# SmartCollision™ SDK
# API Reference

***Version 2.01***

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3D Inc.

**3D Incorporated**

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version 2.01

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# 1. Preface

This reference manual describe class interface of SmartCollisionSDK.

# 2. Class interface

SmartCollisionSDK consists of two classes, namely SCSceneManager, SCObject. Class interface of each class is described below.

## 2.1 The methods of SCSceneManager

The methods of SCSceneManager are as follows.

**Table 2-1: Methods of SCSceneManager**

| Categories | Methods |
|---|---|
| Constructor | SCSceneManager () |
| Destructor | ～SCSceneManager () |
| Setting/Getting attributes | SetAttribute ()<br>GetAttribute () |
| Add/Delete object | AddObject()<br>DeleteObject() |
| Grouping | AddObjectToGroup()<br>DeleteObjectFromGroup()<br>DeleteGroup()<br>ResetGroup() |
| Setting activity of collision detection | SetActivity() |
| Setting/Getting transformation | SetTransformation()<br>GetTransformation() |
| Updating status<br>(Execute collision detection) | UpdateStatus() |
| Getting status<br>(Getting results of collision detection) | GetStatus() |
| Resetting status<br>(Resetting results of collision detection) | ResetStatus() |

## 2.1.1 SCSceneManager ()

### 【Syntax】

SCSceneManager ( SCenum mode);

### 【Description】

The constructor of SCSceneManager.

### 【Arguments】

〈INPUT〉

| | |
|---|---|
| *mode* | Sets mode of model data.<br>Default value is SC_MODE_TRIANGLE_SOUP.<br>■ SC_SCENE_MANAGER_TRIANGLE_SOUP: Arbitrary set of triangles or triangle soup.<br>■ SC_SCENE_MANAGER_CLOSED_POLYHEDRA: Closed polyhedra. This type is more efficient than SC_MODE_TRIANGLE_SOUP. |

〈OUTPUT〉

### 【Return】

## 2.1.2 ～SCSceneManager ()

**【Syntax】**

～SCSceneManager (void);

**【Description】**

The destructor of SCSceneManager.

**【Arguments】**

**【Return】**

## 2.1.3 SetAttribute ()

### 【Syntax】

```
SCint SetAttributeDouble(SCenum attribute,SCdouble value);
SCint SetAttributeFloat(SCenum attribute,SCfloat value);
SCint SetAttributeInteger(SCenum attribute,SCint value);
SCint SetAttributeEnum(SCenum attribute,SCenum value);
```

### 【Description】

Sets attributes of SCSceneManager.

### 【Arguments】

〈INPUT〉

| | |
|---|---|
| *Attribute* | Attribute to set. List of attributes are shown in Table A- 1 |
| *Value* | Value to set. |

〈OUTPUT〉

### 【Return】

SC_NO_ERROR: There has been no error.

SC_INVALID_ATTRIBUTE: The attribute to set is invalid.

SC_INVALID_VALUE: The value to set is invalid.

## 2.1.4 GetAttribute ()

### 【Syntax】

```
SCint GetAttributeDouble(SCenum attribute, SCdouble&value);
SCint GetAttributeFloat(SCenum attribute, SCfloat&value);
SCint GetAttributeInt(SCenum attribute, SCint&value);
SCint GetAttributeEnum(SCenum attribute, SCenum&value);
SCint GetAttributeString(SCenum attribute, const SCchar*&value);
```

### 【Description】

Gets attributes of SCSceneManager.

### 【Arguments】

〈INPUT〉

| | |
|---|---|
| *Attribute* | Attribute to set. List of attributes are shown in Table A- 1 |

〈OUTPUT〉

| | |
|---|---|
| *Value* | Value to get. |

### 【Return】

SC_NO_ERROR: There has been no error.

SC_INVALID_ATTRIBUTE: The attribute to get is invalid.

SC_INVALID_VALUE: The value to get is invalid.

## 2.1.5 AddObject()

### 【Syntax】

SCint AddObject (SCint id, SCObject*object);

### 【Description】

Adds SCObject in the scene. The information of the shape, position and orientation is obtained from SCObject. By default, the objects are automatically added to the static group.

### 【Arguments】

〈INPUT〉

| | |
|---|---|
| *id* | The ID to set to the object. The value of ID is chosen by the user and must be a positive integer. |
| *object* | The address of SCObject to add. |

〈OUTPUT〉

### 【Return】

SC_NO_ERROR: There has been no error.

