

REUSE MANUAL

POLAR STEREOGRAPHIC

10xxxxxx.1

Implementation

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SECTION 1. INTRODUCTION

1.1 PURPOSE OF THE REUSE MANUAL

This document describes the characteristics of the POLAR STEREOGRAPHIC reusable software component and provides instructions on its installation and operation. The manual is a self-contained reference for the software engineer intending to incorporate the component in another software system. This manual was written with the assumption that the user has a basic working knowledge of C and is familiar with fundamental C concepts and terminology.

1.2 PURPOSE OF THE REUSABLE SOFTWARE COMPONENT

The purpose of POLAR STEREOGRAPHIC is to provide a reusable component which supports the following coordinate conversions:

- Geodetic (latitude and longitude) coordinates to Polar Stereographic projection coordinates (easting and northing),
- Polar Stereographic projection coordinates (easting and northing) to geodetic (latitude and longitude) coordinates.

A particular ellipsoid is specified in terms of the following parameters:

- Semi-Major Axis (a): Radius (in meters) at the equator, and
- Semi-Minor Axis (b): Radius (in meters) at a pole.

A particular variation of the Polar Stereographic projection is specified in terms of the following parameters:

- Longitude Down From Pole – Longitude (in radians) along the negative Y axis of the projection coordinate system,
- Latitude of True Scale – Latitude (in radians) where the scale factor is 1.0, and also specifies the hemisphere (north or south),
- False Easting – A coordinate value (in meters) assigned to the origin longitude of the projection to avoid the inconvenience of using negative coordinates,
- False Northing – A coordinate value (in meters) assigned to the origin latitude of the projection to avoid the inconvenience of using negative coordinates.

1.3 GENERAL INFORMATION

1.3.1 POINT OF CONTACT

U.S. Army Topographic Engineering Center (USATEC)

Geospatial Information Division (GID)

ATTN: CETEC-GD-A (Dan Specht)

7701 Telegraph Road

Alexandria, VA 22315-3864

Dan Specht (703) 428 - 6761 Project Manager

1.3.2 CERTIFICATION LEVEL

This RSC has been certified at level 4. A level 4 component satisfies the criteria for reliability, testing, and documentation for the Army Reuse Center (ARC). The component comes with test materials and a Reuse Manual that aids in integrating the component into a software system.

1.3.3 LEGAL RESTRICTIONS

This Reusable Software Component (RSC) contains data with Unlimited Government Rights.

SECTION 2. INSTALLATION

The following is a list of the compilation files for the POLAR STEREOGRAPHIC component:

Source Code Files:

polarst.c

Header Files :

polarst.h

Data Files :

none

The compilation instructions for the POLAR STEREOGRAPHIC component are as follows:

DOS Makefile (Uses Microsoft C):

```
cl /nologo /W3 /FR /G2 /DNDEBUG /Gs /Ox /AM /D_DOS /c polarst.c
```

UNIX Makefile (Uses gcc compiler):

```
cc -g -O -ansi -Wall -c polarst.c
```

The compilation order of the POLAR STEREOGRAPHIC component relative to other components is unconstrained.

2.1 PARTIAL REUSE

The POLAR STEREOGRAPHIC component does not allow for partial reuse.

2.2 MODIFICATIONS

The POLAR STEREOGRAPHIC component does not permit modifications.

SECTION 3. ENVIRONMENT

This section provides details on the environment under which POLAR STEREOGRAPHIC was developed, tested, and executed.

3.1 HARDWARE

3.1.1 DEVELOPMENT

The following is a list of hardware configurations under which POLAR STEREOGRAPHIC was developed and tested.

- SUN SparcStation 20
- IBM compatible Pentium PC

3.1.2 TARGET

The following is a list of hardware configurations under which POLAR STEREOGRAPHIC was executed.

- SUN SparcStation 20
- IBM compatible Pentium PC

3.2 SOFTWARE

3.2.1 OPERATING SYSTEM

The following is a list of operating systems under which POLAR STEREOGRAPHIC was executed and tested.

