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Chapter 1. Welcome

1.1 About this Guide

IBM solidDB Programmer Guide contains information about using IBM solidDB through the different Application Programming Interfaces, with or without the IBM solidDB linked library access and HotStandby.

IBM solidDB ODBC Driver, IBM solidDB Light Client, and IBM solidDB JDBC Driver help your client application access IBM solidDB. IBM solidDB's 32-bit native ODBC Driver conforms to the Microsoft ODBC 3.51 API standard. IBM solidDB Light Client is a lightweight version of the IBM solidDB ODBC API and is intended for environments where the footprint of the client application must be very small. The IBM solidDB JDBC Driver is a IBM solidDB implementation of the JDBC 2.0 standard.

1.1.1 Organization

This manual contains the following chapters:

- Chapter 2, *Introduction to IBM solidDB APIs*,provides an overview of the application programming interfaces available for accessing IBM solidDB databases.
- Chapter 3, *Using IBM solidDB ODBC API*, provides IBM solidDB-specific information for developing applications with ODBC API.
- Chapter 4, *Using UNICODE*, describes how to implement the UNICODE standard, which provides the capability to encode characters used in the major languages of the world.
- Chapter 5, *Using IBM solidDB Light Client*, describes how to use IBM solidDB Light Client, an API especially designed for implementing embedded applications with limited memory resources.
- Chapter 6, *Using the IBM solidDB JDBC Driver*, describes how to use the IBM solidDB JDBC Driver, a 100% Pure JavaTM implementation of the Java Database Connectivity (JDBCTM) 2.0 standard.
- Chapter 7, *Using IBM solidDB SA*, describes how to use IBM solidDB Application Programming Interface (IBM solidDB SA), a low level C-language client library, to access IBM solidDB database management products. This library can be used by a local client (when combined with linked library access), or by a remote client.

The Appendixes give you detailed information about topics such as ODBC-supported data types, etc.

1.1.2 Audience

This guide assumes general knowledge of relational databases and SQL. It also assumes familiarity with IBM solidDB. If you will use the ODBC driver, this manual assumes a working knowledge of the C programming language. If you will use the JDBC driver, this manual assumes a working knowledge of the Java programming language.

1.2 Conventions

1.2.1 Typographic Conventions

This manual uses the following typographic conventions:

Table 1.1. Typographic Conventions

Format	Used for
Database table	This font is used for all ordinary text.
NOT NULL	Uppercase letters on this font indicate SQL keywords and macro names.
`solid.ini`	These fonts indicate file names and path expressions.
`SET SYNC MASTER YES;` `COMMIT WORK;`	This font is used for program code and program output. Example SQL statements also use this font.
run.sh	This font is used for sample command lines.
`TRIG_COUNT()`	This font is used for function names.
`java.sql.Connection`	This font is used for interface names.
`LockHashSize`	This font is used for parameter names, function arguments, and Windows registry entries.
`argument`	Words emphasised like this indicate information that the user or the application must provide.
IBM solidDB Administration Guide	This style is used for references to other documents, or chapters in the same document. New terms and emphasised issues are also written like this.
File path presentation	File paths are presented in the Unix format. The slash (/) character represents the installation root directory.
Operating systems	If documentation contains differences between operating systems, the Unix format is mentioned first. The Microsoft Windows format is mentioned in

Format	Used for
	parentheses after the Unix format. Other operating systems are separately mentioned.

1.2.2 Syntax Notation

This manual uses the following syntax notation conventions:

Table 1.2. Syntax Notation Conventions

Format	Used for
`INSERT INTO` *`table_name`*	Syntax descriptions are on this font. Replaceable sections are on *`this`* font.
`solid.ini`	This font indicates file names and path expressions.
[ ]	Square brackets indicate optional items; if in bold text, brackets must be included in the syntax.
|	A vertical bar separates two mutually exclusive choices in a syntax line.
{ }	Curly brackets delimit a set of mutually exclusive choices in a syntax line; if in bold text, braces must be included in the syntax.
...	An ellipsis indicates that arguments can be repeated several times.
. . .	A column of three dots indicates continuation of previous lines of code.

