

## 8 Spatial reference frames

### 8.1 Introduction

A [spatial coordinate system](#) is a means of associating a unique coordinate with a point in object-space. It is defined by binding an abstract CS to a normal embedding (see 8.2). A [spatial reference frame](#) is a specification of a spatial coordinate system for a region of object-space (see 8.3). It is formed by the binding of an abstract coordinate system to the normal embedding specified by an ORM for that object. A full specification specifies the CS and the ORM and includes values for CS parameters, if any, and a specification of the region of object-space. Some or all CS parameters may be bound by ORM parameters. In particular, a CS based on an oblate ellipsoid (or sphere) must match the parameters of the oblate ellipsoid (or sphere) RD of the ORM.

A [spatial reference frame template](#) is an abstraction of a collection of spatial reference frames that share the same abstract coordinate system, coordinate system parameter binding rules, and similar ORMs that model the same spatial object type (see 8.5). Spatial reference frames may be organized into specified sets so as to form an atlas for a large region of space. This International Standard specifies a collection of spatial reference frame templates, realizations of those templates, and sets of those realizations.

### 8.2 Spatial coordinate systems

If a normal embedding of position-space into object-space is defined, any abstract CS for a region of that position-space can be used to specify a *spatial* CS that associates coordinates in coordinate-space to points in object-space. This association is a *binding of a CS via a normal embedding*. The association is defined as:

$$p = E(G(c))$$

where:

- $c$  is a coordinate in the CS domain,
- $G$  is the CS generating function,
- $E$  is the normal embedding function, and
- $p$  is the point in object-space associated with  $c$ .

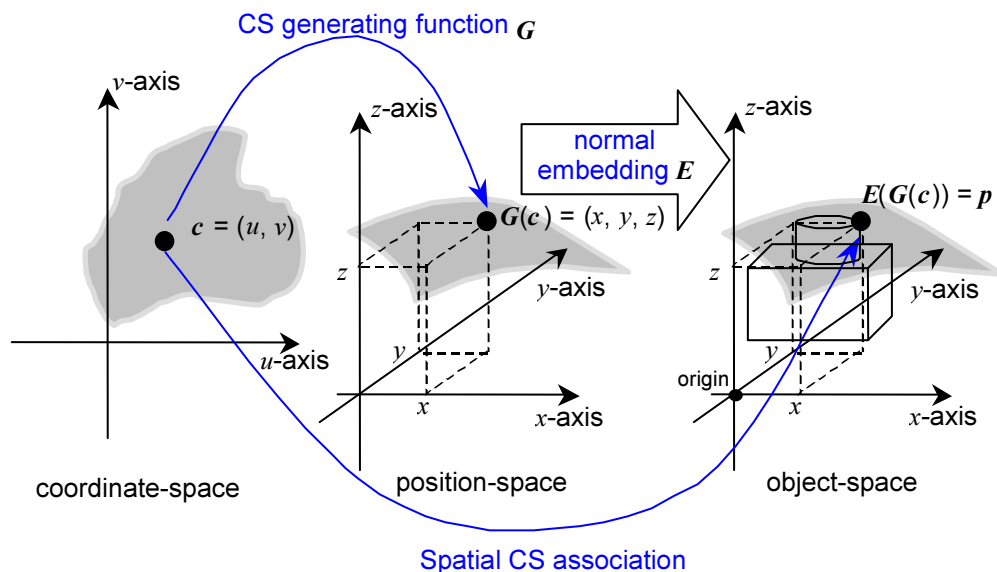


Figure 8.1 — A spatial embedding of a surface CS

EXAMPLE [Figure 8.1](#) illustrates a spatial surface CS bound with a normal embedding of 3D position-space to the 3D object-space. In this illustration, a surface coordinate  $(u, v)$  in coordinate-space is associated to a position  $(x, y, z)$  in the abstract position-space. That position is then identified with a position in the space of an object via the normal embedding of position-space. In this example, the normal embedding is determined by the selection of an origin and three unit points.

## 8.3 Spatial reference frame

### 8.3.1 Specification

A *spatial reference frame* (SRF) is a specification of a spatial coordinate system that is constructed from an ORM and a compatible abstract CS, such that coordinates uniquely specify positions with respect to the spatial object of the ORM. A specification of an SRF includes:

- a) an ORM,
- b) a CS compatible with the ORM,
- c) a binding of all parameters of the spatial CS,
- d) (optionally)  $k^{th}$  coordinate-component names,
- e) (optionally) additional restrictions on the domain of coordinates in that spatial CS, and
- f) (optionally) if the CS is of CS type 3D, a vertical coordinate-component identification (see [8.4](#)).

An SRF implicitly specifies a spatial CS defined by the binding of the CS via the normal embedding associated with the ORM.

Spatial CS compatibility and the other elements of the specification of an SRF are defined in the following clauses.

### 8.3.2 SRF specification elements

#### 8.3.2.1 ORM and CS compatibility

The compatible CS type of the CS element of an SRF depends on the dimension of the ORM. The *dimension of an ORM* is defined as the dimension of the RD components of the specification of the ORM. The compatible CS types by ORM dimension are specified in [Table 8.1](#).

**Table 8.1 — Compatible CS types**

ORM dimension	Compatible CS types
1D	1D CS
2D	Curve CS 2D CS
3D	Curve CS Surface CS 3D CS

The use of surface CSs or 3D CSs that are based on an oblate ellipsoid (or sphere) are restricted to ORMs that are based on an oblate ellipsoid (or respectively, sphere) RD.

The surface CSs that are based on an oblate ellipsoid (or sphere) are:

- a) surface geodetic,
- b) surface planetodetic, and
- c) all map projections.

The 3D CSs that are based on an oblate ellipsoid (or sphere) are:

- a) geodetic 3D,
- b) planetodetic 3D, and
- c) all augmented map projections.

As a further restriction, some CSs are based on spheres only. CS [OBLIQUE MERCATOR SPHERICAL](#) has this restriction.

An SRF may be described in terms of the properties and other characteristics of the CS that is specified by the SRF. In particular, an SRF is said to be a *3D SRF*, *surface SRF*, or *2D SRF* if the CS of the SRF is of the corresponding CS type. Similarly, the CS properties of linearity, orthogonality, and handedness may be used as descriptors of an SRF corresponding to the properties of the CS that is specified by the SRF. Thus, an SRF is said to be a *linear SRF* or a *curvilinear SRF* if the CS of the SRF has the respective linearity property. Every 3D SRF in this International Standard is a right-handed SRF in consequence to the CS handedness restriction imposed in [5.6.4](#).

#### 8.3.2.2 CS parameter binding

All CS parameter values must be specified. In the case of a combination of a CS and an ORM based on an oblate ellipsoid (or sphere), the major semi-axis and minor semi-axis (or equivalently, the inverse flattening) (or respectively, sphere radius) of the ORM and CS shall match.

#### 8.3.2.3 Coordinate-component names

A CS specification (see [5.9](#)) includes the coordinate-component symbols with common names (if any). A specification of an SRF may optionally assign SRF-specific names to the  $k^{th}$  coordinate-components. The name assignment shall reflect the common use in the intended application domain.

**EXAMPLE** For an equatorial spherical CS, the assignment of SRF-specific names to the  $k^{th}$  coordinate-components of “right ascension” for  $\lambda$ , “declination” for  $\theta$ , and “radius” for  $\rho$ .

#### 8.3.2.4 SRF region

A CS specification (see [5.9](#)) includes the specification of the CS domain and CS range where the generating function (or mapping equations) and its inverse(s) are defined. An SRF specification may further restrict the CS domain. An *SRF region* is a restriction of the CS domain as used in an SRF. An *extended SRF region* is a second region that contains the SRF region as a subset. The specification of these restrictions is important for several (SRF specific) reasons:

- a) If the ORM is local, the restrictions are used to model, in coordinate-space, the local region of the space of the object.
- b) If the CS is a map projection or an augmented map projection, the restrictions are used to bound or otherwise limit distortions (see [5.8.3.1](#)).

- c) The SRF may be used in conjunction with other SRFs to form an atlas for a large region (see 8.7 SRF sets). In this case, the restrictions are used to control the pair-wise overlap of the spatial coverage of members of the SRF collection.
- d) If the CS generating function (or map projection mapping equations) or the inverse function(s) have been implemented with a numerical approximation, the restrictions are used to control error bounds.

The extended SRF region is used primarily for overlapping regions in forming an atlas as in (c) above. Not all properties of the SRF that are true in the SRF region will necessarily be true in the extended SRF region. In particular, a distortion error bound that holds in the SRF region may not hold in the extended SRF region.

SRF regions and extended SRF regions may be described and/or specified. An *SRF region description* is a statement that describes the spatial extent of the region such as in terms of named geographic areas or political entities.

EXAMPLE 1 “The German state of Baden-Wurtemberg” and “The Baltic Sea” are SRF region descriptions.

An *SRF region specification* consists of a set of constraints that specifies the spatial extent of the region. The spatial extent of the region may always be specified in terms of coordinate-component value ranges in the coordinate system of the SRF. Such a specification is termed to be of type *coordinate-region*.

If the ORM of the SRF is based on an oblate ellipsoid (or sphere), the spatial extent of the region may alternatively be specified in terms of coordinate-component value ranges in the geodetic coordinate system of the Celestiodetic SRF for that ORM (see 8.5.4). When the coordinate-component value ranges are specified in terms of geodetic coordinates in this way, the specification is termed to be of type *geodetic-region*. To avoid loss of precision, such geodetic coordinate values may be specified in arc degrees. SRF region specifications of type *geodetic-region* may be useful for local Euclidean or map projection-based SRFs.

Each coordinate-component value range may be fully bounded, with both upper and lower bounds specified, semi-bounded, with only one (either upper or lower) bound specified, or unbounded, with no bounds specified. Together, the coordinate-component value ranges specify a full or partial bounding box, in terms of either the coordinate system of the SRF (type *coordinate-region*), or in terms of geodetic coordinates of the Celestiodetic SRF for that ORM (type *geodetic-region*).

If an SRF region has been specified, an *extended SRF region specification* of the same type (type *coordinate-region* or type *geodetic-region*) may also be specified. The ranges specified for an extended SRF region shall contain the corresponding SRF region ranges.

An SRF coordinate is considered to be *within the SRF region* if it is contained in the CS domain of the SRF and satisfies all constraints in the SRF region specification. In the case of an SRF region specification of type *geodetic-region*, the SRF coordinate is considered to be within the SRF region if the corresponding Celestiodetic SRF coordinate satisfies all geodetic constraints in the SRF region specification.

An SRF coordinate is considered to be *within the extended SRF region* if it is contained in the CS domain of the SRF and satisfies the constraints in the extended SRF region specification. In the case of an extended SRF region specification of type *geodetic-region*, the SRF coordinate is considered to be within the extended SRF region if the corresponding Celestiodetic SRF coordinate satisfies all geodetic constraints in the extended SRF region specification.

EXAMPLE 2 The SRF is based on a transverse Mercator map projection (see SRFT [TRANSVERSE MERCATOR](#)).  
 SRF region specification of type *coordinate-region*:  $167\,000 \leq u \leq 833\,000, \quad 0 \leq v \leq 9\,500\,000$   
 Extended SRF region specification of type *coordinate-region*:  $0 < u, \quad -100 < v$   
 Note that the extended SRF region is partially bounded.

EXAMPLE 3 The SRF is based on a transverse Mercator map projection (see SRFT [TRANSVERSE MERCATOR](#)).  
 SRF region specification of type *geodetic-region*:  $-78^\circ \leq \lambda < -72^\circ, \quad 0^\circ \leq \varphi < 84^\circ$   
 Extended SRF region specification of type *geodetic-region*:  $-78,5^\circ \leq \lambda < -71,5^\circ$

Note that the extended SRF region is partially bounded, since no constraint on  $\varphi$  is specified.

## 8.4 SRF induced surface spatial reference frame

In the case of an SRF specified with the combination of a 3D ORM and a 3D CS, the 3D CS induces a surface CS on each coordinate-component surface (see 5.5.2). An SRF specification may optionally identify the 3<sup>rd</sup> coordinate-component as the *vertical coordinate-component* for the SRF. In that case, the surface CS induced on the zero-value vertical coordinate-component surface is the induced surface SRF for the specification. The vertical coordinate-component is optionally specified in the coordinate-component name specification element of the SRF.

The CS [GEODETIC](#) and the CS [PLANETODETIC](#) 3<sup>rd</sup> coordinate-components ( $h$ : ellipsoidal height), and the 3<sup>rd</sup> coordinate-component of any augmented map projection CS ( $h$ : ellipsoidal height) are identified in this International Standard as the vertical coordinate-component. When an SRF is specified with any of these 3D CSs, the  $h = 0$  coordinate-component surface coincides with the surface of the oblate ellipsoid (or sphere) RD of the ORM. Any SRF based on these CSs intrinsically specifies the corresponding surface CS on the oblate ellipsoid (or sphere) RD surface.

In an SRF realized from the SRF template [LOCAL TANGENT SPACE EUCLIDEAN](#) specification (see 8.5.6) or the SRF template [LOCAL TANGENT SPACE CYLINDRICAL](#) specification (see 8.5.8), the 3<sup>rd</sup> coordinate-component, height, is specified as the vertical coordinate-component. In these cases, the zero-value vertical coordinate-component surface is a plane parallel to the tangent plane at the SRF tangent point. SRF templates are defined in 8.5.

The zero-value 3<sup>rd</sup> coordinate-component surface of an SRF realized from the 3D CS SRF template [LOCAL TANGENT SPACE AZIMUTHAL SPHERICAL](#) specification (see 8.5.7) induces a lococentric surface azimuthal CS on the tangent plane of the SRF. For the purpose of specifying an induced surface reference frame, the 3<sup>rd</sup> coordinate-component  $\theta$ , depression/elevation angle, is specified as a vertical coordinate. The zero-value vertical coordinate-component surface is a plane parallel to the tangent plane at the SRF tangent point.

SRF templates that are based on surface CSs that can be induced by a zero-value vertical coordinate-component surface of an SRF based on a 3D CS are not separately specified. The induced surface CS is noted in the corresponding 3D CS based SRF template specification.

**NOTE** Starting with a 3D SRF, this International Standard identifies surface SRFs on coordinate-component surfaces. The relationship between a surface CS and the 3D CS which induces it is functionally similar to, but conceptually different from, the [ISO 19111](#) concept of compound coordinate reference system. A compound coordinate reference system synthesizes a 3D reference frame from a surface and a vertical system. (See also 5.8.6.1 and [Clause 9](#).)

## 8.5 SRF templates

### 8.5.1 Introduction

A *spatial reference frame template* (SRFT) is an abstraction of a collection of SRFs that share the same abstract CS, coordinate component names, CS parameter binding rules, and similar ORMs that model the same spatial object type. An SRF template allows for a consistent derivation of SRFs. It is not necessary that an appropriate SRFT be defined in order to define a new SRF; however in this International Standard all SRFs are derived from SRFTs. The specification elements for SRFTs are defined in [Table 8.2](#).