- Solaris 2.5
- Windows 95

3.2.2 COMPILERS

The following is a list of compilers on which POLAR STEREOGRAPHIC was compiled successfully.

- GCC version 2.8.1

- Microsoft Visual C++ version 6

3.3 ASSUMPTIONS AND PERFORMANCE LIMITATIONS

There are no hardware or environment constraints. There are no limitations.

This RSC is written in ANSI C.

SECTION 4. GLOBAL RSC ENVIRONMENT

4.1 TYPES

Not applicable.

4.2 CONSTANTS

The following is a list of significant visible constants declared globally in POLAR STEREOGRAPHIC with their descriptions.

POLAR_NO_ERROR	: No errors occurred in function
POLAR_LAT_ERROR	: Latitude outside of valid range (-90 to 90 degrees)
POLAR_LON_ERROR	: Longitude outside of valid range (-180 to 360 degrees)
POLAR_ORIGIN_LAT_ERROR	: Latitude of true scale outside of valid range (-90 to 90 degrees)
POLAR_ORIGIN_LON_ERROR	: Longitude down from pole outside of valid range (-180 to 180 degrees)
POLAR_EASTING_ERROR	: Easting outside of valid range, depending on ellipsoid and projection parameters
POLAR_NORTHING_ERROR	: Northing outside of valid range, depending on ellipsoid and projection parameters
POLAR_A_ERROR	: Semi-major axis less than or equal to zero
POLAR_B_ERROR	: Semi-minor axis less than or equal to zero
POLAR_A_LESS_B_ERROR	: Semi-major axis less than semi-minor axis

4.3 VARIABLES

The following is a list of significant global variables declared in POLAR STEREOGRAPHIC with their descriptions.

Ellipsoid Parameters:
static double Polar_a : Semi-major axis of ellipsoid in meters
static double Polar_b : Semi-minor axis of ellipsoid in meters

Projection Parameters:
static double Polar-Origin-Lat : Latitude of origin in radians
static double Polar-Origin-Long : Longitude of origin in radians
static double Polar-False-Easting : False easting in meters
static double Polar-False-Northing : False northing in meters

Maximum values for easting and northing:
static double Polar_Delta_Easting
static double Polar_Delta_Northing

4.4 INCLUDE FILES

<code>math.h</code>	: Standard C math library
<code>polarst.h</code>	: Used for prototype checking

4.5 DEPENDENCIES

None, other than the standard ANSI C math library.

SECTION 5. FUNCTIONS

5.1 SET_POLAR_STEREOGRAPHIC_PARAMETERS

5.1.1 DESCRIPTION

This function sets the ellipsoid parameters and Polar Stereographic projection parameters to the specified values.

5.1.2 INTERFACES AND EXAMPLES

The following is a list of the formal arguments required to use this function.

```
long Set_Polar_Stereographic_Parameters (double a,  
                                          double b,  
                                          double Latitude_of_True_Scale,  
                                          double Longitude_Down_from_Pole,  
                                          double False_Easting,  
                                          double False_Northing);
```

a Semi-major axis of ellipsoid in meters (input),

b Semi-minor axis of ellipsoid in meters (input),

Latitude_of_True_Scale Latitude (in radians) where the scale factor is 1.0, and
also specifies the hemisphere (north or south) (input),

Longitude_Down_from_Pole Longitude (in radians) along the negative Y axis of the
projection coordinate system (input),

False_Easting Coordinate value in meters assigned to the origin longitude (input),

False_Northing Coordinate value in meters assigned to the origin latitude (input).

Example:

```
status = Set_Polar_Stereographic_Parameters (a, b, Latitude_of_True_Scale,  
                                             Longitude_Down_from_Pole, False_Easting, False_Northing)
```

Inputs:

a 6378137.0

b 6356752.3

Latitude_of_True_Scale 0.0

Longitude_Down_from_Pole 0.0

False_Easting 0.0

False_Northing 0.0

Outputs:

None.

5.1.3 DECLARATIONS

5.1.3.1 TYPES

Not applicable.

5.1.3.2 CONSTANTS

Not applicable.