1.3 IBM solidDB Documentation

Below is a complete list of documents available for IBM solidDB. IBM solidDB documentation is distributed in an electronic format, usually PDF files and web pages.

- *Release Notes*. This file contains installation instructions and the most up-to-date information about the specific product version. This file (`releasenotes.txt`) is copied onto your system when you install the software.

- *IBM solidDB Getting Started Guide*. This manual gives you an introduction to IBM solidDB.

- *IBM solidDB SQL Guide*. This manual describes the SQL commands that IBM solidDB supports. This manual also describes some of the system tables, system views, system stored procedures, etc. that the engine makes available to you. This manual contains some basic tutorial material on SQL for those readers who are not already familiar with SQL. Note that some specialized material is covered in other manuals. For example, the IBM solidDB "administrative commands" related to the High Availability (HotStandby) component are described in the *IBM solidDB High Availability User Guide*, not the *IBM solidDB SQL Guide*.

- *IBM solidDB Administration Guide*. This guide describes administrative procedures for IBM solidDB servers. This manual includes configuration information. Note that some administrative commands use an SQL-like syntax and are documented in the *IBM solidDB SQL Guide*.

- *IBM solidDB Programmer Guide*. This guide explains in detail how to use features such as IBM solidDB Stored Procedure Language, triggers, events, and sequences. It also describes the interfaces (APIs and drivers) available for accessing IBM solidDB and how to use them with a IBM solidDB database.

- *IBM solidDB In-Memory Database User Guide*. This manual describes how to use the IBM solidDB in-memory database and main memory engine (MME).

- *IBM solidDB Advanced Replication Guide*. This guide describes how to use the IBM solidDB advanced replication technology to synchronize data across multiple database servers.

- *IBM solidDB Linked Library Access User Guide*. Linking the client application directly to the server improves performance by eliminating network communication overhead. This guide describes how to use the linked library access, a database engine library that can be linked directly to the client application.

  This manual also explains how to use two proprietary Application Programming Interfaces (APIs). The first API is the IBM solidDB SA interface, a low-level C-language interface that allows you to perform simple single-table operations (such as inserting a row in a table) quickly. The second API is SSC API, which allows your C-language program can control the behavior of the embedded (linked) database server

  This manual also explains how to set up a IBM solidDB to run without a disk drive.

- *IBM solidDB High Availability User Guide*. IBM solidDB HotStandby allows your system to maintain an identical copy of the database in a backup server or "secondary server". This secondary database server can continue working if the primary database server fails.

- *IBM solidDB Connector Guide*. This guide explains in detail how to use the IBM solidDB Cache solution. IBM solidDB Cache provides a high-performance, low-latency database front-end solution for IBM Data Servers, namely DB2™ and Informix™. IBM solidDB Cache solution uses a number of in-memory front-

end databases to handle high-volume traffic from the applications. The connectors are applications that manage data between the back-end and the front-ends in IBM solidDB Cache.

Chapter 2. Introduction to IBM solidDB APIs

This chapter provides an overview of the application programming interfaces available to you for accessing IBM solidDB databases. These APIs include:

- IBM solidDB ODBC Driver
- IBM solidDB Light Client
- IBM solidDB JDBC Driver

These interfaces enable applications to establish multiple database connections simultaneously and to process multiple SQL statements simultaneously.

2.1 IBM solidDB ODBC Driver

IBM solidDB's 32-bit native ODBC Driver conforms to the Microsoft ODBC 3.51 API standard. For differences between the ODBC standard and the IBM solidDB implementation, refer to the appropriate topic in this manual.

On most platforms, the IBM solidDB ODBC Driver is included in the IBM solidDB Development Kit (SDK).

IBM solidDB provides both a Unicode and an ASCII version of the ODBC driver. For details about the Unicode version, see Chapter 4, *Using UNICODE*.