Table 8.2 — SRFT specification elements

Element	Definition
<b>SRFT label</b>	The label of the SRF template (see <a href="#">13.2.2</a> ).
<b>SRFT code</b>	The code of the SRF template (see <a href="#">13.2.3</a> ). Code 0 (UNSPECIFIED) is reserved.
<b>Short name and description</b>	A short name as published or as commonly known and an optional description.
<b>Object or object type</b>	One or more of: abstract, physical, Earth, planet, satellite, and Sun; and, optionally, additional restrictions.
<b>ORM constraint</b>	Criteria for applicable ORMs.
<b>CS label</b>	The label of a CS of compatible type.
<b>CS coordinate-component names and/or symbols</b>	SRF-specific names and/or symbols for the $k^{th}$ coordinate-component names and/or symbols. If all coordinate-component names and symbols are the same as the CS, the phrase "The same as the CS." shall be used. In addition, if the CS is 3D, the third coordinate-component may optionally be identified as the "vertical coordinate-component".
<b>Template parameters</b>	CS and RD parameters, if any, and/or SRF parameters that are not specified by a CS parameter binding rule.
<b>CS parameter binding rules</b>	A set of rules for binding for CS parameters and ORM component RD parameters, if any, and/or SRF parameters.
<b>SRF region</b>	Optional restriction of the domain of the CS to an SRF region description and/or an SRF region specification. If an SRF region specification is included, an extended SRF region specification may also be included.  If no SRF region is specified, the phrase "No additional restrictions." shall be used.
<b>Notes</b>	Optional, non-normative information such as a description of the SRF structure, modelled region, intended use, and/or application domain.
<b>References</b>	The references (see <a href="#">13.2.5</a> ).

An ORM is *applicable* to an SRFT if the object associated with the ORM satisfies the object or object type specification of the SRFT, and the ORM satisfies the ORM constraint specification of the SRFT.

Coordinates in a given SRF may be represented in a variety of formats or encodings if the coordinate-component values are sufficiently identified in the representation scheme. In particular, a representation scheme for coordinates of an SRF:

- shall identify the coordinate-components by name and/or symbol, or
- shall identify coordinate-components of an encoding scheme in terms of the coordinate-components specified in the SRF, or
- shall define the ordering of a coordinate-component-tuple representation in terms of the coordinate-components specified in the SRF.

The API (see [11](#)) provides coordinate value encoding schemes in the form of data records with field names that correspond to coordinate-component names. Where coordinate-component-tuples appear in the API, the ordering is the order specified in the corresponding CS specification table.

This International Standard specifies a collection of SRFTs as identified in [Table 8.3](#). Additional SRFTs may be specified by registration in accordance with [Clause 13](#). Registered SRFs shall be derived only from standardized or registered SRFTs.

**Table 8.3 — SRFT directory**

CS type	Short name	SRFT label
<b>3D</b>	Celestiocentric	<a href="#">CELESTIOCENTRIC</a>
	Local space rectangular 3D	<a href="#">LOCAL_SPACE_RECTANGULAR_3D</a>
	Celestiodetic	<a href="#">CELESTIODETTIC</a>
	Planetodetic	<a href="#">PLANETODETTIC</a>
	Local tangent space Euclidean	<a href="#">LOCAL_TANGENT_SPACE_EUCLIDEAN</a>
	Local tangent space azimuthal spherical	<a href="#">LOCAL_TANGENT_SPACE_AZIMUTHAL_SPHERICAL</a>
	Local tangent space cylindrical	<a href="#">LOCAL_TANGENT_SPACE_CYLINDRICAL</a>
	Lococentric Euclidean 3D	<a href="#">LOCOCENTRIC_EUCLIDEAN_3D</a>
	Celestiomagnetic	<a href="#">CELESTIOMAGNETIC</a>
	Equatorial inertial	<a href="#">EQUATORIAL_INERTIAL</a>
	Solar ecliptic	<a href="#">SOLAR_ECLIPTIC</a>
	Solar equatorial	<a href="#">SOLAR_EQUATORIAL</a>
	Solar magnetic ecliptic	<a href="#">SOLAR_MAGNETIC_ECLIPTIC</a>
	Solar magnetic	<a href="#">SOLAR_MAGNETIC_DIPOLE</a>
	Heliospheric Aries ecliptic	<a href="#">HELIOSPHERIC_ARIES_ECLIPTIC</a>
	Heliospheric Earth ecliptic	<a href="#">HELIOSPHERIC_EARTH_ECLIPTIC</a>
	Heliospheric Earth equatorial	<a href="#">HELIOSPHERIC_EARTH_EQUATORIAL</a>
<b>Surface (map projection) and 3D (augmented map projection)</b>	Mercator	<a href="#">MERCATOR</a>
	Oblique Mercator spherical	<a href="#">OBLIQUE_MERCATOR_SPHERICAL</a>
	Transverse Mercator	<a href="#">TRANSVERSE_MERCATOR</a>
	Lambert conformal conic	<a href="#">LAMBERT_CONFORMAL_CONIC</a>
	Polar stereographic	<a href="#">POLAR_STEREOGRAPHIC</a>
	Equidistant cylindrical	<a href="#">EQUIDISTANT_CYLINDRICAL</a>
<b>Surface</b>	Surface celestiodetic ( <i>induced</i> )	<a href="#">CELESTIODETTIC</a>
	Surface planetodetic ( <i>induced</i> )	<a href="#">PLANETODETTIC</a>
	Local tangent plane Euclidean ( <i>induced</i> )	<a href="#">LOCAL_TANGENT_SPACE_EUCLIDEAN</a>
	Local tangent plane azimuthal ( <i>induced</i> )	<a href="#">LOCAL_TANGENT_SPACE_AZIMUTHAL_SPHERICAL</a>



CS type	Short name	SRFT label
	Local tangent plane polar ( <i>induced</i> )	<a href="#">LOCAL_TANGENT_SPACE_CYLINDRICAL</a>
2D	Local space rectangular 2D	<a href="#">LOCAL_SPACE_RECTANGULAR_2D</a>
	Local space azimuthal	<a href="#">LOCAL_SPACE_AZIMUTHAL_2D</a>
	Local space polar	<a href="#">LOCAL_SPACE_POLAR_2D</a>

### 8.5.2 Celestiocentric SRFT

*Celestiocentric SRFs* shall be derived from the SRFT specified in [Table 8.4](#).

**Table 8.4 — Celestiocentric SRFT**

Element	Specification
SRFT label	CELESTIOCENTRIC
SRFT code	1
Short name and description	celestiocentric SRFT The generalization of geocentric spatial reference frames to include non-Earth objects.
Object type	physical
ORM constraint	Shall be derived from any 3D ORM.
CS label	<a href="#">EUCLIDEAN_3D</a>
CS coordinate-component names and/or symbols	The same as the CS.
Template parameters	none
CS parameter binding rules	None (no CS parameters).
SRF region	No additional restrictions.
Notes	When the object is Earth, this SRFT is referred to as a <i>geocentric SRFT</i> .
References	<a href="#">[EDM]</a>

### 8.5.3 Local space rectangular 3D SRFT

*Local space rectangular SRFs* shall be derived from the SRFT specified in [Table 8.5](#).

**Table 8.5 — Local space rectangular 3D SRFT**

Element	Specification
SRFT label	LOCAL_SPACE_RECTANGULAR_3D
SRFT code	2
Short name and description	local space rectangular 3D SRFT A 3D Euclidean spatial reference frame for an abstract 3D space.



Element	Specification
<b>Object type</b>	3D abstract object
<b>ORM constraint</b>	Shall be an ORM for a 3D abstract object.
<b>CS label</b>	<a href="#">LOCOCENTRIC EUCLIDEAN 3D</a>
<b>CS coordinate-component names and/or symbols</b>	The same as the CS.
<b>Template parameters</b>	$r$ = vector direction of forward (forward axis). $s$ = vector direction of up (up axis).
<b>CS parameter binding rules</b>	$q = 0$ , $r$ and $s$ , select from: $+e_1$ positive primary axis, $+e_2$ positive secondary axis, $+e_3$ positive tertiary axis, $-e_1$ negative primary axis, $-e_2$ negative secondary axis, or $-e_3$ negative tertiary axis, subject to: $s \neq \pm r$ , where: $e_1 = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}, e_2 = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}, \text{ and } e_3 = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}.$
<b>SRF region</b>	No additional restrictions.
<b>Notes</b>	<a href="#">CAD/CAM</a> and other engineering applications.
<b>References</b>	<a href="#">[EDM]</a>

#### 8.5.4 Celestiodetic SRFT

*Celestiodetic SRFs* shall be derived from the SRFT specified in [Table 8.6](#).

**Table 8.6 — Celestiodetic SRFT**

Element	Specification
<b>SRFT label</b>	CELESTIODETTIC
<b>SRFT code</b>	3
<b>Short name and description</b>	celestiodetic SRFT The generalization of geodetic SRFs to include other planets and ellipsoidal bodies.
<b>Object type</b>	physical
<b>ORM constraint</b>	Shall be derived from: ORMT <a href="#">OBLATE ELLIPSOID</a> , <a href="#">OBLATE ELLIPSOID ORIGIN</a> , <a href="#">SPHERE</a> , or <a href="#">SPHERE ORIGIN</a> .
<b>CS label</b>	<a href="#">GEODETIC</a>

Element	Specification
<b>CS coordinate-component names and/or symbols</b>	The same as the CS. The vertical coordinate-component is ellipsoidal height ( $h$ ).
<b>Template parameters</b>	none
<b>CS parameter binding rules</b>	CS parameters match RD values. Oblate ellipsoid RD case with major semi-axis $a$ and inverse flattening $f^{-1}$ : $a = a$ $b = a(1 - f)$ Sphere RD case with radius $r$ : $a = b = r.$
<b>SRF region</b>	No additional restrictions.
<b>Notes</b>	1) The <a href="#">SURFACE GEODETIC</a> CS is induced on the oblate ellipsoid (or sphere) RD surface. 2) When the object is Earth, this SRFT is referred to as a <i>geodetic SRFT</i> .
<b>References</b>	<a href="#">[HEIK]</a>

### 8.5.5 Planetodetic SRFT

Planetodetic SRFs shall be derived from the SRFT specified in [Table 8.7](#).

**Table 8.7 — Planetodetic SRFT**

Element	Specification
<b>SRFT label</b>	PLANETODETIC
<b>SRFT code</b>	4
<b>Short name and description</b>	planetodetic SRFT Similar to celestiodetic SRFT with reversed direction for longitude.
<b>Object type</b>	planet
<b>ORM constraint</b>	Shall be derived from: ORMT <a href="#">OBLATE_ELLIPSOID</a> , <a href="#">OBLATE_ELLIPSOID_ORIGIN</a> , <a href="#">SPHERE</a> , or <a href="#">SPHERE_ORIGIN</a> .
<b>CS label</b>	<a href="#">PLANETODETIC</a>
<b>CS coordinate names and/or symbols</b>	The same as the CS. The vertical coordinate-component is ellipsoidal height ( $h$ ).
<b>Template parameters</b>	none
<b>CS parameter binding rules</b>	CS parameters match RD values: Oblate ellipsoid RD case with major semi-axis $a$ and inverse flattening $f^{-1}$ : $a = a$ $b = a(1 - f)$ Sphere RD case with radius $r$ : $a = b = r.$
<b>SRF region</b>	No additional restrictions.

Element	Specification
Notes	Planetary science applications.
References	[RIIC06]

### 8.5.6 Local tangent space Euclidean SRFT

*Local tangent space Euclidean SRFTs* shall be derived from the SRFT specified in [Table 8.8](#). The case with template parameters  $\alpha = 0$  and  $h_0 = 0$  is illustrated in [Figure 8.2](#).

**Table 8.8 — Local tangent space Euclidean SRFT**

Element	Specification
SRFT label	LOCAL_TANGENT_SPACE_EUCLIDEAN
SRFT code	5
Short name and description	local tangent space Euclidean SRFT Euclidean 3D spatial CS with 3 <sup>rd</sup> coordinate-component surfaces that are parallel to a plane tangent to the oblate ellipsoid RD.
Object type	physical
ORM constraint	Shall be derived from: ORMT <a href="#">OBLATE_ELLIPSOID</a> , <a href="#">OBLATE_ELLIPSOID_ORIGIN</a> , <a href="#">SPHERE</a> , or <a href="#">SPHERE_ORIGIN</a> .
CS label	<a href="#">LOCOCENTRIC_EUCLIDEAN_3D</a>
CS coordinate-component names and/or symbols	$u$ : $x$ ( $x$ ) $v$ : $y$ ( $y$ ) $w$ : height ( $h$ ) is the vertical coordinate-component.
Template parameters	$(\lambda, \varphi)$ = surface geodetic coordinate of the tangent point $\alpha$ = azimuth ( $v$ -axis azimuth from north) $x_F$ = false origin $x$ $y_F$ = false origin $y$ $h_0$ = offset height

Element	Specification
CS parameter binding rules	$\mathbf{r} = T \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}, \quad \mathbf{s} = T \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}, \quad \text{and } \mathbf{q} = \mathbf{q}_0 - x_F \mathbf{r} - y_F \mathbf{s}$ <p>where:</p> $\mathbf{q}_0 = \begin{pmatrix} (R_N(\varphi) + h_0) \cos(\varphi) \cos(\lambda) \\ (R_N(\varphi) + h_0) \cos(\varphi) \sin(\lambda) \\ \left( \frac{b^2}{a^2} R_N(\varphi) + h_0 \right) \sin(\varphi) \end{pmatrix},$ <p><math>a</math> and <math>b</math> match the oblate ellipsoid (or sphere) RD values, and</p> $\mathbf{T} = \begin{pmatrix} -\sin \lambda & -\cos \lambda \sin \varphi & \cos \lambda \cos \varphi \\ \cos \lambda & -\sin \lambda \sin \varphi & \sin \lambda \cos \varphi \\ 0 & \cos \varphi & \sin \varphi \end{pmatrix} \begin{pmatrix} \cos \alpha & \sin \alpha & 0 \\ -\sin \alpha & \cos \alpha & 0 \\ 0 & 0 & 1 \end{pmatrix}.$
SRF region	No additional restrictions.
Notes	<ol style="list-style-type: none"> <li>1) The <a href="#">LOCOCENTRIC SURFACE EUCLIDEAN</a> CS is induced on the tangent plane surface.</li> <li>2) The <math>w = -h_0</math> coordinate-component plane<sup>24</sup> is tangent to the oblate ellipsoid RD at the point with surface celestiodetic coordinate <math>(\lambda, \varphi)</math>.</li> <li>3) <math>\alpha</math> is the geodetic azimuth of the <math>v</math>-axis (see <a href="#">Figure 8.2</a>).</li> <li>4) <math>h_0</math> is the ellipsoidal height of the CS origin.</li> </ol>
References	<a href="#">[EDM]</a>

<sup>24</sup> In [ISO 19111](#) terminology, the tangent plane is an engineering datum.