SC_ERROR_DUPLICATE_ID: The *id* specified has already been registered.

SC_ERROR_INVALID_TYPE_COMBINATION: The type of SCObject does not match the type of SCSceneManager.

SC_ERROR_NO_GEOMETRY: The object has no geometry.

SC_ERROR_INVALID_LICENSE: The license is invalid.

SC_ERROR_BAD_ALLOCATION: Bad allocation has happened during the execution.

SC_ERROR_RUNTIME: Runtime error has happened during the execution.

## 2.1.6 DeleteObject()

### 【Syntax】

```
SCint DeleteObject (SCint id);
```

### 【Description】

Deletes the object in the scene. The object specified by *id* must have been registered by AddObject.

### 【Arguments】

〈INPUT〉

| | |
|---|---|
| *id* | The ID of the object to be deleted. |

〈OUTPUT〉

### 【Return】

SC_NO_ERROR: There has been no error.

SC_ERROR_INVALID_ID: The *id* specified is invalid.

## 2.1.7 AddObjectToGroup()

### 【Syntax】

```
SCint AddObjectToGroup(SCint gid,SCint id);
SCint AddControlledObject(SCint id, SCint gid=SC_DEFAULT_GROUP_ID);
```

### 【Description】

Adds the object specified by *id* to the group specified by *gid*. The object specified by *id* must have been registered by AddObject. If the group specified by *gid* does not exist, the new group is created.

A group of objects is treated as one object. The center of rotation of the object which is added first to the group is adopted as the center of rotation of the the group.

AddControlledObject is the obsolete form of AddObjectToGroup.

### 【Arguments】

| | |
|---|---|
| 〈INPUT〉 | |
| *id* | ID of the object to be added to the group. |
| *gid* | ID of the group to be added to.<br>SC_STATIC_GROUP_ID is a negative integer and is reserved as the static group. SC_STATIC_GROUP_ID must not be specified for *gid*. |
| 〈OUTPUT〉 | |

### 【Return】

SC_NO_ERROR: There has been no error.

SC_ERROR_INVALID_ID: The *id* specified is invalid.

SC_ERROR_INVALID_GROUP_ID: The *gid* specified is invalid.

## 2.1.8 DeleteObjectFromGroup()

### 【Syntax】

```
SCint DeleteObjectFromGroup(SCint gid,SCint id);
SCint DeleteControlledObject (SCint id, SCint gid=SC_DEFAULT_GROUP_ID);
```

### 【Description】

Deletes the object specified by id from the group. The object specified by *id* must have been registered by AddObject and added to the group by AddObjectToGroup. Objects deleted from their groups are automatically returned to the static group.

DeleteControlledObject is the obsolete form of DeleteObjectToGroup.

### 【Arguments】

〈INPUT〉

| | |
|---|---|
| *id* | ID of the object to be deleted from the group. |
| *gid* | ID of the group to be deleted from.<br>SC_STATIC_GROUP_ID is a negative integer and is reserved as the static group. SC_STATIC_GROUP_ID must not be specified for *gid*. |

〈OUTPUT〉

### 【Return】

SC_NO_ERROR: There has been no error.

SC_ERROR_INVALID_ID: The *id* specified is invalid.

SC_ERROR_INVALID_GROUP_ID: The *gid* specified is invalid.

## 2.1.9 DeleteGroup()

### 【Syntax】

```
SCint DeleteGroup(SCint gid);
```

### 【Description】

Deletes a group specified by *gid*.

### 【Arguments】

〈INPUT〉

| | |
|---|---|
| *gid* | ID of the group to be deleted.<br>SC_STATIC_GROUP_ID is a negative integer and is reserved as the static group. SC_STATIC_GROUP_ID must not be specified for *gid*. |

〈OUTPUT〉

### 【Return】

SC_NO_ERROR: There has been no error.

SC_ERROR_INVALID_GROUP_ID: The *gid* specified is invalid.

## 2.1.10 ResetGroup()

### 【Syntax】

SCint ResetGroup(void);

### 【Description】

Deletes all existing groups and adds all objects to the static group whose *gid* is SC_STATIC_GROUP_ID.

### 【Arguments】

〈INPUT〉

〈OUTPUT〉

### 【Return】

SC_NO_ERROR: There has been no error.