5.1.3.3 VARIABLES

Not applicable.

5.1.4 DEPENDENCIES

None.

5.1.5 ERROR HANDLING

This function returns the following status codes:

POLAR_NO_ERROR	: No errors occurred in function
POLAR_A_ERROR	: Semi-major axis less than or equal to zero
POLAR_B_ERROR	: Semi-minor axis less than or equal to zero
POLAR_A_LESS_B_ERROR	: Semi-major axis less than semi-minor axis
POLAR_ORIGIN_LAT_ERROR	: Latitude of true scale outside of valid range (-90 to 90 degrees)
POLAR_ORIGIN_LON_ERROR	: Longitude down from pole outside of valid range (-180 to 360 degrees)

5.2 GET_POLAR_STEREOGRAPHIC_PARAMETERS

5.2.1 DESCRIPTION

This function returns the current values of the ellipsoid parameters and Polar Stereographic projection parameters.

5.2.2 INTERFACES AND EXAMPLES

The following is a list of the formal arguments required to use this function.

```
void Get_Polar_Stereographic_Parameters (double *a,  
                                         double *b,  
                                         double *Latitude_of_True_Scale,  
                                         double *Longitude_Down_from_Pole,  
                                         double *False_Easting,  
                                         double *False_Northing);
```

a	Semi-major axis of ellipsoid in meters (output),
b	Semi-minor axis of ellipsoid in meters (output),
Latitude_of_True_Scale	Latitude (in radians) where the scale factor is 1.0, and also specifies the hemisphere (north or south) (output),
Longitude_Down_from_Pole	Longitude (in radians) along the negative Y axis of the projection coordinate system (output),
False_Easting	Coordinate value in meters assigned to the origin longitude (output),
False_Northing	Coordinate value in meters assigned to the origin latitude (output).

5.2.3 DECLARATIONS

5.2.3.1 TYPES

Not applicable.

5.2.3.2 CONSTANTS

Not applicable.

5.2.3.3 VARIABLES

Not applicable.

5.2.4 DEPENDENCIES

None.

5.2.5 ERROR HANDLING

No errors are reported by this function.

5.3 CONVERT_GEODETTIC_TO_POLAR_STEREOGRAPHIC

5.3.1 DESCRIPTION

This function converts Geodetic coordinates (latitude and longitude in radians) to Polar Stereographic projection coordinates (easting and northing in meters), using the current ellipsoid and Polar Stereographic projection parameters.

5.3.2 INTERFACES AND EXAMPLES

The following is a list of the formal arguments required to use this function.

```
long Convert_Geodetic_To_Polar_Stereographic (double Latitude,  
                                              double Longitude,  
                                              double *Easting,  
                                              double *Northing);
```

Latitude	Latitude in radians (input),
Longitude	Longitude in radians (input),
Easting	Easting (X) in meters (output),
Northing	Northing (Y) in meters (output).

Example:

```
status = Convert_Geodetic_To_Polar_Stereographic (Latitude, Longitude,  
                                                  Easting, Northing)
```

Inputs:

Latitude:	-35.0
Longitude:	75.0

Outputs:

Easting:	11789412
Northing:	-3158963

5.3.3 DECLARATIONS

5.3.3.1 TYPES

Not applicable.

5.3.3.2 CONSTANTS

Not applicable.

5.3.3.3 VARIABLES

Not applicable.

5.3.4 DEPENDENCIES

None.

5.3.5 ERROR HANDLING

This function returns the following status codes:

POLAR_NO_ERROR	: No errors occurred in function
POLAR_LAT_ERROR	: Latitude outside of valid range (-90 to 90 degrees)
POLAR_LON_ERROR	: Longitude outside of valid range (-180 to 360 degrees)

5.4 CONVERT_POLAR_STEREOGRAPHIC_TO_GEODETTIC

5.4.1 DESCRIPTION

This function converts Polar Stereographic projection coordinates (easting and northing in meters) to Geodetic coordinates (latitude and longitude in radians), using the current ellipsoid and Polar Stereographic projection parameters.