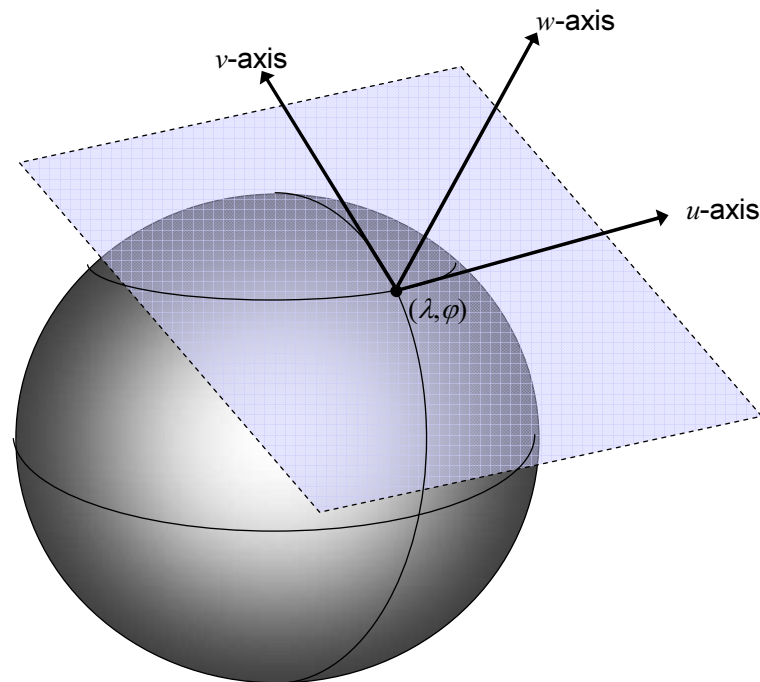


Figure 8.2 — Local tangent space Euclidean SRFT

### 8.5.7 Local tangent space azimuthal spherical SRFT

Local tangent space azimuthal spherical SRFs shall be derived from the SRFT specified in [Table 8.9](#).

Table 8.9 — Local tangent space azimuthal spherical SRFT

Element	Specification
SRFT label	LOCAL_TANGENT_SPACE_AZIMUTHAL_SPHERICAL
SRFT code	6
Short name and description	local tangent space azimuthal spherical SRFT Azimuthal spherical spatial CS with the zero 3 <sup>rd</sup> coordinate-component surface that is tangent to the oblate ellipsoid RD and with CS natural origin at the tangent point.
Object type	physical
ORM constraint	Shall be derived from: ORMT <a href="#">OBLATE_ELLIPSOID</a> , <a href="#">OBLATE_ELLIPSOID_ORIGIN</a> , <a href="#">SPHERE</a> , or <a href="#">SPHERE_ORIGIN</a> .
CS label	<a href="#">LOCOCENTRIC_AZIMUTHAL_SPHERICAL</a>
CS coordinate-component names and/or symbols	The same as the CS. $\theta$ : depression/elevation angle, is the vertical coordinate-component.

Element	Specification
Template parameters	$(\lambda, \varphi)$ = surface geodetic coordinate of the tangent point $\alpha$ = azimuth ( $v$ -axis azimuth from north) $h_0$ = offset height
CS parameter binding rules	$\mathbf{q} = \begin{pmatrix} (R_N(\varphi) + h_0) \cos(\varphi) \cos(\lambda) \\ (R_N(\varphi) + h_0) \cos(\varphi) \sin(\lambda) \\ \left( \frac{b^2}{a^2} R_N(\varphi) + h_0 \right) \sin(\varphi) \end{pmatrix}$ $\mathbf{r} = T \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$ $\mathbf{s} = T \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$ <p>where:</p> <p><math>a</math> and <math>b</math> match the oblate ellipsoid (or sphere) RD values, and</p> $T = \begin{pmatrix} -\sin \lambda & -\cos \lambda \sin \varphi & \cos \lambda \cos \varphi \\ \cos \lambda & -\sin \lambda \sin \varphi & \sin \lambda \cos \varphi \\ 0 & \cos \varphi & \sin \varphi \end{pmatrix} \begin{pmatrix} \cos \alpha & \sin \alpha & 0 \\ -\sin \alpha & \cos \alpha & 0 \\ 0 & 0 & 1 \end{pmatrix}$
SRF region	No additional restrictions.
Notes	1) Used in radar localization. 2) $h_0$ is the ellipsoidal height of the CS origin. 3) $\alpha$ is the geodetic azimuth of the $v$ -axis (see <a href="#">Figure 8.2</a> ).
References	<a href="#">[EDM]</a>

### 8.5.8 Local tangent space cylindrical SRFT

Local tangent space cylindrical SRFs shall be derived from the SRFT specified in [Table 8.10](#).

**Table 8.10 — Local tangent space cylindrical SRFT**

Element	Specification
SRFT label	LOCAL_TANGENT_SPACE_CYLINDRICAL
SRFT code	7
Short name and description	local tangent space cylindrical SRFT Cylindrical spatial CS with 3 <sup>rd</sup> coordinate-component surfaces that are parallel to a plane tangent to the oblate ellipsoid RD.
Object type	physical

Element	Specification
<b>ORM constraint</b>	Shall be derived from: ORMT <a href="#">OBLATE ELLIPSOID</a> , <a href="#">OBLATE ELLIPSOID ORIGIN</a> , <a href="#">SPHERE</a> , or <a href="#">SPHERE ORIGIN</a> .
<b>CS label</b>	<a href="#">LOCOCENTRIC CYLINDRICAL</a>
<b>CS coordinate-component names and/or symbols</b>	The same as the CS. The same as the CS. $\zeta$ : height ( $h$ ) is the vertical coordinate
<b>Template parameters</b>	$(\lambda, \varphi)$ = surface geodetic coordinate of the tangent point $\alpha$ = azimuth ( $v$ -axis azimuth from north) $h_0$ = offset height
<b>CS parameter binding rules</b>	$\mathbf{q} = \begin{pmatrix} (R_N(\varphi) + h_0) \cos(\varphi) \cos(\lambda) \\ (R_N(\varphi) + h_0) \cos(\varphi) \sin(\lambda) \\ \left( \frac{b^2}{a^2} R_N(\varphi) + h_0 \right) \sin(\varphi) \end{pmatrix}$ $\mathbf{r} = \mathbf{T} \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$ $\mathbf{s} = \mathbf{T} \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$ <p>where:</p> <p><math>a</math> and <math>b</math> match the oblate ellipsoid (or sphere) RD values, and</p> $\mathbf{T} = \begin{pmatrix} -\sin \lambda & -\cos \lambda \sin \varphi & \cos \lambda \cos \varphi \\ \cos \lambda & -\sin \lambda \sin \varphi & \sin \lambda \cos \varphi \\ 0 & \cos \varphi & \sin \varphi \end{pmatrix} \begin{pmatrix} \cos \alpha & \sin \alpha & 0 \\ -\sin \alpha & \cos \alpha & 0 \\ 0 & 0 & 1 \end{pmatrix}$
<b>SRF region</b>	No additional restrictions.
<b>Notes</b>	<ol style="list-style-type: none"> <li>1) The <a href="#">LOCOCENTRIC SURFACE POLAR</a> CS is induced on the tangent plane surface.</li> <li>2) The <math>w = -h_0</math> coordinate-component plane<sup>24</sup> is tangent to the oblate ellipsoid RD at the point with surface geodetic coordinate <math>(\lambda, \varphi)</math>.</li> <li>3) <math>\alpha</math> is the geodetic azimuth of the <math>v</math>-axis (see <a href="#">Figure 8.2</a>).</li> <li>4) <math>h_0</math> is the ellipsoidal height of the CS origin.</li> </ol>
<b>References</b>	<a href="#">[EDM]</a>



## 8.5.9 Lococentric Euclidean 3D SRFT

Lococentric Euclidean 3D SRFs shall be derived from the SRFT specified in [Table 8.11](#).

Table 8.11 — Lococentric Euclidean 3D SRFT

Element	Specification
SRFT label	LOCOCENTRIC_EUCLIDEAN_3D
SRFT code	8
Short name and description	Lococentric Euclidean 3D SRFT Euclidean 3D spatial CS with a localised origin and axes orientations.
Object type	any 3D object
ORM constraint	Shall be derived from any 3D ORM.
CS label	<a href="#">LOCOCENTRIC_EUCLIDEAN_3D</a>
CS coordinate-component names and/or symbols	The same as the CS.
Template parameters	<p>Localization parameters:</p> <p><math>q</math>: the lococentric origin,  <math>r</math>: primary axis direction, and  <math>s</math>: secondary axis direction.</p> <p>Constraints:  <math>r</math> and <math>s</math> are orthonormal vectors.</p>
CS parameter binding rules	The template parameters are the CS parameters.
SRF region	No additional restrictions.
Notes	<ol style="list-style-type: none"> <li>1) A <a href="#">CELESTIOCENTRIC</a> SRFT is special case of an instance of this SRFT with <math>q = (0 \ 0 \ 0)</math>, <math>r = (1 \ 0 \ 0)</math>, <math>s = (0 \ 1 \ 0)</math>, and a physical object.</li> <li>2) A <a href="#">LOCAL_SPACE_RECTANGULAR_3D</a> SRFT is special case of an instance of this SRFT with <math>q = (0 \ 0 \ 0)</math>, and an abstract object.</li> <li>3) A <a href="#">LOCAL_TANGENT_SPACE_EUCLIDEAN</a> SRFT is special case of an instance of this SRFT with <math>q, r, s</math>, satisfying the SRFT LOCAL_TANGENT_SPACE_EUCLIDEAN CS parameter binding rules and ORM constraint.</li> <li>4) This SRFT is required for the SRM treatment of directions (see <a href="#">10.5</a>).</li> </ol>
References	<a href="#">[EDM]</a>

### 8.5.10 Celestiomagnetic SRFT

*Celestiomagnetic SRFs* shall be derived from the SRFT specified in [Table 8.12](#).

**Table 8.12 — Celestiomagnetic SRFT**

Element	Specification
SRFT label	CELESTIOMAGNETIC
SRFT code	9
Short name and description	celestiomagnetic SRFT An equatorial spherical CS based SRFT aligned with the magnetic dipole of a celestial object.
Object type	A planet or rotating satellite in a solar system with a magnetic dipole axis distinct from its rotational axis.
ORM constraint	Based on ORMT <a href="#">BI AXIS ORIGIN 3D</a> and OBRS <a href="#">CELESTIOMAGNETIC</a> .
CS label	<a href="#">EQUATORIAL SPHERICAL</a>
CS coordinate-component names and/or symbols	The same as the CS.
Template parameters	none
CS parameter binding rules	none
SRF region	No additional restrictions.
Notes	1) See <a href="#">7.5.8</a> . 2) When the object is Earth, this SRFT is referred to as a <i>geomagnetic SRFT</i> . 3) These SRFs are typically used at radii where the magnetic field is approximated by a dipole.
References	<a href="#">[CRUS]</a>

### 8.5.11 Equatorial inertial SRFT

*Equatorial inertial SRFs* shall be derived from the SRFT specified in [Table 8.13](#).

**Table 8.13 — Equatorial inertial SRFT**

Element	Specification
SRFT label	EQUATORIAL_INERTIAL
SRFT code	10
Short name and description	equatorial inertial SRFT An equatorial spherical CS based SRF aligned with the equator of a planet and the direction to the Sun at the vernal equinox (at a specified epoch).
Object type	A planet in the solar system for which the ecliptic plane is distinct from the equatorial plane.
ORM constraint	Based on ORMT <a href="#">BI AXIS ORIGIN 3D</a> and OBRS <a href="#">EQUATORIAL_INERTIAL</a> .

Element	Specification
CS label	<a href="#">EQUATORIAL SPHERICAL</a>
CS coordinate-component names and/or symbols	$\lambda$ : right ascension ( <i>ra</i> ) $\theta$ : declination ( <i>dec</i> ) $\rho$ : radius or range( <i>r</i> )
Template parameters	none
CS parameter binding rules	none
SRF region	No additional restrictions.
Notes	1) See <a href="#">7.5.2</a> . 2) Star catalogues use right ascension and declination to specify directions.
References	<a href="#">[SEID]</a>

### 8.5.12 Solar ecliptic SRFT

*Solar ecliptic SRFs* shall be derived from the SRFT specified in [Table 8.14](#).

**Table 8.14 — Solar ecliptic SRFT**

Element	Specification
SRFT label	SOLAR_ECLIPTIC
SRFT code	11
Short name and description	solar ecliptic SRFT An equatorial spherical CS based SRF aligned with the ecliptic plane of a planet and the direction of the Sun.
Object type	A planet in the solar system.
ORM constraint	Based on ORMT <a href="#">BI_AXIS_ORIGIN_3D</a> and OBRS <a href="#">SOLAR_ECLIPTIC</a> .
CS label	<a href="#">EQUATORIAL SPHERICAL</a>
CS coordinate-component names and/or symbols	The same as the CS.
Template parameters	none
CS parameter binding rules	none
SRF region	No additional restrictions.
Notes	See <a href="#">7.5.3</a> .
References	<a href="#">[HAPG]</a>

### 8.5.13 Solar equatorial SRFT

*Solar equatorial SRFs* shall be derived from the SRFT specified in [Table 8.15](#).

**Table 8.15 — Solar equatorial SRFT**

Element	Specification
SRFT label	SOLAR_EQUATORIAL
SRFT code	12
Short name and description	solar equatorial SRFT An equatorial spherical CS based planet centred SRF aligned with the ecliptic plane and the rotational axis of the Sun.
Object type	A planet in the solar system for which the ecliptic plane is distinct from the equatorial plane.
ORM constraint	Based on ORMT <a href="#">BI AXIS ORIGIN 3D</a> and OBRS <a href="#">SOLAR EQUATORIAL</a> .
CS label	<a href="#">EQUATORIAL SPHERICAL</a>
CS coordinate-component names and/or symbols	The same as the CS.
Template parameters	none
CS parameter binding rules	none
SRF region	No additional restrictions.
Notes	See <a href="#">7.5.4</a> .
References	<a href="#">[CRUS]</a>

### 8.5.14 Solar magnetic ecliptic SRFT

*Solar magnetic ecliptic SRFs* shall be derived from the SRFT specified in [Table 8.16](#).