## 2.1.11 SetActivity()

### 【Syntax】

SCint SetActivityGroup (SCint gid,SCenum type);

SCint SetActivityGroupPair (SCint gid1,SCint gid2, SCenum type);

SCint SetActivityObject (SCint oid,SCenum type);

SCint ActivateObject (SCint oid);

SCint DeactivateObject (SCint oid);

### 【Description】

Sets activity of the object, the group or the pair of groups specified by ID or IDs.

ActivateObject and DeactivateObject are the obsolete forms of SetActivity.

ActivateObject(oid) is equivalent to SetActivityObject (oid , SC_ACTIVITY_ACTIVE ).

DeactivateObject(oid) is equivalent to SetActivityObject (oid , SC_ACTIVITY_INACTIVE ).

### 【Arguments】

〈INPUT〉

*oid* The ID of the object to set activity of.

*gid* The ID of the group to set activity of.

*gid1,gid2* The IDs of the pair of groups to set activity of.

*type* Possible types of activities are as follows.

■ SC_ACTIVITY_ACTIVE: The object, the group or the pair of groups is taken into account of collision detection.

■ SC_ACTIVITY_INACTIVE: The object, the group or the pair of groups is not taken into account of collision detection. Statuses of collision detection are discarded.

■ SC_ACTIVITY_PASSIVE: The group is taken into account of collision detection only if the other group is active. The penetration depth computation is performed only in the direction from the active group to the passive group.

■ SC_ACTIVITY_SLEEPING: The group is taken into account of collision detection only if the other group is active. However, statuses of collision detection are kept in memory, even if the other group is passive.

■ SC_ACTIVITY_ONE_WAY_ACTIVE: The collision detection from *gid1* to *gid2* is performed, ignoring the other configurations.

■ SC_ACTIVITY_ONE_WAY_INACTIVE: The collision detection from *gid1* to *gid2* is not performed, ignoring the other configurations.

Activities of collision detection according to the activities of two groups are shown in Appendix A- 2.

〈OUTPUT〉

### 【Return】

SC_NO_ERROR: There has been no error.

SC_ERROR_INVALID_TYPE: The type specified is invalid.

SC_ERROR_INVALID_ID: The *id* specified is invalid.

SC_ERROR_INVALID_GROUP_ID: The *gid* specified is invalid.

## 2.1.12 SetTransformation()

### 【Syntax】

```
SCint SetTransformation(SCint gid,SCenum type, const Float*trans);
SCint SetTransformation(SCint gid,SCenum type, const SCdouble*trans);
SCint SetTransformation(SCenum type, const Float*trans, SCint gid=0);
SCint SetTransformation(SCenum type, const SCdouble*trans, SCint gid=0);
```

### 【Description】

Sets transformation of the group specified by *gid*.

### 【Arguments】

〈INPUT〉

*gid* ID of a group. SC_STATIC_GROUP_ID is a negative integer and is reserved as static object group.

ID of the group to be set transformation of.

SC_STATIC_GROUP_ID is a negative integer and is reserved as the static group. SC_STATIC_GROUP_ID must not be specified for *gid*.

*trans* Transformation to set

*type* The type of transformation. Possible types of transformation are shown in Appendix A- 3.

〈OUTPUT〉

### 【Return】

SC_NO_ERROR: There has been no error.

SC_ERROR_INVALID_TYPE: The type specified is invalid.

SC_ERROR_INVALID_GROUP_ID: The *gid* specified is invalid.

## 2.1.13 GetTransformation()

### 【Syntax】

```
SCint GetTransformation(SCint gid ,SCenum type,SCdouble position[3]) const;
SCint GetTransformation(SCenum type,SCfloat position[3], SCint gid=0) const;
```

### 【Description】

Gets transformation of the group specified by *gid*.

### 【Arguments】

〈INPUT〉

*gid* ID of a group. SC_STATIC_GROUP_ID is a negative integer and is reserved as static object group.

*type* The type of transformation. Possible types of transformation are shown in Appendix A- 3.

〈OUTPUT〉

*position* Position to get

### 【Return】

SC_NO_ERROR: There has been no error.

SC_ERROR_INVALID_TYPE: The type specified is invalid.

SC_INVALID_ID: The ID specified is invalid.

SC_ERROR_INVALID_GROUP_ID: The *gid* specified is invalid.

### 2.1.14 UpdateStatus()

**【Syntax】**

SCint UpdateStatus(void);

**【Description】**

Updates the statuses of distance computation or penetration depth computation with respect to current transformations.