2.1.1 Using IBM solidDB ODBC Driver Functions

Users on all platforms can also access ODBC Driver supported functions with IBM solidDB ODBC API. The IBM solidDB ODBC API is the native call level interface (CLI) for IBM solidDB databases. It is a distributed in the form of a library (a Dynamic Link Library (DLL) on Microsoft Windows). The IBM solidDB ODBC API is compliant with ANSI X3H2 SQL CLI standard.

IBM solidDB's implementation of ODBC API supports a rich set of database access operations sufficient for creating robust database applications, including:

- Allocating and deallocating handles
- Getting and setting attributes

- Opening and closing database connections
- Accessing descriptors
- Executing SQL statements
- Accessing schema metadata
- Controlling transactions
- Accessing diagnostic information

Depending on the application's request, the IBM solidDB ODBC Driver can automatically commit each SQL statement or wait for an explicit commit or rollback request. When the driver performs a commit or rollback operation, the driver resets all statement requests associated with the connection.

2.1.2 ODBC API Basic Application Steps

A client database application calls the IBM solidDB ODBC API directly (or through the ODBC Driver Manager) to perform all interactions with a database. For example, to insert, delete, update, or select records, you make a series of calls to functions in the ODBC API.

An application using ODBC API performs the following tasks:

1. The application allocates memory and creates handles, and establishes a connection to the database.

    a. The application allocates memory for an environment handle (*henv*) and a connection handle (*hdbc*); both are required to establish a database connection.

    An application may request multiple connections for one or more data sources. Each connection is considered a separate transaction space. In other words, a COMMIT or ROLLBACK on one connection will not commit or rollback any statements executed through any other connection.

    b. The `SQLConnect()` call establishes the database connection, specifying the server name (a connect string or a data source name), user id, and password.

    c. The application then allocates memory for a statement handle.

2. The application executes the statement. This requires a series of function calls.

    a. The application calls either `SQLExecDirect()`, which both prepares and executes an SQL statement, or `SQLPrepare()` and `SQLExecute()`, which allows statements to be executed multiple times.

b. If the statement was a SELECT, the result columns must be bound to variables in the application so that the application can see the returned data. The `SQLBindCol()` function will bind the application's variables to the columns of the result set. The rows can then be fetched using `SQLFetch()` repeatedly. SELECT statements must be committed as soon as processing of the resultset is done.

   If the statement was an UPDATE, DELETE, or INSERT, then the application needs to check if the execution succeeded and call `SQLEndTran()` to commit the transaction.

3. Finally the application closes the connection and frees any handles.

   a. The application frees the statement handle.

   b. The application closes the connection.

   c. The application frees the connection and environment handles (*hdbc* and *henv*).

Note that step 2 (executing SQL statements) may be done repeatedly, depending upon how many SQL statements need to be executed.

Read Chapter 3, *Using IBM solidDB ODBC API* for more information on using these API calls.

2.1.3 Format of the Connect String

Connect strings used in ODBC and Light Client applications follow a common format shown here. The same format applies also to listen parameters in the configuration file `solid.ini`.

Connect string format:

```
protocol_name [options] [server_name] [port_number]
```

where options may be any number of:

Table 2.1. Connect String Options

Option	Meaning
-z	Data compression is enabled for this connection
-c *milliseconds*	Login timeout is specified (the default is operating-system-specific). A login request fails after the specified time has elapsed. Note: applies only for the TCP protocol.

Option	Meaning
-r *milliseconds*	Connection (or read) timeout is specified (the default is 60 s). A network request fails when no response is received during the time specified. The value 0 sets the timeout to infinite. Note: applies only for the TCP protocol.

Examples:

```
tcp localhost 1315
tcp 1315
tcp -z -c1000 1315
nmpipe host22 SOLIDDB
```

2.1.4 Client-Side Configuration File

IBM solidDB gets its client configuration information from the client-side `solid.ini` file. The client-side configuration file is used if the ODBC driver is used and the file must be located in the working directory of the application.