**Table 8.16 — Solar magnetic ecliptic SRFT**

Element	Specification
SRFT label	SOLAR_MAGNETIC_ECLIPTIC
SRFT code	13
Short name and description	solar magnetic ecliptic SRFT A Euclidean 3D CS based planet centred SRF aligned with the direction to the Sun and the plane determined by that direction and the magnetic dipole of the planet.
Object type	A planet in the solar system with a magnetic dipole.
ORM constraint	Based on ORMT <a href="#">BI AXIS ORIGIN 3D</a> and OBRS <a href="#">SOLAR MAGNETIC ECLIPTIC</a> .
CS label	<a href="#">EUCLIDEAN 3D</a>
CS coordinate-component names and/or symbols	The same as the CS.

Element	Specification
Template parameters	none
CS parameter binding rules	none
SRF region	No additional restrictions.
Notes	1) See <a href="#">7.5.9</a> . 2) In the case of planet Earth, this SRFT is also known as a <i>geocentric solar magnetospheric SRFT</i> .
References	<a href="#">[CRUS]</a>

### 8.5.15 Solar magnetic dipole SRFT

*Solar magnetic dipole SRFs* shall be derived from the SRFT specified in [Table 8.17](#).

**Table 8.17 — Solar magnetic dipole SRFT**

Element	Specification
SRFT label	SOLAR_MAGNETIC_DIPOLE
SRFT code	14
Short name and description	solar magnetic dipole SRFT A Euclidean 3D CS based planet centred SRF with the <i>z</i> -axis aligned with the magnetic dipole and the <i>xz</i> -plane containing the Sun.
Object type	A planet in the solar system with a magnetic dipole axis distinct from its rotational axis.
ORM constraint	Based on ORMT <a href="#">BI AXIS ORIGIN 3D</a> and OBRS <a href="#">SOLAR MAGNETIC DIPOLE</a> .
CS label	<a href="#">EUCLIDEAN 3D</a>
CS coordinate-component names and/or symbols	The same as the CS.
Template parameters	none
CS parameter binding rules	none
SRF region	No additional restrictions.
Notes	See <a href="#">7.5.10</a> .
References	<a href="#">[CRUS]</a> , <a href="#">[BHAV]</a>

### 8.5.16 Heliospheric Aries ecliptic SRFT

*Heliospheric Aries ecliptic SRFs* shall be derived from the SRFT specified in [Table 8.18](#).

**Table 8.18 — Heliospheric Aries ecliptic SRFT**

Element	Specification
SRFT label	HELIOSPHERIC_ARIES_ECLIPTIC
SRFT code	15
Short name and description	heliospheric Aries ecliptic SRFT An equatorial spherical CS based Sun centred SRF with zero spherical latitude aligned with the ecliptic plane and zero longitude aligned to the first point of Aries.
Object type	Sun
ORM constraint	Based on ORMT <a href="#">BI AXIS ORIGIN 3D</a> and OBRS <a href="#">HELIOCENTRIC_ARIES_ECLIPTIC</a> .
CS label	<a href="#">EQUATORIAL_SPHERICAL</a>
CS coordinate-component names and/or symbols	The same as the CS.
Template parameters	none
CS parameter binding rules	none
SRF region	No additional restrictions.
Notes	See <a href="#">7.5.5</a> .
References	<a href="#">[HAPG]</a>

### 8.5.17 Heliospheric Earth ecliptic SRFT

*Heliospheric Earth ecliptic SRFs* shall be derived from the SRFT specified in [Table 8.19](#).

**Table 8.19 — Heliospheric Earth ecliptic SRFT**

Element	Specification
SRFT label	HELIOSPHERIC_EARTH_ECLIPTIC
SRFT code	16
Short name and description	heliospheric Earth ecliptic SRFT An equatorial spherical CS based Sun centred SRF with zero spherical latitude aligned with the ecliptic plane and zero longitude aligned to the centre of the Earth.
Object type	Sun
ORM constraint	Based on ORMT <a href="#">BI AXIS ORIGIN 3D</a> and OBRS <a href="#">HELIOCENTRIC_PLANET_ECLIPTIC</a> .
CS label	<a href="#">EQUATORIAL_SPHERICAL</a>

Element	Specification
<b>CS coordinate-component names and/or symbols</b>	The same as the CS.
<b>Template parameters</b>	none
<b>CS parameter binding rules</b>	none
<b>SRF region</b>	No additional restrictions.
<b>Notes</b>	See <a href="#">7.5.6</a> .
<b>References</b>	<a href="#">[HAPG]</a>

### 8.5.18 Heliospheric Earth equatorial SRFT

*Heliospheric Earth equatorial SRFs* shall be derived from the SRFT specified in [Table 8.20](#).

**Table 8.20 — Heliospheric Earth equatorial SRFT**

Element	Specification
<b>SRFT label</b>	HELIOSPHERIC_EARTH_EQUATORIAL
<b>SRFT code</b>	17
<b>Short name and description</b>	heliospheric Earth equatorial SRFT An equatorial spherical CS based Sun centred SRF with zero spherical latitude aligned with the equator of the Sun and zero longitude aligned to the centre of the Earth.
<b>Object type</b>	Sun
<b>ORM constraint</b>	Based on ORMT <a href="#">BI_AXIS_ORIGIN_3D</a> and OBRs <a href="#">HELIOCENTRIC_PLANET_EQUATORIAL</a> with respect to Earth.
<b>CS label</b>	<a href="#">EQUATORIAL_SPHERICAL</a>
<b>CS coordinate-component names and/or symbols</b>	The same as the CS.
<b>Template parameters</b>	none
<b>CS parameter binding rules</b>	none
<b>SRF region</b>	No additional restrictions.
<b>Notes</b>	See <a href="#">7.5.7</a> .
<b>References</b>	<a href="#">[HAPG]</a>



## 8.5.19 Mercator SRFT

Mercator SRFs shall be derived from the SRFT specified in [Table 8.21](#).

Table 8.21 — Mercator SRFT

Element	Specification
SRFT label	MERCATOR
SRFT code	18
Short name and description	Mercator SRFT A Mercator and augmented Mercator map projection of the oblate or sphere RD component of the ORM.
Object type	physical
ORM constraint	Shall be derived from: ORMT <a href="#">OBLATE ELLIPSOID</a> , <a href="#">OBLATE ELLIPSOID ORIGIN</a> , <a href="#">SPHERE</a> , or <a href="#">SPHERE ORIGIN</a> .
CS label	<a href="#">MERCATOR</a>
CS coordinate-component names and/or symbols	The same as the CS. $h$ : ellipsoidal height is the vertical coordinate-component.
Template parameters	$\lambda_{\text{origin}}$ : longitude of origin ( $-\pi < \lambda_{\text{origin}} \leq \pi$ ) $k_0$ : central scale ( $0 < k_0 \leq 1$ ) $u_F$ : false easting $v_F$ : false northing
CS parameter binding rules	CS parameters match RD values: Oblate ellipsoid RD case - Major semi-axis $a$ , $\varepsilon = \sqrt{1 - b^2/a^2}$ Sphere RD case - Radius $a$ , $\varepsilon = 0$
SRF region	No additional restrictions.
Notes	1. The augmented Mercator CS induces the Mercator CS on the zero-value vertical coordinate-component surface (which coincides with the RD surface). 2. True scale (point distortion = 1) may be specified at a given latitude $\varphi_1$ by setting: $k_0 = (1/a) R_N(\varphi_1) \cos(\varphi_1)$ .
References	<a href="#">[SNYD]</a>

## 8.5.20 Oblique Mercator spherical SRFT

Oblique Mercator spherical SRFs shall be derived from the SRFT specified in [Table 8.22](#).

Table 8.22 — Oblique Mercator spherical SRFT

Element	Specification
SRFT label	OBLIQUE_MERCATOR_SPHERICAL
SRFT code	19
Short name and description	oblique Mercator SRFT for a sphere ORM An oblique Mercator and augmented oblique Mercator map projection of the sphere RD component of the ORM.
Object type	physical
ORM constraint	Shall be derived from ORMT <a href="#">SPHERE</a> or <a href="#">SPHERE_ORIGIN</a> .
CS label	<a href="#">OBLIQUE_MERCATOR_SPHERICAL</a>
CS coordinate-component names and/or symbols	The same as the CS. $h$ : ellipsoidal height is the vertical coordinate-component.
Template parameters	$(\lambda_1, \varphi_1)$ : first point on the central line $(\lambda_2, \varphi_2)$ : second point on central line $k_0$ : central scale ( $0 < k_0 \leq 1$ ) $u_F$ : false easting $v_F$ : false northing $(\lambda_1, \varphi_1)$ and $(\lambda_2, \varphi_2)$ are two distinct points on the shortest great circle arc on the sphere representing the desired central line, $k_0$ is the point distortion on the central line, and $-\frac{\pi}{2} < \varphi_1 < \frac{\pi}{2}, \quad -\frac{\pi}{2} < \varphi_2 < \frac{\pi}{2}, \quad  \varphi_1  +  \varphi_2  > 0,$ $-\pi < \lambda_1 \leq \pi, \quad -\pi < \lambda_2 \leq \pi, \quad \lambda_1 \neq \lambda_2, \quad \text{and} \quad  \lambda_1 - \lambda_2  \neq \pi.$
CS parameter binding rules	<p>The CS parameter <math>R</math> matches the RD value: Radius <math>R = r</math>.</p> <p>The values of <math>\lambda_1, \varphi_1, \lambda_2, \varphi_2, k_0, u_F</math>, and <math>v_F</math> match the corresponding template parameters.</p>
SRF region	No additional restrictions.
Notes	The augmented oblique Mercator CS induces the oblique Mercator CS on the zero-value vertical coordinate-component surface (which coincides with the RD surface).
References	<a href="#">[SNYD]</a>

## 8.5.21 Transverse Mercator SRFT

*Transverse Mercator SRFs* shall be derived from the SRFT specified in [Table 8.23](#).

Table 8.23 — Transverse Mercator SRFT

Element	Specification
SRFT label	TRANSVERSE_MERCATOR
SRFT code	20
Short name and description	transverse Mercator SRFT A transverse Mercator and augmented transverse Mercator map projection of the oblate or sphere RD component of the ORM.
Object type	physical
ORM constraint	Shall be derived from: ORMT <a href="#">OBLATE_ELLIPSOID</a> , <a href="#">OBLATE_ELLIPSOID_ORIGIN</a> , <a href="#">SPHERE</a> , or <a href="#">SPHERE_ORIGIN</a> .
CS label	<a href="#">TRANSVERSE_MERCATOR</a>
CS coordinate-component names and/or symbols	The same as the CS. $h$ : ellipsoidal height is the vertical coordinate-component.
Template parameters	$\lambda_{\text{origin}}$ : longitude of origin ( $-\pi < \lambda_{\text{origin}} \leq \pi$ ) $\varphi_{\text{origin}}$ : latitude of origin ( $-\pi/2 < \varphi_{\text{origin}} < \pi/2$ ) $k_0$ : central scale ( $0 < k_0 \leq 1$ ) $u_F$ : false easting $v_F$ : false northing
CS parameter binding rules	CS parameters match RD values: Oblate ellipsoid RD case - Major semi-axis $a$ , $\varepsilon = \sqrt{1 - b^2/a^2}$ Sphere RD case - Radius $a$ , $\varepsilon = 0$
SRF region	No additional restrictions.
Notes	The augmented transverse Mercator CS induces the transverse Mercator CS on the zero-value vertical coordinate-component surface (which coincides with the RD surface).
References	<a href="#">[SNYD]</a>

## 8.5.22 Lambert conformal conic SRFT

Lambert conformal conic SRFs shall be derived from the SRFT specified in [Table 8.24](#).

Table 8.24 — Lambert conformal conic SRFT

Element	Specification
SRFT label	LAMBERT_CONFORMAL_CONIC
SRFT code	21
Short name and description	Lambert conformal conic SRFT A Lambert conformal conic and augmented Lambert conformal conic map projection of the oblate or sphere RD component of the ORM.
Object type	physical
ORM constraint	Shall be derived from: ORMT <a href="#">OBLATE ELLIPSOID</a> , <a href="#">OBLATE ELLIPSOID ORIGIN</a> , <a href="#">SPHERE</a> , or <a href="#">SPHERE ORIGIN</a> .
CS label	<a href="#">LAMBERT CONFORMAL CONIC</a>
CS coordinate-component names and/or symbols	The same as the CS. $h$ : ellipsoidal height is the vertical coordinate-component.
Template parameters	$\lambda_{\text{origin}}$ : longitude of origin ( $-\pi < \lambda_{\text{origin}} \leq \pi$ ) $\varphi_{\text{origin}}$ : latitude of the origin ( $-\pi/2 \leq \varphi_{\text{origin}} \leq \pi/2$ ) $\varphi_1, \varphi_2$ : standard latitudes ( $-\pi/2 < \varphi_1 < \pi/2$ , $-\pi/2 < \varphi_2 < \pi/2$ ) $\varphi_1, \varphi_2$ : $\varphi_1 \neq -\varphi_2$ $u_F$ : false easting $v_F$ : false northing
CS parameter binding rules	CS parameters match RD values: Oblate ellipsoid RD case - Major semi-axis $a$ , $\varepsilon = \sqrt{1 - b^2/a^2}$ Sphere RD case - Radius $a$ , $\varepsilon = 0$
SRF region	No additional restrictions.
Notes	The augmented Lambert conformal conic CS induces the Lambert conformal conic CS on the zero-value vertical coordinate-component surface (which coincides with the RD surface).
References	<a href="#">[SNYD]</a>

## 8.5.23 Polar stereographic SRFT

Polar stereographic SRFs shall be derived from the SRFT specified in [Table 8.25](#).

Table 8.25 — Polar stereographic SRFT

Element	Specification
SRFT label	POLAR_STEREOGRAPHIC
SRFT code	22
Short name and description	polar stereographic SRFT A polar stereographic and augmented polar stereographic map projection of the oblate or sphere RD component of the ORM.
Object type	physical
ORM constraint	Shall be derived from: ORMT <a href="#">OBLATE ELLIPSOID</a> , <a href="#">OBLATE ELLIPSOID ORIGIN</a> , <a href="#">SPHERE</a> , or <a href="#">SPHERE ORIGIN</a> .
CS label	<a href="#">POLAR STEREOGRAPHIC</a>
CS coordinate-component names and/or symbols	The same as the CS. $h$ : ellipsoidal height is the vertical coordinate-component.
Template parameters	polar aspect: north or south $\lambda_{\text{origin}}$ : longitude of origin ( $-\pi < \lambda_{\text{origin}} \leq \pi$ ) $k_0$ : central scale ( $1/2 < k_0 \leq 1$ ) $u_F$ : false easting $v_F$ : false northing
CS parameter binding rules	CS parameters match RD values: Oblate ellipsoid RD case - Major semi-axis $a$ , $\varepsilon = \sqrt{1 - b^2/a^2}$ Sphere RD case - Radius $a$ , $\varepsilon = 0$ $\varphi_{\text{origin}} = +\pi/2$ if north aspect $\varphi_{\text{origin}} = -\pi/2$ if south aspect
SRF region	No additional restrictions.
Notes	1. The augmented polar stereographic CS induces the polar stereographic CS on the zero-value vertical coordinate-component surface (which coincides with the RD surface). 2. True scale (point distortion = 1) may be specified at a given latitude $\varphi_1$ by setting: $k_0 = R_N(\varphi_1)\cos(\varphi_1)/2aE\tau(\varphi_1)$ .
References	<a href="#">[SNYD]</a>

## 8.5.24 Equidistant cylindrical SRFT

Equidistant cylindrical SRFs shall be derived from the SRFT specified in [Table 8.26](#).

