[3] ISO 19111, *Geographic Information - Spatial referencing by coordinates*

[4] ISO 19112, *Geographic information — Spatial referencing by geographic identifier*s

[3] ISO 31 (all parts), *Quantities and units*.

[4] IEC 60027 (all parts), *Letter symbols to be used in electrical technology*.

[5] ISO 1000, SI units and recommendations for the use of their multiples and of certain other units.

[6] Bufkin, Michael P., George G. Demmy, and D. Alan Stewart. 2009. *Methods and systems for encoding geographic coordinates and features in a portable document format file.* U. S. Patent 7562289.