Important

In most cases, only IBM solidDB server-side parameters are used when programming for the IBM solidDB. However, occasionally there is a need to use client-side parameters. For example, you may want to create an application that defines no data source, but takes the data source from the connect string in the client-side configuration file.

Note

In IBM solidDB documentation, references to `solid.ini` file are usually for the server-side `solid.ini` file.

When the IBM solidDB is started, it attempts to open the configuration file `solid.ini`. If the file does not exist, IBM solidDB will use the factory values for the parameters. If the file exists, but a value for a particular parameter is not set in the `solid.ini` file, IBM solidDB will use a factory value for that parameter. The factory values may depend on the operating system you are using.

By default, the client looks for the `solid.ini` file in the current working directory, which is normally the directory from which you started the client. When searching for the file, the IBM solidDB uses the following precedence (from high to low):

- location specified by the *SOLIDDIR* environment variable (if this environment variable is set)

- current working directory

Client-Side Parameters

This section describes the most important IBM solidDB client-side parameters.

- *Com.Connect*

  The *Connect* parameter in the *[Com]* section defines the default network name (connect string) for a client to connect to when it communicates with a server. Not surprisingly, since the client should talk to the same network name as the server is listening to, the value of the *Connect* parameter on the client should match the value of the *Listen* parameter on the server.

  The same format of the connect string applies to all listen configuration parameters as well as to connect strings used in ODBC and Light Client applications.

- *Com.Trace*

  If you change the *Trace* parameter default setting from No to Yes, IBM solidDB starts logging trace information on network messages for the established network connection to the default trace file or to the file specified in the *TraceFile* parameter.

- *Com.TraceFile*

  If the *TraceFile* parameter is set to Yes, then trace information on network messages is written to a file specified by the *TraceFile* parameter. If no file name is specified, the server uses the default value `soltrace.out`, which is written to the current working directory of the server or client, depending on which end the tracing is started at.

2.2 IBM solidDB Light Client

IBM solidDB Light Client allows you to develop small-footprint applications using C (or any tool that conforms to the C function call convention). It is a 20-function subset of the ODBC API, providing full SQL capabilities for application developers accessing data from IBM solidDB databases. It provides functions for controlling database connections, executing SQL statements, retrieving result sets, committing transactions, and other data management functionality.

You can find sample C programs that use IBM solidDB Light Client API from the `/samples/lightclient` subdirectory.

Read Chapter 5, *Using IBM solidDB Light Client* for more details.

Note

IBM solidDB Light Client is not available on all platforms.

2.3 IBM solidDB JDBC Driver

The JDBC 2.0 Driver provides support for JDBC 2.0. The driver has been independently certified as J2EE compliant. [1]

IBM solidDB JDBC Driver allows you to develop your application with a Java tool that accesses the database using JDBC. The JDBC API, the core API for JDK 1.2, defines Java classes to represent database connections, SQL statements, result sets, database metadata, and so on. It allows you to issue SQL statements and process the results. JDBC is the primary API for database access in Java.

In order to use JDBC, you have to install the IBM solidDB JDBC Driver. Usage of JDBC drivers varies depending on your Java development environment. Instructions and samples for using the IBM solidDB JDBC Driver are located in the `/jdbc` subdirectory and in Chapter 6, *Using the IBM solidDB JDBC Driver*.

2.4 Building Client Applications

This section gives you an overview of how to create a client application that will work with IBM solidDB.

This section applies primarily to C-language programs that use the ODBC driver or the light client driver.

2.4.1 What Is a Client?

A client application, or "client" for short, is a program that submits requests (SQL queries) to the server and gets results back from the server. A client program is separate from the server program. [2] In many cases, the client is also running on a separate computer.

[1] The certification was done using J2EE 1.3.1 (JDK 1.4). The following exceptions were noted:

- User defined types (UDTs) are not supported.
- ColumnPriviliges are not supported.
- Stored Procedure OUT parameters are not supported.
- IBM solidDB DBMS returns update count 0 when executing procedure calls.