Table 8.26 — Equidistant cylindrical SRFT

Element	Specification
SRFT label	EQUIDISTANT_CYLINDRICAL
SRFT code	23
Short name and description	equidistant cylindrical SRFT A equidistant cylindrical and augmented equidistant cylindrical map projection of the sphere RD component of the ORM.
Object type	physical
ORM constraint	Shall be derived from: ORMT <a href="#">OBLATE_ELLIPSOID</a> , <a href="#">OBLATE_ELLIPSOID_ORIGIN</a> , <a href="#">SPHERE</a> , or <a href="#">SPHERE_ORIGIN</a> .
CS label	<a href="#">EQUIDISTANT_CYLINDRICAL</a>
CS coordinate-component names and/or symbols	The same as the CS. $h$ : ellipsoidal height is the vertical coordinate-component.
Template parameters	$\lambda_{\text{origin}}$ : longitude of origin ( $-\pi < \lambda_{\text{origin}} \leq \pi$ ) $k_o$ : central scale ( $0 < k_o \leq 1$ ) $u_F$ : false easting $v_F$ : false northing
CS parameter binding rules	CS parameters match RD values: Oblate ellipsoid RD case - Major semi-axis $a$ , $\varepsilon = \sqrt{1 - b^2/a^2}$ Sphere RD case - Radius $a$ , $\varepsilon = 0$
SRF region	No additional restrictions.
Notes	1. The augmented equidistant cylindrical CS induces the equidistant cylindrical CS on the zero-value vertical coordinate-component surface (which coincides with the RD surface). 2. Longitudinal point distortion may be set to one at a given latitude $\varphi_1$ by setting: $k_o = (1/a) R_N(\varphi_1) \cos(\varphi_1)$ .
References	<a href="#">[SNYD]</a>

### 8.5.25 Local space rectangular 2D SRFT

Local space rectangular 2D SRFs shall be derived from the SRFT specified in [Table 8.27](#).

**Table 8.27 — Local space rectangular 2D SRFT**

Element	Specification
SRFT label	LOCAL_SPACE_RECTANGULAR_2D
SRFT code	24
Short name and description	local space rectangular 2D SRFT A 2D Euclidean spatial reference frame for an abstract 2D space.
Object type	2D abstract object
ORM constraint	Shall be an ORM for a 2D abstract object.
CS label	<a href="#">LOCOCENTRIC_EUCLIDEAN_2D</a>
CS coordinate-component names and/or symbols	The same as the CS.
Template parameters	$r$ = vector direction of forward (forward axis).
CS parameter binding rules	$e_1 = \begin{pmatrix} 1 \\ 0 \end{pmatrix}, \text{ and } e_2 = \begin{pmatrix} 0 \\ 1 \end{pmatrix}.$ $E(\text{axis}) = \begin{cases} +e_1 & \text{positive primary axis} \\ +e_2 & \text{positive secondary axis} \\ -e_1 & \text{negative primary axis} \\ -e_2 & \text{negative secondary axis} \end{cases}$ $r = E(\text{forward axis})$ $s = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} r$ $q = 0$
SRF region	No additional restrictions.
Notes	<a href="#">CAD/CAM</a> and 2D graphic applications.
References	<a href="#">[EDM]</a>

### 8.5.26 Local space azimuthal 2D SRFT

Azimuthal 2D SRFs shall be derived from the SRFT specified in [Table 8.28](#).

**Table 8.28 — Local space azimuthal 2D SRFT**

Element	Specification
SRFT label	LOCAL_SPACE_AZIMUTHAL_2D
SRFT code	25
Short name and description	local space azimuthal 2D SRFT An azimuthal CS based SRF for 2D abstract space.



Element	Specification
<b>Object type</b>	2D abstract object
<b>ORM constraint</b>	Shall be an ORM for a 2D abstract object.
<b>CS label</b>	<a href="#">AZIMUTHAL</a>
<b>CS coordinate-component names and/or symbols</b>	The same as the CS.
<b>Template parameters</b>	none
<b>CS parameter binding rules</b>	none
<b>SRF region</b>	No additional restrictions.
<b>Notes</b>	none
<b>References</b>	<a href="#">[EDM]</a>

### 8.5.27 Local space polar 2D SRFT

*Polar 2D SRFs* shall be derived from the SRFT specified in [Table 8.29](#).

**Table 8.29 — Local space polar 2D SRFT**

Element	Specification
<b>SRFT label</b>	LOCAL_SPACE_POLAR_2D
<b>SRFT code</b>	26
<b>Short name and description</b>	local space polar 2D SRFT A polar CS based SRF for 2D abstract space.
<b>Object type</b>	2D abstract object
<b>ORM constraint</b>	Shall be an ORM for a 2D abstract object.
<b>CS label</b>	<a href="#">POLAR</a>
<b>CS coordinate-component names and/or symbols</b>	The same as the CS.
<b>Template parameters</b>	none
<b>CS parameter binding rules</b>	none
<b>SRF region</b>	No additional restrictions.
<b>Notes</b>	none
<b>References</b>	<a href="#">[EDM]</a>

## 8.6 Standardized SRFs

### 8.6.1 Introduction

This International Standard specifies a collection of standardized SRFs. These SRFs are derived from SRFTs. The specification elements for these standardized SRFs are defined in [Table 8.30](#). [Table 8.31](#) is a directory of

these specifications, which appear in [Table 8.32](#) through [Table 8.45](#). Additional SRFs derived from SRTs may be specified by registration in accordance with [Clause 13](#)

**Table 8.30 — Standardized SRF specification elements**

Element	Definition
<b>SRF label</b>	The label of the SRF (see <a href="#">13.2.2</a> ).
<b>SRF code</b>	The code of the SRF (see <a href="#">13.2.3</a> ). Code 0 (UNSPECIFIED) is reserved.
<b>Short name</b>	A short name as published or as commonly known and an optional description.
<b>SRF template</b>	The label of the applicable SRF template.
<b>ORM label</b>	The label of the applicable ORM.
<b>SRF region</b>	Optional restriction of the domain of the CS to an SRF region description and/or an SRF region specification. If an SRF region specification is included, an extended SRF region specification may also be included.  If no SRF region is specified, the phrase “No additional restrictions.” shall be used.
<b>Parameter values</b>	The SRF template parameter values specified by value or by reference. If by reference, this specification element shall contain a citation(s) for the SRF template parameters values. Terms appearing in the references that are cited for a value shall be enclosed in brackets ( { } ). Any parameter value that is not specified in the citation(s) shall be specified by value.
<b>Notes</b>	Optional, additional, non-normative information concerning the SRF, such as a description of its structure, modelled region, intended use, and/or application domain.
<b>References</b>	The references (see <a href="#">13.2.5</a> ).

**Table 8.31 — Directory of standardized SRFs**

Short name	SRF label
British national grid	<a href="#">BRITISH_NATIONAL_GRID_AIRY</a>
UK ordnance survey GRS80 grid.	<a href="#">BRITISH_OSGRS80_GRID</a>
Delaware ( <a href="#">US</a> ) state plane coordinate system	<a href="#">DELAWARE_SPCS_1993</a>
Geocentric <a href="#">WGS</a> 1984	<a href="#">GEOCENTRIC_WGS_1984</a>
Geodetic Australia 1984	<a href="#">GEODETTIC_AUSTRALIA_1984</a>
Geodetic <a href="#">WGS</a> 1984	<a href="#">GEODETTIC_WGS_1984</a>
Geodetic north american 1983	<a href="#">GEODETTIC_N_AMERICAN_1983</a>
Irish grid	<a href="#">IRISH_GRID_1965</a>
Irish transverse Mercator	<a href="#">IRISH_TRANSVERSE_MERCATOR_1989</a>
Lambert-93	<a href="#">LAMBERT_93</a>

Short name	SRF label
Lambert II étendu (Lambert II wide)	<a href="#">LAMBERT II WIDE</a>
Mars planetocentric	<a href="#">MARS PLANETOCENTRIC 2000</a>
Mars planetodetic	<a href="#">MARS PLANETOGRAPHIC 2000</a>
Maryland ( <a href="#">US</a> ) state plane coordinate system	<a href="#">MARYLAND SPCS 1983</a>

### 8.6.2 British national grid

Table 8.32 — British national grid SRF

Element	Specification	Element	Specification
SRF label	BRITISH_NATIONAL_GRID_AIRY	SRF code	1
Short name	British national grid. A transverse Mercator projection using the <a href="#">AIRY_1830</a> ellipsoid.		
SRF template	<a href="#">TRANSVERSE_MERCATOR</a>	ORM label	<a href="#">OSGB_1936</a>
SRF region	SRF region description: Great Britain.		
Parameter values	longitude of origin: $\lambda_{\text{origin}} = -2^{\circ}$ latitude of origin: $\varphi_{\text{origin}} = 49^{\circ}$ central scale: $k_0 = 0,999\ 601\ 271\ 7$ false easting: $u_F = 400\ 000\ \text{m}$ false northing: $v_F = -100\ 000\ \text{m}$		
Notes	Also known as the <a href="#">UK</a> national projection.		
References	<a href="#">[OSTM]</a> , Section 7, "National projection"]		

### 8.6.3 UK ordnance survey GRS80 grid

Table 8.33 — UK ordnance survey GRS80 grid SRF

Element	Specification	Element	Specification
SRF label	BRITISH_OSGRS80_GRID	SRF code	2
Short name	UK ordnance survey GRS80 grid. A transverse Mercator projection using the <a href="#">GRS 1980</a> ellipsoid.		
SRF template	<a href="#">TRANSVERSE_MERCATOR</a>	ORM label	<a href="#">ETRF</a>
SRF region	SRF region description: Great Britain.		
Parameter values	longitude of origin: $\lambda_{\text{origin}} = -2^{\circ}$ latitude of origin: $\varphi_{\text{origin}} = 49^{\circ}$ central scale: $k_0 = 0,999\ 601\ 271\ 7$ false easting: $u_F = 400\ 000\ \text{m}$ false northing: $v_F = -100\ 000\ \text{m}$		
Notes	Also known as the OSGRS80 grid.		
References	<a href="#">[OSTM]</a> , Section 7, "OSGRS80"]		

## 8.6.4 Delaware (US) state plane coordinate system

Table 8.34 — Delaware (US) state plane coordinate system SRF

Element	Specification	Element	Specification
SRF label	DELAWARE_SPCS_1983	SRF code	3
Short name	Delaware ( <a href="#">US</a> ) state plane coordinate system		
SRF template	<a href="#">TRANSVERSE_MERCATOR</a>	ORM label	<a href="#">N_AM_1983</a>
SRF region	SRF region description: State of Delaware ( <a href="#">US</a> ).		
Parameter values	longitude of origin: $\lambda_{\text{origin}} = -75^{\circ}25'$ latitude of origin: $\varphi_{\text{origin}} = 38^{\circ}$ central scale: $k_0 = 1 - 1/200\,000$ false easting: $u_F = 200\,000$ m false northing: $v_F = 0$ m		
Notes	The conventional coordinate unit is <a href="#">US</a> survey feet. To convert a coordinate in metres to a grid coordinate in <a href="#">US</a> survey feet, use $1\text{m} = (39,37 / 12)$ <a href="#">US</a> survey feet.		
References	<a href="#">[SNYD]</a> , Table 8 and Appendix C, "Delaware"]		

## 8.6.5 Geocentric WGS 1984

Table 8.35 — Geocentric WGS 1984 SRF

Element	Specification	Element	Specification
SRF label	GEOCENTRIC_WGS_1984	SRF code	4
Short name	Geocentric <a href="#">WGS</a> 1984		
SRF template	<a href="#">CELESTIOCENTRIC</a>	ORM label	<a href="#">WGS_1984</a>
SRF region	SRF region description: Earth, global.		
Parameter values	none		
Notes	Mass centred.		
References	<a href="#">[83502T]</a> , Chapter 2.1]		

## 8.6.6 Geodetic Australia 1984

Table 8.36 — Geodetic Australia 1984 SRF

Element	Specification	Element	Specification
SRF label	GEODETIC_AUSTRALIA_1984	SRF code	5
Short name	Geodetic Australia 1984		
SRF template	<a href="#">CELESTIODETIC</a>	ORM label	<a href="#">AUSTRALIAN_GEOD_1984</a>

Element	Specification	Element	Specification
<b>SRF region</b>	SRF region description: Australia and Tasmania.		
<b>Parameter values</b>	none		
<b>Notes</b>	none		
<b>References</b>	<a href="#">[CECT]</a>		

## 8.6.7 Geodetic WGS 1984

Table 8.37 — Geodetic WGS 1984 SRF

Element	Specification	Element	Specification
<b>SRF label</b>	<b>GEODETIC_WGS_1984</b>	<b>SRF code</b>	<b>6</b>
<b>Short name</b>	Geodetic <a href="#">WGS</a> 1984		
<b>SRF template</b>	<a href="#">CELESTIODETIC</a>	<b>ORM label</b>	<a href="#">WGS_1984</a>
<b>SRF region</b>	SRF region description: Earth, global.		
<b>Parameter values</b>	none		
<b>Notes</b>	none		
<b>References</b>	<a href="#">[83502T]</a> , Chapter 3]		

## 8.6.8 Geodetic North American 1983

Table 8.38 — Geodetic North American 1983 SRF

Element	Specification	Element	Specification
<b>SRF label</b>	<b>GEODETIC_N_AMERICAN_1983</b>	<b>SRF code</b>	<b>7</b>
<b>Short name</b>	Geodetic North American 1983		
<b>SRF template</b>	<a href="#">CELESTIODETIC</a>	<b>ORM label</b>	<a href="#">N_AM_1983</a>
<b>SRF region</b>	SRF region description: Continental United States		
<b>Parameter values</b>	none		
<b>Notes</b>	none		
<b>References</b>	<a href="#">[SNYD]</a>		