**【Arguments】**

〈INPUT〉

〈OUTPUT〉

**【Return】**

SC_NO_ERROR: If there is no error, otherwise as follows.

SC_ERROR_INVALID_INITIAL_TRANSFORMATION: Failed to perform penetration depth computation. To perform the penetration depth computation, non-penetrating initial transformation of the controlled object is required.

SC_ERROR_UNKNOWN_DISTANCE: The controlled object is not penetrating with the static object, but the result of distance computation is unknown. This happens when the minimum distance between the controlled object and the static objects is further than threshold of distance computation.

SC_ERROR_NO_RESULT: There is no result.

SC_ERROR_FAILED: Failed to get status.

SC_ERROR_BAD_ALLOCATION: Bad allocation has happened during the execution.

SC_ERROR_RUNTIME: Runtime error has happened during the execution.

## 2.1.15 GetStatus()

### 【Syntax】

```
SCint GetStatus(SCenum type, SCint*status);
SCint GetStatus(SCenum type, SCfloat*status);
SCint GetStatus(SCenum type, SCdouble*status);
SCint GetStatus(SCenum type,SCint*status, SCint index, SCbool reverseFlag=false);
SCint GetStatus(SCenum type,SCfloat*status, SCint index, SCbool reverseFlag=false);
SCint GetStatus(SCenum type,SCdouble*status, SCint index, SCbool reverseFlag=false);
```

### 【Description】

Gets the statuses of minimum distance/penetration depth computation between groups of objects. If there are more than two groups of objects, the number of statuses is at most the number of combination of the two groups. Only the statues between the two groups whose distance is within less equal than SC_MAX_DISTANCE can be obtained. The number of statues can be obtained by using SC_STATUS_COUNT. If the reverseFlag is true, the status reversed the order of the groups can be obtained.

### 【Arguments】

〈INPUT〉

| | |
|---|---|
| *index* | Index specifies one of the results. Index starts at 0. |
| *reverseFlag* | If the reverseFlag is true, the status reversed the order of the groups can be obtained. |
| *type* | Type of status to get. Possible types of status are shown in Appendix A- 4. |

〈OUTPUT〉

| | |
|---|---|
| *status* | Status to get. |

### 【Return】

SC_NO_ERROR: There has been no error. Distance computation or penetration depth computation has been performed normally.

SC_ERROR_INVALID_INITIAL_TRANSFORMATION: Failed to perform penetration depth computation. To perform the penetration depth computation, non-penetrating initial transformation of the controlled object is required.

SC_ERROR_UNKNOWN_DISTANCE: the controlled object is not penetrating with the static object, but the result of distance computation is unknown. This happens when the minimum distance between the controlled object and the static objects is further than threshold of distance computation.

SC_ERROR_NO_RESULT: There is no result.

SC_ERROR_INVALID_TYPE: The type specified is invalid.

SC_ERROR_INVALID_INDEX: The index specified is invalid.

SC_ERROR_FAILED: Failed to get status.

### 2.1.16 ResetStatus()

**【Syntax】**

```
SCint ResetStatus(void);
```

**【Description】**

Resets the statuses of distance computation or penetration depth computation.

**【Arguments】**

〈INPUT〉

〈OUTPUT〉

**【Return】**

SC_NO_ERROR: There has been no error.

## 2.2 The methods of SCObject

The methods of SCObject are as follows.

**Table 2-2: Methods of SCObject**

| Categories | Methods |
|---|---|
| Constructor | SCObject () |
| Destructor | ～SCObject () |
| Setting geometry | AddTriangles() |
| Setting/Getting transformation | SetTransformation()<br>GetTransformation() |

## 2.2.1 SCObject ()

### 【Syntax】

```
SCObject (SCenum type);
SCObject (void);
```

### 【Description】

The constructor of SCObject.

### 【Arguments】

〈INPUT〉

*type*

Type of triangles to set.

- ■ SC_OBJECT_TYPE_CLOSED_POLYHEDRA / SC_OBJECT_TYPE_CLOSED_POLYHEDRON: Closed polyhedra. This type of object can be add to SCSceneManager in SC_MODE_CLOSED_POLYHEDRA mode.
- ■ SC_OBJECT_TYPE_TRIANGLE_SOUP: Arbitrary set of triangles. So-called triangle soup. This type of object can be add to SCSceneManager in SC_MODE_TRIANGLE_SOUP mode.