[2] Using linked library access, you can actually link the client's code directly to the server's code so that both run as a single process, but that is an advanced topic that we will leave for *IBM solidDB Linked Library Access User Guide*.

Since the client is a separate program, it cannot directly call functions in the server. Instead, it must use a communications protocol (such as TCP/IP, named pipes, shared memory, etc.) to communicate with the server. Different platforms support different protocols. On some platforms, you may need to link a specific library file (which supports a specific protocol) to your application so that your application can communicate with the server.

2.4.2 How Is the Query Passed to the Server?

As we saw in previous chapters, queries are written using the SQL programming language. One way that the server and client can exchange data is simply to pass literal strings back and forth. The client could send the server the string:

```
SELECT name FROM employees WHERE id = 12;
```

and the server could send back the string:

```
"Smith, Jane".
```

In practice, however, communication is usually done via a "driver", such as an ODBC driver or a JDBC driver. "ODBC" stands for "Open DataBase Connectivity" and is an API (Application Programming Interface) designed by Microsoft to make database access more consistent across vendors. If your client program follows the ODBC conventions, then your client program will be able to talk with any database server that follows those same conventions. Most major database vendors support ODBC to at least some extent. The ODBC standard is generally used by programs written in the C programming language.

"JDBC" stands for "Java DataBase Connectivity". It is based heavily on the ODBC standard, and not surprisingly it is essentially "ODBC for Java programs". Information about JDBC is available from the main Java website:

http://java.sun.com/

There are two major ways to pass specific data values (e.g. "Smith, Jane" to the server. The first way is to simply embed the values as literals in the query. You've already seen this in SQL statements like:

```
INSERT INTO employees (id, name) VALUES (12, 'Smith, Jane');
```

This works well if you have a single statement that you want to execute. There are times, however, that you may want to execute the same basic statement with different values. For example, if you want to insert data for 500 employees, you may not want to compose 500 separate statements such as

```
INSERT INTO employees (id, name) VALUES (12, 'Smith, Jane');
INSERT INTO employees (id, name) VALUES (13, 'Jones, Sally');
...
```

Instead, you might prefer to compose a single "generic" statement and then pass specific values for that statement. For example, you might want to compose the following statement:

```
INSERT INTO employees (id, name) VALUES (?, ?);
```

and have the question marks replaced with specific data values. This way you can easily execute all 500 INSERT statements inside a loop without composing a unique INSERT statement for each employee. By using parameters, you can specify different values each time a statement executes. A parameter allows you to specify a variable that will be used by the client program and the ODBC driver to store values that the client and server exchange. In essence, you pass a parameter for each place in the statement where you have a question mark.

Another situation where you might want to use parameters to exchange data values is when working with data that is difficult to represent as string literals. For example, if I want to insert a digitized copy of the song "American Pie" into my database, and I don't want to compose an SQL statement with a literal that contains a series of hexadecimal numbers to represent that digitized data, then I can store the digitized data in an array and notify the ODBC driver of the location of that array.

To use parameters with SQL statements, you go through a multi-step process. Below we describe the process when you are inserting data. The process is somewhat similar when you want to retrieve data.

1. "Prepare" the SQL statement. During the "prepare" phase, the server analyzes the statement and (among other things) looks to see how many parameters there will be. The number and meaning of the parameters is shown by the question marks that are included in the SQL statement.

2. Tell the ODBC driver which variables will be used as parameters. (Telling the ODBC driver which variable is associated with which column or value is called "binding" the parameters)

3. Put values into the parameters (i.e. set the values of the variables).

4. "Execute" the prepared statement.

During the execution phase, the ODBC driver will read the values you have stored in the parameters and will pass those values to the server to use with the statement that it has already prepared.

The process for getting results back is similar, and is described in the next section.