## 8.6.9 Irish Grid

Table 8.39 — Irish Grid SRF

Element	Specification	Element	Specification
SRF label	IRISH_GRID_1965	SRF code	8
Short name	Irish Grid		
SRF template	<a href="#">TRANSVERSE_MERCATOR</a>	ORM label	<a href="#">IRELAND_1965</a>
SRF region	SRF region description: Ireland.		
Parameter values	longitude of origin: $\lambda_{\text{origin}} = -8^\circ$ latitude of origin: $\phi_{\text{origin}} = 53^\circ 30'$ central scale: $k_0 = 1,000\,035$ false easting: $u_F = 200\,000\text{ m}$ false northing: $v_F = 250\,000\text{ m}$		
Notes	The Irish Grid has been developed over more than two hundred years and is the coordinate reference system used in Ireland.		
References	<a href="#">IGRID</a> , "The Transverse Mercator Map Projection"]		

## 8.6.10 Irish transverse Mercator

Table 8.40 — Irish transverse Mercator SRF

Element	Specification	Element	Specification
SRF label	IRISH_TRANSVERSE_MERCATOR_1989	SRF code	9
Short name	Irish transverse Mercator		
SRF template	<a href="#">TRANSVERSE_MERCATOR</a>	ORM label	<a href="#">ETRF</a>
SRF region	SRF region description: Ireland.		
Parameter values	longitude of origin: $\lambda_{\text{origin}} = -8^\circ$ latitude of origin: $\phi_{\text{origin}} = 53^\circ 30'$ central scale: $k_0 = 0,999\,820$ false easting: $u_F = 600\,000\text{ m}$ false northing: $v_F = 750\,000\text{ m}$		
Notes	A newly derived projection designed for GPS compatibility. The longitude and latitude of origin defined in the Irish Grid are maintained.		
References	<a href="#">NMPI</a> , Table 1, "ITM"]		

## 8.6.11 Lambert-93

Table 8.41 — Lambert-93 SRF

Element	Specification	Element	Specification
SRF label	LAMBERT_93	SRF code	10
Short name	Lambert-93		
SRF template	<a href="#">LAMBERT_CONFORMAL_CONIC</a>	ORM label	<a href="#">RGF_1993</a>
SRF region	SRF region description: France.		
Parameter values	First parallel: $\varphi_1 = 44^\circ$ Second parallel: $\varphi_2 = 49^\circ$ Longitude of origin: $\lambda_{\text{origin}} = 3^\circ$ Latitude of origin: $\varphi_{\text{origin}} = 46^\circ 30'$ False easting: $u_F = 700\,000\text{ m}$ False northing: $v_F = 6\,600\,000\text{ m}$		
Notes	Originally specified in September 1996.		
References	[ <a href="#">PASG</a> , "Caractéristiques de la projection conique conforme (projection dite de Lambert)"]		

## 8.6.12 Lambert II étendu (Lambert II wide)

Table 8.42 — Lambert II étendu (Lambert II wide) SRF

Element	Specification	Element	Specification
SRF label	LAMBERT_II_WIDE	SRF code	11
Short name	Lambert II étendu (Lambert II wide)		
SRF template	<a href="#">LAMBERT_CONFORMAL_CONIC</a>	ORM label	<a href="#">NTF_1896_PM_PARIS</a>
SRF region	SRF region description: France.		
Parameter values	First parallel: $\varphi_1 = 45^\circ 53' 56,108''$ Second parallel: $\varphi_2 = 47^\circ 41' 45,652''$ Longitude of origin: $\lambda_{\text{origin}} = 0^\circ$ Latitude of origin: $\varphi_{\text{origin}} = 46^\circ 48'$ False easting: $u_F = 600\,000\text{ m}$ False northing: $v_F = 2\,200\,000\text{ m}$		
Notes	An extension of Lambert Zone II to cover all of France. The prime meridian of the ORM is Paris (not Greenwich).		
References	[ <a href="#">LIIE</a> , "Valeurs pour le calcul des coordonnées en projection Lambert de l'ellipsoïde de Clarke 1880 IGN.", "Zone lambert: II étendu"]		



## 8.6.13 Mars planetocentric

Table 8.43 — Mars planetocentric SRF

Element	Specification	Element	Specification
SRF label	MARS_PLANETOCENTRIC_2000	SRF code	12
Short name	Mars planetocentric		
SRF template	<a href="#">CELESTIODETIC</a>	ORM label	<a href="#">MARS_SPHERE_2000</a>
SRF region	SRF region description: Mars, global.		
Parameter values	none		
Notes	1) Also referred to as "east/ocentric"; adopted as the basis for current map production by the United States Geological Survey (USGS), National Aeronautics and Space Administration (NASA, <a href="#">US</a> ), and the European Space Agency (ESA). 2) Spherical latitude coincides with geodetic latitude.		
References	<a href="#">[DUXB]</a>		

## 8.6.14 Mars planetographic

Table 8.44 — Mars planetographic SRF

Element	Specification	Element	Specification
SRF label	MARS_PLANETOGRAPHIC_2000	SRF code	13
Short name	Mars planetodetic		
SRF template	<a href="#">PLANETODETIC</a>	ORM label	<a href="#">MARS_2000</a>
SRF region	SRF region description: Mars, global.		
Parameter values	none		
Notes	1) Also referred to as "west/ographic"; used historically for map production. 2) Planetodetic longitude is positive westwards.		
References	<a href="#">[DUXB]</a>		

## 8.6.15 Maryland (US) state plane coordinate system

Table 8.45 — Maryland (US) state plane coordinate system SRF

Element	Specification	Element	Specification
SRF label	MARYLAND_SPCS_1983	SRF code	14
Short name	Maryland ( <a href="#">US</a> ) state plane coordinate system		

Element	Specification	Element	Specification
SRF template	<a href="#">LAMBERT CONFORMAL CONIC</a>	ORM label	<a href="#">N_AM_1983</a>
SRF region	SRF region description: State of Maryland ( <a href="#">US</a> ).		
Parameter values	First parallel: $\varphi_1 = 38^{\circ}18'$ Second parallel: $\varphi_2 = 39^{\circ}27'$ Longitude of origin: $\lambda_{\text{origin}} = -77^{\circ}$ Latitude of origin: $\varphi_{\text{origin}} = 37^{\circ}40'$ False easting: $u_F = 400\,000$ m False northing: $v_F = 0$ m		
Notes	The conventional coordinate unit is <a href="#">US</a> survey feet. To convert a coordinate in metres to a grid coordinate in <a href="#">US</a> survey feet, use $1\text{ m} = (39,37 / 12)$ <a href="#">US</a> survey feet.		
References	<a href="#">[SNYD]</a> , Table 8 and Appendix C, "Maryland"]		

## 8.7 Standardized SRF sets

### 8.7.1 Introduction

An *SRF set* for an ORM is a finite parameterized set of two or more spatial reference frames that:

- a) are derived from the same SRF template using the given ORM, and
- b) the SRF regions of the set members have non-overlapping interiors.

An SRF set specification may further restrict the ORM constraints of the SRFT. The specification elements for SRF sets are defined in [Table 8.46](#). Specification elements for SRF set members are defined in [Table 8.47](#). Each SRF set member shall have a code. The members of an SRF set member may be labelled. If any member of an SRF set has been assigned a label, all members of the set shall be assigned unique labels. An SRF set may contain a large number of members. In particular, the SRF set [GTRS GLOBAL COORDINATE SYSTEM](#), has more than 49 000 members. In such cases, assigning a label to each set member may provide no additional information beyond that which can be obtained from the corresponding code. For such cases, labels may be omitted. In cases where legacy SRF sets have commonly known and widely used member identifiers, such identifiers may be retained as the label for each set member. In particular, the members of the SRF set [UNIVERSAL TRANSVERSE MERCATOR](#) are labelled.

SRF set member specifications may be either explicit, with a complete specification given for each individual set member, or implicit, with specifications given in terms of general rules that can be instantiated for each individual member. The SRF sets [GTRS GLOBAL COORDINATE SYSTEM](#) and [UNIVERSAL TRANSVERSE MERCATOR](#) illustrate the implicit specification concept.

This International Standard specifies a collection of SRF sets. These specifications appear in [Table 8.49](#) through [Table 8.62](#). [Table 8.48](#) is a directory of standardized SRF sets. The specified collection is not intended to be exhaustive. It includes national and regional grid systems as exemplars of the SRF set concept. Additional SRF sets and their members may be specified by registration in accordance with [Clause 13](#).

Table 8.46 — SRF set specification elements

Element	Definition
<b>SRF set label</b>	The label of the SRF set (see <a href="#">13.2.2</a> ).
<b>SRF set code</b>	The code of the SRF set (see <a href="#">13.2.3</a> ). Code 0 is reserved.
<b>Short name</b>	A short name as published or as commonly known, and an optional description.
<b>SRF template</b>	The label of the applicable SRF template.
<b>ORM constraints</b>	Criteria for applicable ORMs. Specifying a single ORM indicates that only that ORM shall be used.
<b>Coverage description</b>	Optional description of the region corresponding to the union of the SRF regions of all of the set members.
<b>SRF set membership</b>	A specification of the parameterization of the set members by listing or parameter algorithm, and SRF region descriptions or specifications. If SRF region specifications are included, extended SRF region specifications may also be included. References to other specification tables may be used for this purpose (see <a href="#">Table 8.47</a> ).
<b>Notes</b>	An optional description of the structure, modelled region, intended use, and/or application domain of the SRF set.
<b>References</b>	Optional references (see <a href="#">13.2.5</a> ).

The specification elements for an *SRF set member* (SSM) is defined in [Table 8.47](#).

Table 8.47 — SRF set member specification elements

Element	Definition
<b>SSM label</b>	The optional label of the SRF set member (see <a href="#">13.2.2</a> ), or "n/a" (see <a href="#">8.7.1</a> ).
<b>SSM code</b>	The code of the SRF set member (see <a href="#">13.2.3</a> ); the set member parameter. Code 0 is reserved.
<b>Short name</b>	A short name as published or as commonly known and an optional description.
<b>SRF region</b>	An SRF region description or SRF region specification. If an SRF region specification is included, an extended SRF region specification may also be included.
<b>Parameter values</b>	The SRF template parameter values specified by value or by reference. If by reference, this specification element shall contain a citation(s) for the SRF template parameters values. Terms appearing in the references that are cited for a value shall be enclosed in brackets ( { } ). Any parameter value that is not specified in the citation(s) shall be specified by value case.

Element	Definition
Notes	Optional, additional, non-normative information concerning the SRF set member.

Table 8.48 — Directory of SRF sets

Short name	SRF set label
Alabama ( <a href="#">US</a> ) state plane coordinate system.	<a href="#">ALABAMA_SPCS</a>
<a href="#">GTRS</a> global coordinate system (GCS) (Earth).	<a href="#">GTRS_GLOBAL_COORDINATE_SYSTEM</a>
Japan plane coordinate system	<a href="#">JAPAN_RECTANGULAR_PLANE_CS</a>
Lambert NTF	<a href="#">LAMBERT_NTF</a>
Universal polar stereographic (Earth)	<a href="#">UNIVERSAL_POLAR_STEREOGRAPHIC</a>
Universal transverse Mercator (Earth)	<a href="#">UNIVERSAL_TRANSVERSE_MERCATOR</a>
Wisconsin ( <a href="#">US</a> ) state plane coordinate system	<a href="#">WISCONSIN_SPCS</a>

## 8.7.2 Alabama (US) state plane coordinate system

Table 8.49 — Alabama (US) state plane coordinate system SRF set

Element	Specification	Element	Specification
SRF set label	ALABAMA_SPCS	SRF set code	1
Short name	Alabama ( <a href="#">US</a> ) state plane coordinate system		
SRF template	<a href="#">TRANSVERSE_MERCATOR</a>	ORM constraints	ORM <a href="#">N_AM_1983</a>
Coverage description	SRF region description: State of Alabama ( <a href="#">US</a> ).		
SRF set membership	Specified in <a href="#">Table 8.50</a> .		
Notes	1) A set of two localized adjacent SRFs where only one SRF is used for each county in the state and no overlap is allowed. 2) The conventional coordinate unit is <a href="#">US</a> survey feet. To convert a coordinate in metres to a grid coordinate in <a href="#">US</a> survey feet, use $1\text{m} = (39,37 / 12)$ <a href="#">US</a> survey feet.		
References	<a href="#">[SNYD]</a> , Table 8 and Appendix C, "Alabama" (East and West)], <a href="#">[ALSP]</a>		

Table 8.50 — SRF set membership Alabama (US) state plane coordinate system

Element	Specification	Element	Specification
SSM label	WEST_ZONE	SSM code	1
Short name	West zone		

Element	Specification	Element	Specification
<b>SRF region</b>	SRF region description: Counties: Autauga, Baldwin, Bibb, Blount, Butler, Chilton, Choctaw, Clarke, Colbert, Conecuh, Cullman, Dallas, Escambia, Fayette, Franklin, Greene, Hale, Jefferson, Lamar, Lauderdale, Lawrence, Limestone, Lowndes, Marengo, Marion, Mobile, Monroe, Morgan, Perry, Pickens, Shelby, Sumter, Tuscaloosa, Walker, Washington, Wilcox and Winston.		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = -87^{\circ}30'$ latitude of origin: $\varphi_{\text{origin}} = 30^{\circ}$ central scale: $k_0 = 1 - 1/15\,000$ false easting: $u_F = 600\,000\text{ m}$ false northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	EAST_ZONE	<b>SSM code</b>	2
<b>Short name</b>	East zone		
<b>SRF region</b>	SRF region description: Counties: Barbour, Bullock, Calhoun, Chambers, Cherokee, Clay, Cleburne, Coffee, Coosa, Covington, Crenshaw, Dale, DeKalb, Elmore, Etowah, Geneva, Henry, Houston, Jackson, Lee, Macon, Madison, Marshall, Montgomery, Pike, Randolph, Russell, Saint Clair, Talladega and Tallapoosa.		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = -85^{\circ}50'$ latitude of origin: $\varphi_{\text{origin}} = 30^{\circ}30'$ central scale: $k_0 = 1 - 1/25\,000$ false easting: $u_F = 200\,000\text{ m}$ false northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		

### 8.7.3 GTRS global coordinate system (GCS)

Table 8.51 — GTRS global coordinate system (GCS) SRF set

Element	Specification	Element	Specification
<b>SRF set label</b>	GTRS_GLOBAL_COORDINATE_SYSTEM	<b>SRF set code</b>	2
<b>Short name</b>	<a href="#">GTRS</a> global coordinate system (GCS) (Earth)		
<b>SRF template</b>	<a href="#">LOCAL TANGENT SPACE EUCLIDEAN</a>	<b>ORM constraints</b>	A global model ERM such as ORM <a href="#">WGS 1984</a> .
<b>Coverage description</b>	SRF region description: Earth (complete).		
<b>SRF set membership</b>	Specified in <a href="#">Table 8.52</a> .		