〈OUTPUT〉

### 【Return】

### 2.2.2 ～SCObject ()

**【Syntax】**

～SCObject (void);

**【Description】**

The distructor of SCObject.

**【Arguments】**

**【Return】**

## 2.2.3 AddTriangles()

### 【Syntax】

SCint AddTriangles (const SCfloat*vertices, SCint vertexNum, const SCint triangles, SCint triangleNum, const SCchar*bvhFile=NULL);

SCint AddTriangles (const SCdouble*vertices, SCint vertexNum, const SCint triangles, SCint triangleNum, const SCchar*bvhFile=NULL);

SCint AddTriangles (SCenum type, const SCfloat*vertices, SCint vertexNum, const SCint triangles, SCint triangleNum, const SCchar*bvhFile=NULL);

SCint AddTriangles (SCenum type, const SCdouble*vertices, SCint vertexNum, const SCint triangles, SCint triangleNum, const SCchar*bvhFile=NULL);

### 【Description】

Adds triangles to the object.

It is possible to call AddTriangles at multiple times, but combinations of different type of model are not allowed.

### 【Arguments】

〈INPUT〉

*type* Type of triangles to set.

■ SC_OBJECT_TYPE_CLOSED_POLYHEDRA / SC_OBJECT_TYPE_CLOSED_POLYHEDRON: Closed polyhedra. This type of object can be add to SCSceneManager in SC_MODE_CLOSED_POLYHEDRA mode.

■ SC_OBJECT_TYPE_TRIANGLE_SOUP: Arbitrary set of triangles. So-called triangle soup. This type of object can be add to SCSceneManager in SC_MODE_TRIANGLE_SOUP mode.

*vertices* The array of vertices. The array has the 3*vertexNum elements.

*vertexNum* The number of vertices.

*triangles* The array of index of vertices of triangles. Index starts from 0. The array has the 3*triangleNum elements.

*triangleNum* The number of triangles.

*bvhFile* File name of BVH file to set, if the type of triangles is SC_OBJECT_TYPE_CLOSED_POLYHEDRA. Otherwise, ignores this argument. If BVH file exits, reads the file. If BVH file does not exist, creates the file. If BVH file is NULL or not specified, creates a temporary BVH when the object is added in the scene.

〈OUTPUT〉

## 【Return】

SC_NO_ERROR: There has been no error.

SC_ERROR_INVALID_TYPE: The type specified is invalid.

SC_ERROR_FAILED: Failed to execution.

SC_ERROR_INVALID_TYPE_COMBINATION: The combination of type of data is invalid.

SC_ERROR_INVALID_DATA: The data specified is invalid.

SC_ERROR_INVALID_BVH_FILE: The BVH file specified is invalid.

SC_ERROR_INVALID_LICENSE: The license is invalid.

SC_ERROR_BAD_ALLOCATION: Bad allocation has happened during the execution.

SC_ERROR_RUNTIME: Runtime error has happened during the execution.

# 2.2.4 SetTransformation()

### 【Syntax】

SCint SetTransformation(SCenum type,const SCfloat*transformation);

SCint SetTransformation(SCenum type,const SCdouble*transformation);

### 【Description】

Sets position of the object. After a SCObject has been added to SCSceneManager, it is required that you use the method SCSceneManger::SetTransformation to set the transformations of the SCObject.

### 【Arguments】

〈INPUT〉

| | |
|---|---|
| *transformation* | Transformation to set. |
| *type* | The type of transformation. Possible types of transformation are shown in Appendix A- 3. |

〈OUTPUT〉

### 【Return】

SC_NO_ERROR: There has been no error.

SC_ERROR_FAILED: Falied to execution.

## 2.2.5 GetTransformation()

### 【Syntax】

```
SCint GetTransformation(SCenum type,SCfloat position[3]) const;
SCint GetTransformation(SCenum type,SCdouble position[3]) const;
```

### 【Description】

Gets position of the object. Even after a SCObject has been added to SCSceneManager, it is possible to use SCObject::GetTransformation to get transformations for each object.

### 【Arguments】

〈INPUT〉

| | |
|---|---|
| *type* | The type of transformation. Possible types of transformation are shown in Appendix A- 3. |

〈OUTPUT〉

| | |
|---|---|
| *transformation* | Transformation to get |

### 【Return】

SC_NO_ERROR: There has been no error.

SC_ERROR_FAILED: Falied to execution.