2.4.3 How Are the Results Passed Back to the Client?

The result of a query is a set of 0 or more rows. If you are using the ODBC driver (or JDBC driver) then you retrieve each row by using the appropriate ODBC (or JDBC) functions.

As a general rule, you go through the following steps

1. "Prepare" the SQL statement. During the "prepare" phase, the server analyzes the statement and (among other things) looks to see how many parameters there will be. The number and meaning of the parameters is shown by the question marks that are included in the SQL statement.

2. Tell the ODBC driver which variables will be used as parameters. (Telling the ODBC driver which variable is associated with which column or value is called "binding" the parameters.)

3. "Execute" the prepared statement. This tells the server to execute the query and collect the result set. Note that the result set is NOT immediately passed to the client, however.

4. "Fetch" the next row of the result set. When you do a "fetch", you tell the server and the ODBC driver to retrieve one row of results from the result set, and then store the values of that row into the parameters that you previously defined for the ODBC driver to share with your application.

Not surprisingly, you will normally perform a loop, fetching one row at a time and reading the data from the parameters after each fetch.

2.4.4 Using the ODBC Driver or Light Client Library

These drivers/libraries must be linked with your client application program. You will then be able to call the functions that are defined in these libraries. For details about library names, see the release notes file.

Static vs. Dynamic Libraries

Some library files are static — i.e. they are linked to your client application's executable program at the time that you do a compile-and-link operation. Other library files are dynamic - these are stored separately from your executable and are loaded into memory at the time your program executes.

The advantage of a static library is that your application is largely self-contained; if you distribute the application to your customers, those customers do not have to install a separate shared library in addition to installing your application.

The advantage of a dynamic library is that on many systems it requires less disk space (and, on some platforms, less memory space) if more than one client uses that library. For example, if you have two client applications that each link to a 5 MB static library, you will need not only 5 MB of disk space to store the static library, but also 10MB of additional disk space to store both copies of the library that are linked into the application.

However, if you link two client applications to a dynamic library, no additional copies of that library will be required; each application does not keep its own copy.

For many libraries, IBM solidDB provides both a static and a dynamic version on some or all platforms.

In addition, on Microsoft Windows, IBM solidDB provides an import library in some cases. Each import library is associated with a corresponding dynamic link library. Your application will link to the import library. When the application is actually loaded and executed, then the operating system will load the corresponding dynamic link library.

2.4.5 Statement Cache

Processing of queries is additionally optimized by a built-in "statement cache". Statement cache is an internal memory storing a few previously prepared SQL statements. The number of cached statements, for a session, can be set by using a client-side `solid.ini` configuration parameter *`Client.StatementCache`*. The default value is 6.

The statement cache operates in such a way that the prepare phase is omitted if the prepared statement is in the cache. If a connection is closed, the statement cache is purged.

In JDBC, the statement cache size can be dynamically set by using a non-standard driver property. For more information, see Section 6.5.3, “Statement Cache Property”.

Chapter 3. Using IBM solidDB ODBC API

This chapter contains IBM solidDB-specific information for developing applications that use the ODBC API.

In general, IBM solidDB conforms to the Microsoft ODBC 3.51 standard. IBM solidDB ODBC APIs are defined based on the function prototypes provided by Microsoft. This chapter details those areas where IBM solidDB-specific usage applies and where support for options, datatypes, and functions differ.

Note

This *IBM solidDB Programmer Guide* does not contain a full ODBC API reference. This chapter provides IBM solidDB-specific additions, supplements, and usage samples.

For details on developing applications with ODBC API, refer to the Microsoft Data Access SDK *Online ODBC Programmer's Reference*. For your convenience, the main portions of this reference are available in PDF format on the IBM Corporation Web site. This reference includes usage chapters that describe how to develop applications with ODBC API, as well as a comprehensive function reference.

IBM solidDB provides two versions of the ODBC driver, one for Unicode and one for ASCII. The Unicode version is a superset of the ASCII version; you may use it with either Unicode or ASCII character sets.