Element	Specification	Element	Specification
Notes	A set of 49 896 localized SRFs, each approximately 100 kilometres square, that are identified according to the geotile reference system indexing scheme. The members of this SRF set are known as cells. For much of the RD surface, each cell valid-region covers one arc degree of geodetic latitude by one arc degree of geodetic longitude. However, near the poles, many arc degrees of longitude are grouped together into a single GCS cell since an arc degree of geodetic longitude becomes arbitrarily small near the poles. GCS cells are always one arc degree of geodetic latitude in extent. Within each GCS cell, a false origin offset is provided. The point of tangency is at the centre of the rectangular GCS cell, even if more than one arc degree of geodetic longitude falls within the GCS SRF cell. The SRFT <a href="#">LOCAL TANGENT SPACE EUCLIDEAN</a> azimuth parameter ( $\alpha$ ) is zero.		
References	<a href="#">ISO/IEC 18025</a> , Table 6.11, GTRS_GEOTILE, <a href="#">BIRK</a>		

Table 8.52 — SRF set membership GTRS global coordinate system (GCS)

Element	Specification	Element	Specification
SSM label	n/a	SSM code	1...49 896: As specified in <a href="#">Table 8.53</a> .
Short name	Tile <code>		
SRF region	SRF region specification: As specified in <a href="#">Table 8.53</a> as type geodetic-region.		
Parameter values	Surface geodetic coordinate of the tangent point: As specified in <a href="#">Table 8.53</a> . Azimuth: $\alpha = 0$ Offset height: $h_0 = 0$ m false easting: $x_F = 50\,000$ m false northing: $y_F = 50\,000$ m		
Notes	none		

Table 8.53 — GTRS natural origin and SRF region by code index

Latitude band (Tile size)	Tile code	Surface geodetic coordinate of the tangent point ( $\lambda_{\text{origin}}, \varphi_{\text{origin}}$ )	SRF region specification
88°-90°S (1° x 30°)	$1 + 12 \cdot m + n$ ( $m=0,1; n=0,\dots,11$ )	$(-165^\circ + n \cdot 30^\circ, -89,5^\circ + m \cdot 1^\circ)$	$-15^\circ \leq \lambda - \lambda_{\text{origin}} \leq +15^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$
86°-88°S (1° x 15°)	$25 + 24 \cdot m + n$ ( $m=0,1; n=0,\dots,23$ )	$(-172,5^\circ + n \cdot 15^\circ, -87,5^\circ + m \cdot 1^\circ)$	$-7,5^\circ \leq \lambda - \lambda_{\text{origin}} \leq +7,5^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$
84°-86°S (1° x 10°)	$73 + 36 \cdot m + n$ ( $m=0,1; n=0,\dots,35$ )	$(-175^\circ + n \cdot 10^\circ, -85,5^\circ + m \cdot 1^\circ)$	$-5^\circ \leq \lambda - \lambda_{\text{origin}} \leq +5^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$
80°-84°S (1° x 6°)	$145 + 60 \cdot m + n$ ( $m=0,\dots,3; n=0,\dots,59$ )	$(-177^\circ + n \cdot 6^\circ, -83,5^\circ + m \cdot 1^\circ)$	$-3^\circ \leq \lambda - \lambda_{\text{origin}} \leq +3^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$
78°-80°S (1° x 5°)	$385 + 72 \cdot m + n$ ( $m=0,1; n=0,\dots,71$ )	$(-177,5^\circ + n \cdot 5^\circ, -79,5^\circ + m \cdot 1^\circ)$	$-2,5^\circ \leq \lambda - \lambda_{\text{origin}} \leq +2,5^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$

Latitude band (Tile size)	Tile code	Surface geodetic coordinate of the tangent point ( $\lambda_{\text{origin}}$ , $\varphi_{\text{origin}}$ )	SRF region specification
71°-78°S (1° x 3°)	$529 + 120 \cdot m + n$ ( $m=0, \dots, 6$ ; $n=0, \dots, 119$ )	$(-178,5^\circ + n \cdot 3^\circ, -77,5^\circ + m \cdot 1^\circ)$	$-1,5^\circ \leq \lambda - \lambda_{\text{origin}} \leq +1,5^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$
60°-71°S (1° x 2°)	$1\,369 + 180 \cdot m + n$ ( $m=0, \dots, 10$ ; $n=0, \dots, 179$ )	$(-179^\circ + n \cdot 2^\circ, -70,5^\circ + m \cdot 1^\circ)$	$-1^\circ \leq \lambda - \lambda_{\text{origin}} \leq +1^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$
60°S - 60°N (1° x 1°)	$3\,349 + 360 \cdot m + n$ ( $m=0, \dots, 119$ ; $n=0, \dots, 359$ )	$(-179,5^\circ + n \cdot 1^\circ, -59,5^\circ + m \cdot 1^\circ)$	$-0,5^\circ \leq \lambda - \lambda_{\text{origin}} \leq +0,5^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$
71°-60°N (1° x 2°)	$46\,549 + 180 \cdot m + n$ ( $m=0, \dots, 10$ ; $n=0, \dots, 179$ )	$(-179^\circ + n \cdot 2^\circ, 60,5^\circ + m \cdot 1^\circ)$	$-1^\circ \leq \lambda - \lambda_{\text{origin}} \leq +1^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$
78°-71°N (1° x 3°)	$48\,529 + 120 \cdot m + n$ ( $m=0, \dots, 6$ ; $n=0, \dots, 119$ )	$(-178,5^\circ + n \cdot 3^\circ, 71,5^\circ + m \cdot 1^\circ)$	$-1,5^\circ \leq \lambda - \lambda_{\text{origin}} \leq +1,5^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$
80°-78°N (1° x 5°)	$49\,369 + 72 \cdot m + n$ ( $m=0, 1$ ; $n=0, \dots, 71$ )	$(-177,5^\circ + n \cdot 5^\circ, 78,5^\circ + m \cdot 1^\circ)$	$-2,5^\circ \leq \lambda - \lambda_{\text{origin}} \leq +2,5^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$
84°-80°N (1° x 6°)	$49\,513 + 60 \cdot m + n$ ( $m=0, \dots, 3$ ; $n=0, \dots, 59$ )	$(-177^\circ + n \cdot 6^\circ, 80,5^\circ + m \cdot 1^\circ)$	$-3^\circ \leq \lambda - \lambda_{\text{origin}} \leq +3^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$
86°-84°N (1° x 10°)	$49\,752 + 36 \cdot m + n$ ( $m=0, 1$ ; $n=0, \dots, 35$ )	$(-175^\circ + n \cdot 10^\circ, 84,5^\circ + m \cdot 1^\circ)$	$-5^\circ \leq \lambda - \lambda_{\text{origin}} \leq +5^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$
88°-86°N (1° x 15°)	$49\,825 + 24 \cdot m + n$ ( $m=0, 1$ ; $n=0, \dots, 23$ )	$(-172,5^\circ + n \cdot 15^\circ, 86,5^\circ + m \cdot 1^\circ)$	$-7,5^\circ \leq \lambda - \lambda_{\text{origin}} \leq +7,5^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$
90°-88°N (1° x 30°)	$49\,873 + 12 \cdot m + n$ ( $m=0, 1$ ; $n=0, \dots, 11$ )	$(-165^\circ + n \cdot 30^\circ, 88,5^\circ + m \cdot 1^\circ)$	$-15^\circ \leq \lambda - \lambda_{\text{origin}} \leq +15^\circ$ $-0,5^\circ \leq \varphi - \varphi_{\text{origin}} \leq +0,5^\circ$

#### 8.7.4 Japan plane coordinate system

Table 8.54 — Japan plane coordinate system SRF set

Element	Specification	Element	Specification
SRF set label	JAPAN_RECTANGULAR_PLANE_CS	SRF set code	3
Short name	Japan plane coordinate system		
SRF template	<a href="#">TRANSVERSE MERCATOR</a>	ORM constraints	ORM <a href="#">JGD 2000</a>
Coverage description	SRF region description: Japan excluding northern territories.		
SRF set membership	Specified in <a href="#">Table 8.55</a> .		
Notes	<p>1) The official representation scheme for the Japan plane coordinate system is (v:northing, u:easting) and the coordinate values are commonly encoded in the form NE, where N denotes digits of northing in metres and E denotes the same number of digits of easting in metres.</p> <p>2) A set of nineteen localized SRFs, each limited to 130 km eastward and westward from the central meridian. SRF regions are described by political regions (cities, prefectures, counties, and/or partitions thereof).</p>		

Element	Specification	Element	Specification
References	<a href="#">[JMLIT]</a>		

Table 8.55 — SRF set membership Japan plane coordinate system

Element	Specification	Element	Specification
<b>SSM label</b>	ZONE_I	<b>SSM code</b>	1
<b>Short name</b>	Zone I		
<b>SRF region</b>	SRF region description: Prefectures: Nagasaki, Kagosima ( $128^{\circ}18' \leq \lambda \leq 130^{\circ}$ ( $130^{\circ}13'$ for Amami Islands )); islands, atolls and reefs in $27^{\circ} \leq \varphi \leq 32^{\circ}$ )		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +129^{\circ}30'$ latitude of origin: $\varphi_{\text{origin}} = +33^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_II	<b>SSM code</b>	2
<b>Short name</b>	Zone II		
<b>SRF region</b>	SRF region description: Prefectures: Hukuoka, Saga, Kumamoto, Oita, Miyazaki, Kagosima (excluding the range in Zone_I)		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +131^{\circ}$ latitude of origin: $\varphi_{\text{origin}} = +33^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_III	<b>SSM code</b>	3
<b>Short name</b>	Zone III		
<b>SRF region</b>	SRF region description: Prefectures: Yamaguti, Simane, Hirosima		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +132^{\circ}10'$ latitude of origin: $\varphi_{\text{origin}} = +36^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_IV	<b>SSM code</b>	4
<b>Short name</b>	Zone IV		
<b>SRF region</b>	SRF region description: Prefectures: Kagawa, Ehime, Tokusima, Koti		



Element	Specification	Element	Specification
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +133^{\circ}30'$ latitude of origin: $\varphi_{\text{origin}} = +33^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_V	<b>SSM code</b>	5
<b>Short name</b>	Zone V		
<b>SRF region</b>	SRF region description: Prefectures: Hyogo, Tottori, Okayama		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +134^{\circ}20'$ latitude of origin: $\varphi_{\text{origin}} = +36^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_VI	<b>SSM code</b>	6
<b>Short name</b>	Zone VI		
<b>SRF region</b>	SRF region description: Prefectures: Kyoto, Osaka, Hukui, Siga, Mie, Nara, Wakayama		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +136^{\circ}00'$ latitude of origin: $\varphi_{\text{origin}} = +36^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_VII	<b>SSM code</b>	7
<b>Short name</b>	Zone VII		
<b>SRF region</b>	SRF region description: Prefectures: Isikawa, Toyama, Gihu, Aiti		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +137^{\circ}10'$ latitude of origin: $\varphi_{\text{origin}} = +36^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_VIII	<b>SSM code</b>	8
<b>Short name</b>	Zone VIII		
<b>SRF region</b>	SRF region description: Prefectures: Niigata, Nagano, Yamanasi, Sizuoka		

Element	Specification	Element	Specification
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +138^{\circ}30'$ latitude of origin: $\varphi_{\text{origin}} = +36^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\ \text{m}$ False northing: $v_F = 0\ \text{m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_IX	<b>SSM code</b>	9
<b>Short name</b>	Zone IX		
<b>SRF region</b>	SRF region description: Prefectures: Tokyo(excluding the range in Zone_XIV, Zone_XVIII, and Zone_XIX), Hukusima, Totigi, Ibaraki, Saitama, Tiba, Gunma, Kanagawa		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +139^{\circ}50'$ latitude of origin: $\varphi_{\text{origin}} = +36^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\ \text{m}$ False northing: $v_F = 0\ \text{m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_X	<b>SSM code</b>	10
<b>Short name</b>	Zone X		
<b>SRF region</b>	SRF region description: Prefectures: Aomori, Akita, Yamagata, Iwate, Miyagi		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +140^{\circ}50'$ latitude of origin: $\varphi_{\text{origin}} = +40^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\ \text{m}$ False northing: $v_F = 0\ \text{m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_XI	<b>SSM code</b>	11
<b>Short name</b>	Zone XI		
<b>SRF region</b>	SRF region description: Cities: Otaru, Hakodate, Date Branch offices: Iburi (only Usu County and Abuta County), Hiyama, Siribesi, Osima		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +140^{\circ}15'$ latitude of origin: $\varphi_{\text{origin}} = +44^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\ \text{m}$ False northing: $v_F = 0\ \text{m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_XII	<b>SSM code</b>	12
<b>Short name</b>	Zone XII		

Element	Specification	Element	Specification
<b>SRF region</b>	SRF region description: Cities: Sapporo, Asahikawa, Wakkanai, Rumoi, Bibai Yuubari, Iwamizawa, Tomakomai, Muroran, Sibetu, Nayoro, Asibetu, Akabira, Mikasa, Takikawa, Sunagawa, Ebetu, Titose, Utsunai, Hukagawa, Monbetu, Hurano, Noboribetu, Eniwa, Kitahirosima, Isikari Branch offices: Isikari, Abasiri(only Monbetu County), Kamikawa, Soya, Hidaka, Iburi (excluding Usu County and Abuta County), Sorati, Rumoi		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +142^{\circ}15'$ latitude of origin: $\varphi_{\text{origin}} = +44^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_XIII	<b>SSM code</b>	13
<b>Short name</b>	Zone XIII		
<b>SRF region</b>	SRF region description: Cities: Kitami, Obihiro, Kusiuro, Abasiri, Nemuro Branch offices: Nemuro, Kusiuro, Abasiri (excluding Monbetu County), Tokati		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +144^{\circ}15'$ latitude of origin: $\varphi_{\text{origin}} = +44^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_XIV	<b>SSM code</b>	14
<b>Short name</b>	Zone XIV		
<b>SRF region</b>	SRF region description: Tokyo ( $140^{\circ}30' < \lambda < 143^{\circ}00'$ , $\varphi < 28^{\circ}$ )		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +142^{\circ}00'$ latitude of origin: $\varphi_{\text{origin}} = +26^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_XV	<b>SSM code</b>	15
<b>Short name</b>	Zone XV		
<b>SRF region</b>	SRF region description: Okinawa Prefecture ( $126^{\circ} < \lambda < 130^{\circ}$ )		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +127^{\circ}30'$ latitude of origin: $\varphi_{\text{origin}} = +26^{\circ}$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		