# Appendix A

## Appendix A- 1 Attributes of SCSceneManager

Table A- 1 shows attributes of SCSceneManager.

### Table A- 1:Attributes of SCSceneManager

| Name of attributes | Type | Units | Description |
|---|---|---|---|
| SC_SCENE_MANAGER_TOLERANCE | SCdouble<br>SCfloat | [Length] | Tolerance for penetration depth computation.<br>Default value is 0.2. |
| SC_SCENE_MANAGER_ROTATION_MODE | SCenum | | Rotation mode.<br>■ SC_ROTATION_MODE_NONE: Contact orientation keeps the value at the time when the penetration happened. This is the default.<br>■ SC_ROTATION_MODE_INPUT: The combination of the penetration depth vector and the penetration rotation vector is determined such that the norm of the penetration rotation vector has the minimum value.<br>■ SC_ROTATION_MODE_FREE: The combination of the penetration depth vector and the penetration rotation vector is determined such that the norm of the penetration depth has the minimum value.<br>■ SC_ROTATION_MODE_MIX: The combination of the penetration depth vector and the penetration rotation vector is determined such that potential has the minimum value. |
| SC_SCENE_MANAGER_MAX_ITERATION | SCint | | Maximum iteration of penetration depth computation.<br>Default value is 5. |
| SC_SCENE_MANAGER_MAX_DISTANCE | SCdouble<br>SCfloat | [Length] | Maximum distance for distance computation.<br>If the distance between the controlled object and the static object beyond the value, the results of distance computation may be unknown. Default value is 0.5. |
| SC_SCENE_MANAGER_FORCE_STIFFNESS | SCdouble<br>SCfloat | [Force/Length] | Stiffness of force to calculate potential.<br>Defalut value is 0.4. |
| SC_SCENE_MANAGER_TORQUE_STIFFNESS | SCdouble<br>SCfloat | [Force*Length] | Stiffness of torque to calculate potential.<br>Default value is 100. |
| SC_SCENE_MANAGER_SAFETY_COEFFICIENT | SCdouble<br>SCfloat | | Safety coefficient of penetration depth computation. The value must be larger than 0 and less than 0.5. Default value is 0.49. |
| SC_SCENE_MANAGER_PENETRATION_DEPTH_COMPUTATION | SCenum | | Execution of penetration depth computation.<br>■ SC_TRUE: Penetration depth computation is enabled. This is the default.<br>■ SC_FALSE: Penetration depth computation is disabled. |
| SC_ VERSION | const SCchar* | | Version of SmartCollision. |

# Appendix A- 2 Activities of minimum distance computation

Table A- 2 shows activities of collision detection according to the activities of two groups. In Table A- 2 , the group at the origin of the arrow plays the role of the **target**, and the group at the head of the arrow plays the role of the **opponent**.

**Table A- 2: Activities of collision detection according to the activities of two groups**

| Activity of group B<br>Activity of group A | SC_ACTIVITY_ACTIVE | SC_ACTIVITY_SLEEPING | SC_ACTIVITY_PASSIVE | SC_ACTIVITY_INACTIVE |
|---|---|---|---|---|
| SC_ACTIVITY_ACTIVE | A⇄B | A→B | A→B | — |
| SC_ACTIVITY_SLEEPING | A←B | — | — | — |
| SC_ACTIVITY_PASSIVE | A←B | — | — | — |
| SC_ACTIVITY_INACTIVE | — | — | — | — |

# Appendix A- 3 Types of transformation

Table A- 3 shows types of transformation.

### Table A- 3:Types of transformation

| Type of transformation | Type of array | Size | Description |
|---|---|---|---|
| SC_POSITION_ORIGIN | SCfloat<br>SCdouble | 3 | The origin of local coordinates system of the object in world coordinates system. |
| SC_POSITION_WORLD_CENTER | SCfloat<br>SCdouble | 3 | The center of rotation of the object in world coordinates system. |
| SC_POSITION_LOCAL_CENTER | SCfloat<br>SCdouble | 3 | The center of rotation of the object in local coordinates system. |
| SC_ORIENTATION_QUATERNION | SCfloat<br>SCdouble | 4 | The orientation of the object specified by quaternion. |
| SC_ORIENTATION_MATRIX | SCfloat<br>SCdouble | 16 | The orientation of the object specified by matrix. Transformation is expressed by 4x4 matrix. |
| SC_TRANSFORMATION_MATRIX | SCfloat<br>SCdouble | 16 | Transformation of the object specityed by 4x4 matrix. |
| SC_POSITION_NEW_WORLD_CENTER | SCfloat<br>SCdouble | 3 | The new center of rotation of the object in world coordinates system. |
| SC_POSITION_NEW_LOCAL_CENTER | SCfloat<br>SCdouble | 3 | The new center of rotation of the object in local coordinates system. |

# Appendix A- 4 Types of status

Table A- 4 shows types of status of SCSceneManager.