3.1 IBM solidDB ODBC Driver 3.51 Features Support

For users who have migrated from a previous version (1.0, 2.0, and 3.0) of the IBM solidDB ODBC Driver to IBM solidDB ODBC Driver 3.51, please note the following supported features in this driver:

- Complete support of descriptors
- All catalog API support
- Unicode support
- Multithread support
- ADO/DAO/RDO/OLE DB support
- Data access through MSAccess and MS Query

- Block cursor support

3.2 Overview of Usage on Microsoft Windows

On Microsoft Windows, the IBM solidDB ODBC Libraries are provided as .DLL files. The files are named `socw32VV.dll` and `sacw32VV.dll` (where "VV" indicates the version number) for the Unicode and ASCII versions, respectively. For example, the Unicode ODBC driver in version 4.1 is named `socw3241.dll`. To call the functions in one of these .DLL files, you must link to a IBM solidDB import library file. For the IBM solidDB on Microsoft Windows, this import library file is named `solidimpodbcu.lib` (Unicode) or `solidimpodbca.lib` (ASCII). This import library file contains the entry points to the corresponding IBM solidDB ODBC DLL (e.g. `socw3241.dll`).

Note

The library file(s) have been produced with Microsoft C++. Other development toolkit manufacturers' linkers may expect different library file formats. In such cases, the Import Library utility of the development toolkit should be used to build a library file that is compatible with your linker. This should be necessary only for the "light client" library; for other library files, we have created import libraries that are compatible with most non-Microsoft linkers.

3.2.1 Instructions for Usage of IBM solidDB Client DLLs (Solid ODBC Driver Files)

There are two alternatives to building application programs that use the IBM solidDB ODBC driver:

1. Using Microsoft ODBC Driver Manager.

   Microsoft ODBC software needs to be installed on all client workstations and a Data Source must be defined using IBM solidDB ODBC Driver. If you use the Driver Manager, then any application that can use the IBM solidDB ODBC driver will also work with any other ODBC compliant engine.

2. Using IBM solidDB ODBC driver directly.

   Connections are opened directly to a server process without using Microsoft ODBC Driver Manager. This usually makes embedded deployment of IBM solidDB easier. However, the application can only use the functions provided by the IBM solidDB library (i.e. the Solid ODBC driver); the application cannot use the ODBC functions that are implemented by the Microsoft ODBC Driver Manager or the Microsoft Cursor library.

IBM solidDB provides some sample programs that can be used either with or without the Microsoft ODBC Driver Manager. These samples are in subdirectories of the "samples" directory that is created when you install

the IBM solidDB Development Kit (SDK). Below are brief instructions on how to build and run the provided samples in both of the alternative ways:

1. Building the samples to use ODBC Driver Manager.
    1. Create a new application project.
    2. Add the C-source file (e.g. `sqled.c` or `embed.c`) to the project.
    3. Set the IBM solidDB SQL API headers visible to the compiler.
    4. Define SS_WINDOWS for the compiler.
    5. Compile and link.
    6. Make sure that you have installed the IBM solidDB ODBC driver. Also, make sure that the connection string you intend to use is defined as the ODBC data source name.
    7. Run to connect to a listening IBM solidDB server.

2. Building the samples to use IBM solidDB ODBC library directly.

    The necessary changes to the ODBC Driver Manager configuration are listed below.

    1. Add IBM solidDB ODBC driver library file (`solidimpodbcu.lib`) to the project.
    2. Remove ODBC Driver manager libraries `ODBC*.LIB` from the default library list.
    3. Compile and link.
    4. Now it is possible to connect to data sources bypassing ODBC Driver Manager. Make sure that the SQL API DLL `socw32<VV>.dll` (where "VV" indicates the version number) and the IBM solidDB communication DLLs are available. Data Sources may be defined in `solid.ini` or in the ODBC Administration Window.
    5. Run the client to connect to a listening IBM solidDB server.