Element	Specification	Element	Specification
<b>SSM label</b>	ZONE_XVI	<b>SSM code</b>	16
<b>Short name</b>	Zone XVI		
<b>SRF region</b>	SRF region description: Okinawa Prefecture ( $\lambda < 126^\circ$ )		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +124^\circ 00'$ latitude of origin: $\varphi_{\text{origin}} = +26^\circ$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_XVII	<b>SSM code</b>	17
<b>Short name</b>	Zone XVII		
<b>SRF region</b>	SRF region description: Okinawa Prefecture ( $130^\circ < \lambda$ )		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +131^\circ 00'$ latitude of origin: $\varphi_{\text{origin}} = +26^\circ$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_XVIII	<b>SSM code</b>	18
<b>Short name</b>	Zone XVIII		
<b>SRF region</b>	SRF region description: Tokyo ( $\lambda < 140^\circ 30'$ , $\varphi < 28^\circ$ )		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +136^\circ 00'$ latitude of origin: $\varphi_{\text{origin}} = +20^\circ$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		
<b>SSM label</b>	ZONE_XIX	<b>SSM code</b>	19
<b>Short name</b>	Zone XIX		
<b>SRF region</b>	SRF region description: Tokyo ( $143^\circ < \lambda$ , $\varphi < 28^\circ$ )		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = +154^\circ 00'$ latitude of origin: $\varphi_{\text{origin}} = +26^\circ$ central scale: $k_0 = 0,999\ 9$ False easting: $u_F = 0\text{ m}$ False northing: $v_F = 0\text{ m}$		
<b>Notes</b>	none		

## 8.7.5 Lambert NTF

Table 8.56 — Lambert NTF SRF set

Element	Specification	Element	Specification
SRF set label	LAMBERT_NTF	SRF set code	4
Short name	Lambert NTF The Lambert projection-based mapping system for France associated with the <a href="#">NTF</a> .		
SRF template	<a href="#">LAMBERT_CONFORMAL_CONIC</a>	ORM constraints	ORM <a href="#">NTF 1896 PM PARIS</a>
Coverage description	SRF region description: France.		
SRF set membership	Specified in <a href="#">Table 8.57</a> .		
Notes	A set of four localized adjacent SRFs where only one SRF is used for each portion of France and no overlap is allowed. The prime meridian for each is Paris, France.		
References	<a href="#">[LIIIE]</a> , "Valeurs pour le calcul des coordonnées en projection Lambert de l'ellipsoïde de Clarke 1880 IGN.", "Zone lambert" (I, II, III, and IV)]		

Table 8.57 — SRF set membership Lambert NTF

Element	Specification	Element	Specification
SSM label	ZONE_I	SSM code	1
Short name	Zone I		
SRF region	SRF region specification of type geodetic-region: $-5^{\circ} \leq \lambda \leq 10^{\circ}$ $53,5^{\circ} \leq \varphi < 57^{\circ}$		
Parameter values	First parallel: $\varphi_1 = 48^{\circ}35'54,682''$ Second parallel: $\varphi_2 = 50^{\circ}23'45,282''$ Longitude of origin: $\lambda_{\text{origin}} = 0^{\circ}$ Latitude of origin: $\varphi_{\text{origin}} = 49,5^{\circ}$ False easting: $u_F = 600\,000\text{ m}$ False northing: $v_F = 200\,000\text{ m}$		
Notes	The prime meridian is Paris, France.		
SSM label	ZONE_II	SSM code	2
Short name	Zone II		
SRF region	SRF region specification of type geodetic-region: $-5^{\circ} \leq \lambda \leq 10^{\circ}$ $50,5^{\circ} \leq \varphi < 53,5^{\circ}$		
Parameter values	First parallel: $\varphi_1 = 45^{\circ}53'56,108''$ Second parallel: $\varphi_2 = 47^{\circ}41'45,652''$ Longitude of origin: $\lambda_{\text{origin}} = 0^{\circ}$ Latitude of origin: $\varphi_{\text{origin}} = 46,8^{\circ}$ False easting: $u_F = 600\,000\text{ m}$ False northing: $v_F = 200\,000\text{ m}$		

Element	Specification	Element	Specification
Notes	The prime meridian is Paris, France.		
SSM label	ZONE_III	SSM code	3
Short name	Zone III		
SRF region	SRF region specification of type geodetic-region: $-5^{\circ} \leq \lambda \leq 10^{\circ}$ $47^{\circ} \leq \varphi < 50,5^{\circ}$		
Parameter values	First parallel: $\varphi_1 = 43^{\circ}11'57,449''$ Second parallel: $\varphi_2 = 44^{\circ}59'45,938''$ Longitude of origin: $\lambda_{\text{origin}} = 0^{\circ}$ Latitude of origin: $\varphi_{\text{origin}} = 44,1^{\circ}$ False easting: $u_F = 600\,000$ m False northing: $v_F = 200\,000$ m		
Notes	The prime meridian is Paris, France.		
SSM label	ZONE_IV	SSM code	4
Short name	Zone IV		
SRF region	SRF region description: The island of Corsica.		
Parameter values	First parallel: $\varphi_1 = 41^{\circ}33'37,396''$ Second parallel: $\varphi_2 = 42^{\circ}46'3,588''$ Longitude of origin: $\lambda_{\text{origin}} = 0^{\circ}$ Latitude of origin: $\varphi_{\text{origin}} = 42^{\circ}9'54''$ False easting: $u_F = 234\,358$ m False northing: $v_F = 185\,861,369$ m		
Notes	The prime meridian is Paris, France.		

### 8.7.6 Universal polar stereographic

Table 8.58 — Universal polar stereographic (UPS) SRF set

Element	Specification	Element	Specification
SRF set label	UNIVERSAL_POLAR_STEREOGRAPHIC	SRF set code	5
Short name	Universal polar stereographic (UPS) (Earth)		
SRF template	<a href="#">POLAR_STEREOGRAPHIC</a>	ORM constraints	A global model ERM such as ORM <a href="#">WGS_1984</a> .
Coverage description	SRF region specification of type geodetic-region: $\varphi \leq -80^{\circ}$ or $84^{\circ} \leq \varphi$ Extended SRF region specification: $\varphi \leq -79,5^{\circ}$ or $83,5^{\circ} \leq \varphi$		
SRF set membership	Specified in <a href="#">Table 8.59</a> .		
Notes	A set of two localized SRFs addressing the north and south polar regions of the Earth. Shares a common boundary with SRF set <a href="#">UNIVERSAL_TRANSVERSE_MERCATOR</a> .		

Element	Specification	Element	Specification
References	<a href="#">[83582]</a> , "3-2.4 Specifications of the UPS"]		

Table 8.59 — SRF set membership Universal polar stereographic (UPS)

Element	Specification	Element	Specification
SSM label	NORTHERN_POLE.	SSM code	1
Short name	UPS, northern pole		
SRF region	SRF region specification of type geodetic-region: $\varphi \geq 84^\circ$ Extended SRF region specification: $\varphi \geq 83,5^\circ$		
Parameter values	longitude of origin: $\lambda_{\text{origin}} = 0^\circ$ latitude of true scale: $\varphi_1 = +90^\circ$ scale at $\varphi_1$ : $k_1 = 0,994$ false easting: $u_F = 2\,000\,000$ m false northing: $v_F = 2\,000\,000$ m		
Notes	none		
SSM label	SOUTHERN_POLE	SSM code	2
Short name	UPS, southern pole		
SRF region	SRF region specification of type geodetic-region: $\varphi \leq -80^\circ$ Extended SRF region specification: $\varphi \leq -79,5^\circ$		
Parameter values	longitude of origin: $\lambda_{\text{origin}} = 0^\circ$ latitude of true scale: $\varphi_1 = -90^\circ$ scale at $\varphi_1$ : $k_1 = 0,994$ false easting: $u_F = 2\,000\,000$ m false northing: $v_F = 2\,000\,000$ m		
Notes	none		

### 8.7.7 Universal transverse Mercator

Table 8.60 — Universal transverse Mercator (UTM) SRF set

Element	Specification	Element	Specification
SSM label	UNIVERSAL_TRANSVERSE_MERCATOR	SRF set code	6
Short name	Universal transverse Mercator (UTM) (Earth)		
SRF template	<a href="#">TRANSVERSE_MERCATOR</a>	ORM constraints	A global model ERM such as ORM <a href="#">WGS 1984</a> .
Coverage description	SRF region specification of type geodetic-region: $-80^\circ \leq \varphi \leq 84^\circ$ Extended SRF region specification: $-80,5^\circ \leq \varphi \leq 84,5^\circ$		
SRF set membership	Specified in <a href="#">Table 8.61</a> .		

Element	Specification	Element	Specification
Notes	A set of 120 localized SRFs, where limited overlap is modelled by extended SRF regions in the member SRFs. Shares a common boundary with SRF set <a href="#">UNIVERSAL POLAR STEREOGRAPHIC</a> .		
References	<a href="#">[83582]</a> , "2-3 Specifications of the UTM"]		

Table 8.61 — SRF set membership Universal transverse Mercator (UTM)

Element	Specification	Element	Specification
<b>SSM label</b>	"ZONE_" + <code> + "_NORTHERN_HEMISPHERE", where the "+" symbol shall denote concatenation of character strings	<b>SSM code</b>	1...60
<b>Short name</b>	UTM Zone <code>, Northern hemisphere		
<b>SRF region</b>	SRF region specification of type geodetic-region: $(-186^{\circ} + (\text{<code>}) \cdot 6^{\circ}) \leq \lambda \leq (-180^{\circ} + (\text{<code>}) \cdot 6^{\circ})$ $0^{\circ} \leq \varphi \leq 84^{\circ}$ Extended SRF region specification: $(-186,5^{\circ} + (\text{<code>}) \cdot 6^{\circ}) \leq \lambda \leq (-179,5^{\circ} + (\text{<code>}) \cdot 6^{\circ})$ $-0,5^{\circ} \leq \varphi \leq 84,5^{\circ}$		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = (-183^{\circ} + (\text{<code>}) \cdot 6^{\circ})$ latitude of origin: $\varphi_{\text{origin}} = 0^{\circ}$ central scale: $k_0 = 0,999\ 6$ false easting: $u_F = 500\ 000\ \text{m}$ false northing: $v_F = 0\ \text{m}$		
Notes	none		
<b>SSM label</b>	"ZONE_" + (<code> - 60) + "_SOUTHERN_HEMISPHERE", where the "+" symbol shall denote concatenation of character strings	<b>SSM code</b>	61...120
<b>Short Name</b>	UTM Zone <code>, Southern hemisphere		
<b>SRF region</b>	SRF region specification of type geodetic-region: $(-186^{\circ} + (\text{<code>} - 60) \cdot 6^{\circ}) \leq \lambda \leq (-180^{\circ} + (\text{<code>} - 60) \cdot 6^{\circ})$ $-80^{\circ} \leq \varphi \leq 0^{\circ}$ Extended SRF region specification: $(-186,5^{\circ} + (\text{<code>} - 60) \cdot 6^{\circ}) \leq \lambda \leq (-179,5^{\circ} + (\text{<code>} - 60) \cdot 6^{\circ})$ $-80,5^{\circ} \leq \varphi \leq 0,5^{\circ}$		
<b>Parameter values</b>	longitude of origin: $\lambda_{\text{origin}} = (-183^{\circ} + (\text{<code>} - 60) \cdot 6^{\circ})$ latitude of origin: $\varphi_{\text{origin}} = 0^{\circ}$ central scale: $k_0 = 0,999\ 6$ false easting: $u_F = 500\ 000\ \text{m}$ false northing: $v_F = 10\ 000\ 000\ \text{m}$		
Notes	none		



## 8.7.8 Wisconsin (US) state plane coordinate system

Table 8.62 — Wisconsin (US) state plane coordinate system SRF set

Element	Specification	Element	Specification
SRF set label	WISCONSIN_SPCS	SRF set code	7
Short name	Wisconsin ( <a href="#">US</a> ) state plane coordinate system		
SRF template	<a href="#">LAMBERT CONFORMAL CONIC</a>	ORM constraints	ORM <a href="#">N AM 1983</a>
Coverage description	SRF region description: State of Wisconsin ( <a href="#">US</a> ).		
SRF set membership	Specified in <a href="#">Table 8.63</a> .		
Notes	1) A set of three localized adjacent SRFs where only one SRF is used for each county in the state and no overlap is allowed. 2) The conventional coordinate unit is <a href="#">US</a> survey feet. To convert a coordinate in metres to a grid coordinate in <a href="#">US</a> survey feet, use $1\text{ m} = (39,37 / 12)$ <a href="#">US</a> survey feet.		
References	<a href="#">WSCO</a> , "SPC 83" (South, Central, and North)]		

Table 8.63 — SRF set membership Wisconsin (US) state plane coordinate

Element	Specification	Element	Specification
SSM label	SOUTH_ZONE	SSM code	1
Short name	South zone		
SRF region	SRF region description: Counties: Adams, Calumet, Columbia, Crawford, Dane, Dodge, Fond Du Lac, Grant, Green Lake, Green, Iowa, Jefferson, Juneau, Kenosha, La Crosse, Lafayette, Manitowoc, Marquette, Milwaukee, Monroe, Ozaukee, Racine, Richland, Rock, Sauk, Sheboygan, Vernon, Walworth, Washington, Waukesha, Waushara, Winnebago		
Parameter values	First parallel: $\varphi_1 = 42^\circ 44'$ Second parallel: $\varphi_2 = 44^\circ 04'$ Longitude of origin: $\lambda_{\text{origin}} = -90^\circ$ Latitude of origin: $\varphi_{\text{origin}} = 42^\circ$ False easting: $u_F = 600\,000\text{ m}$ False northing: $v_F = 0\text{ m}$		
Notes	none		
SSM label	CENTRAL_ZONE	SSM code	2
Short name	Central zone		
SRF region	SRF region description: Counties: Barron, Brown, Buffalo, Chippewa, Clark, Door, Dunn, Eau Claire, Jackson, Kewaunee, Langlade, Lincoln, Marathon, Marinette, Menominee, Oconto, Outagamie, Pepin, Pierce, Polk, Portage, Rusk, Shawano, St. Croix, Taylor, Trempealeau, Waupaca, Wood		

Element	Specification	Element	Specification
<b>Parameter values</b>	First parallel: $\varphi_1 = 44^\circ 15'$ Second parallel: $\varphi_2 = 45^\circ 30'$ Longitude of origin: $\lambda_{\text{origin}} = -90^\circ$ Latitude of origin: $\varphi_{\text{origin}} = 43^\circ 50'$ False easting: $u_F = 600\,000$ m False northing: $v_F = 0$ m		
<b>Notes</b>	none		
<b>SSM label</b>	NORTH_ZONE	<b>SSM code</b>	3
<b>Short name</b>	North zone		
<b>SRF region</b>	SRF region description: Counties: Ashland, Bayfield, Burnett, Douglas, Florence, Forest, Iron, Oneida, Price, Sawyer, Vilas, Washburn		
<b>Parameter values</b>	First parallel: $\varphi_1 = 45^\circ 34'$ Second parallel: $\varphi_2 = 46^\circ 46'$ Longitude of origin: $\lambda_{\text{origin}} = -90^\circ$ Latitude of origin: $\varphi_{\text{origin}} = 45^\circ 10'$ False easting: $u_F = 600\,000$ m False northing: $v_F = 0$ m		
<b>Notes</b>	none		

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