### Table A- 4: Types of status of SCSceneManager

| Type of transformation | Type of array | Size | Description |
|---|---|---|---|
| SC_PAIR_COUNT<br>SC_STATUS_COUNT | SCint | 1 | The number of pair. |
| SC_ STATUS_ RESULT | SCint | 1 | The status of result. The possible values are as follows.<br>■ SC_NO_ERROR: Either minimum distance computation or penetration depth computation was executed normally.<br>■ SC_ERROR_INVALID_INITIAL_TRANSFORMATION : There were intersections, before penetration depth computation started.<br>■ SC_ERROR_UNKNOWN_DISTANCE: There was no penetration, but minimum distance computation was not executed, because the distance was greater than the threshold.<br>■ SC_ERROR_NO_RESULT: There was no result between the pair in this direction. |
| SC_GROUP_ID | SCint | 2 | The IDs of the pair of the groups, which have end points of minimum distance / penetration depth computation. |
| SC_OBJECT_ID | SCint | 2 | The IDs of the pair of the objects, which have end points of minimum distance /penetration depth computation. |
| SC_TARGET_OBJECT_ID<br>SC _CONTROLLED_OBJECT_ID | SCint | 1 | The ID of the target object, which has the end point of distance/penetration depth computation. |
| SC_OPPONENT_OBJECT_ID<br>SC _STATIC_OBJECT_ID | SCint | 1 | The ID of the opponent object which has the end point of distance/penetration depth computation. |
| SC_DISTANCE | SCfloat<br>SCdouble | 1 | Positive value means the minimum distance between the pair. If the value is zero or negative, there is penetration between the pair. If penetration depth computation is enabled, the magnitude means magnitude of translational penetration depth vector. Otherwise,the magnitude has no meaning. |
| SC_CONTACT_NORMAL | SCfloat<br>SCdouble | 3 | The normal between the target in contact state and opponent |
| SC_MD_VECTOR | SCfloat<br>SCdouble | 3 | Minimum distance vector. If there are penetrations, this is zero vector. |
| SC_TPD_VECTOR | SCfloat<br>SCdouble | 3 | Translational penetration depth vector. If there is no penetration, this is zero vector. |
| SC_RPD_VECTOR | SCfloat<br>SCdouble | 3 | Rotational penetration depth vector. If there is no penetration, this is zero vector. |
| SC_RPD_QUATERNION | SCfloat<br>SCdouble | 4 | Quaternion representation of rotational penetration depth vector. If there is no penetration, this is identical quaternion. |
| SC_PD_MATRIX | SCfloat<br>SCdouble | 16 | Matrix representation of penetration depth. |
| SC_PD_INVERSE_MATRIX | SCfloat<br>SCdouble | 16 | Inverse matrix of penetration depth. |
| SC_CONTACT_POSITION | SCfloat<br>SCdouble | 3 | The contact position. The position is expressed by the center of rotation of the object in world coordinates system. |
| SC_CONTACT_ORIENTATION | SCfloat<br>SCdouble | 4 | The contact orientation. The orientation is expressed by quaternion representation. |

| | | | |
|---|---|---|---|
| SC_CONTACT_TRANSFORMATION_MATRIX | SCfloat<br>SCdouble | 16 | Contact transformation. Transformation is specified by 4x4 matrix. |
| SC_POINT_ON_TARGET<br>SC_POINT_ON_CONTROLLED_OBJECT | SCfloat<br>SCdouble | 3 | The end point on the target of the result of minimum distance/penetration depth computation. |
| SC_POINT_ON_TARGET_IN_CONTACT<br>SC_POINT_ON_CONTACT_OBJECT | SCfloat<br>SCdouble | 3 | The end point on the target in contact of the result of penetration depth computation. |
| SC_POINT_ON_OPPONENT<br>SC_POINT_ON_STATIC_OBJECT | SCfloat<br>SCdouble | 3 | The end point on the opponent of the result of distance/penetration depth computation. |