5.4.2 INTERFACES AND EXAMPLES

The following is a list of the formal arguments required to use this function.

```
long Convert_Polar_Stereographic_To_Geodetic (double Easting,
```

```
double Northing,
double *Latitude,
double *Longitude);
```

Easting	Easting (X) in meters (input),
Northing	Northing (Y) in meters (input),
Latitude	Latitude in radians (output),
Longitude	Longitude in radians (output).

Example:

```
status = Convert_Polar_Stereographic_To_Geodetic (Easting, Northing, Latitude,
Longitude)
```

Inputs:

Easting:	11789412
Northing:	-3158963

Outputs:

Latitude:	-35.0
Longitude:	75.0

5.4.3 DECLARATIONS

5.4.3.1 TYPES

Not applicable.

5.4.3.2 CONSTANTS

Not applicable.

5.4.3.3 VARIABLES

Not applicable.

5.4.4 DEPENDENCIES

None.

5.4.5 ERROR HANDLING

This function returns the following status codes:

POLAR_NO_ERROR	: No errors occurred in function
POLAR_EASTING_ERROR	: Easting outside of valid range, depending on ellipsoid and projection parameters
POLAR_NORTHING_ERROR	: Northing outside of valid range, depending on ellipsoid and projection parameters

APPENDIX A STRUCTURE/DEPENDENCY DIAGRAMS

This component consists of a single compilation unit and depends only on the ANSI C standard math library.

APPENDIX B DEFINITIONS/GLOSSARY

Coordinate – Linear or angular quantities that designate the position that a point occupies in a given reference frame or system. Also used as a general term to designate the particular kind of reference frame or system, such as Cartesian coordinates or spherical coordinates.

Ellipsoid – The surface generated by an ellipse rotating about one of its axes.

False Easting – A coordinate value (in meters) assigned to the origin longitude of the projection to avoid the inconvenience of using negative coordinates.

False Northing – A coordinate value (in meters) assigned to the origin latitude of the projection to avoid the inconvenience of using negative coordinates.

Geodetic Coordinates – The quantities of latitude and longitude that define the position of a point on the surface of the earth with respect to the reference ellipsoid. Also, imprecisely called geographic coordinates.

Geodetic Latitude – The angle between the plane of the equator and the normal to the ellipsoid through the computation point. Geodetic latitude is positive north of the equator and negative south of the equator.

Geodetic Longitude – The angle between the plane of a meridian and the plane of the prime meridian. A longitude can be measured from the angle formed between the local and prime meridians at the pole of rotation of the reference ellipsoid, or by the arc along the equator intercepted by these meridians.

Map Projection – A function relating coordinates of points on a curved surface (usually an ellipsoid or sphere) to coordinates of points on a plane. A map projection may be established by analytical computation or, less commonly, may be constructed geometrically.

Map Scale – The ratio between a distance on a map and the corresponding actual distance on the earth's surface.

Meridian – A north-south reference line, particularly a great circle through the geographical poles of the earth, from which longitudes and azimuths are determined; or the intersection of a plane forming a great circle that contains both geographic poles of the earth, and the ellipsoid.

Origin Latitude – Latitude of the origin of the projected coordinate system.

Origin Longitude – Longitude at the horizontal center of a projection; Central Meridian.

Parallel – A line on the earth, or a representation thereof, that represents the same latitude at every point.

Polar Stereographic Projection – A conformal projection which is a limiting case of the Lambert Conformal Conic projection when the one standard parallel approaches a pole. In this conformal projection, meridians are straight lines, parallels are concentric circles, and the point scale factor is one at the pole.

Scale Factor (Projection) – A multiplier for reducing a distance in a map projection to the actual distance on the chosen reference ellipsoid.

APPENDIX C REFERENCES

(1) Topographic Engineering Center, TEC-SR-7, **Handbook for transformation of DATUMS, PROJECTIONS, GRIDS, AND COMMON COORDINATE SYSTEMS**, January 1996.

(2) Snyder, J. P., **Geological Survey Professional Paper 1395 Map Projections - A Working Manual**, 1987.