3.3 Calling Functions

3.3.1 Header Files and Function Prototypes

If your program calls functions in the ODBC driver, your program must include the ODBC header files. These files define the ODBC functions, and the data types and constants that are used with ODBC functions. The header files are not IBM solidDB-specific; they are standard header files provided by Microsoft. The IBM solidDB ODBC driver (like any ODBC driver) implements the functions that are specified in these header files.

3.3.2 ASCII and Unicode

ODBC drivers come in two "flavors": ASCII and Unicode. The ASCII flavor supports only ASCII character sets. The Unicode flavor supports both the Unicode and the ASCII character sets.

If your program calls only the ASCII flavor of ODBC functions, then you should include the following header files:

- `SQL.H`
- `SQLEXT.H`

If your program calls Unicode ODBC functions, then you should include the following

- `SQLUCODE.H`
- `WCHAR.H` This file is provided with Microsoft Visual C++ (or Developer Studio).

If your program calls both the ASCII and Unicode flavors of ODBC functions, then you should include just the header files for Unicode. (The Unicode version of the header files also contains definitions for the ASCII functions. In other words, the Unicode headers are a superset of the ASCII headers.)

For details on driver, API, and SQL conformance levels, refer to the Microsoft ODBC API Specification (Part I PDF file), "Introduction to ODBC" available on the IBM Corporation Web site (http://www.ibm.com/software/data/soliddb).

3.3.3 Using the ODBC Driver Manager

An application may link directly to the IBM solidDB ODBC driver, or the application may link to an ODBC Driver Manager. In this section, we discuss using an ODBC Driver Manager.

On Microsoft Windows, the Driver Manager is required if applications that connect to IBM solidDB use OLE DB or ADO APIs, or you use database tools that require the Driver Manager, such as Microsoft Access, FoxPro, or Crystal Reports. In most other situations, you may link directly to the ODBC driver instead of linking to the Driver Manager.

On Microsoft Windows platforms, Microsoft supplies the Driver Manager, and you link to the Driver Manager import library (`ODBC32.LIB`) to gain access to the Driver Manager. On other platforms, you can link to another vendor's Driver Manager. For example, on Linux and Solaris 8, you can use Merant's Driver Manager or iODBC's Driver Manager.

For basic application steps that occur whenever an application calls an ODBC function and details on calling ODBC functions, refer to the Microsoft ODBC API Specification (Part I PDF file), "Introduction to ODBC", available on the IBM Corporation Web site.

3.3.4 Data Types

Appendix E, *Data Types* provides information about SQL data types that are supported by IBM solidDB. The header files from Microsoft provide information about C-language data types used by your client program. To transfer data between the application program and the database server, you must use appropriate types. For example, on most 32-bit platforms, the C-language "int" data type corresponds to the SQL data type "INT". The C-language "float" data type corresponds to the SQL "REAL" data type. (Note that C "float" does NOT correspond to SQL "FLOAT"!) For more information about the C-language data types used to transfer data via ODBC calls, you may want to read the appropriate header files: `SQL.H` and `SQLEXT.H` and `SQLUCODE.H` and `WCHAR.H`. Note that `WCHAR.H` contains information regarding the "wide" character format, which corresponds to Unicode.

3.3.5 Scalar Functions

Scalar functions return a value for each row. For example, the "absolute value" scalar function takes a numeric column as an argument and returns the absolute value of each value in the column. Scalar functions are invoked with the following ODBC escape sequence:

```
{fn scalar-function}
```

(Note that the starting and ending characters are the curly bracket characters, not parentheses.) For a list of scalar functions and a more complete example of their usage, refer to Appendix F, *Scalar Functions*.

IBM solidDB Native Scalar Functions

IBM solidDB provides the following native scalar functions, which cannot be invoked using the ODBC escape sequence. They are:

- `CURRENT_CATALOG()` - returns a WVARCHAR string that contains the current active catalog name. This name is the same as ODBC scalar function `{fn DATABASE()}`.
- `LOGIN_CATALOG()` - returns a WVARCHAR string that contains the login catalog for the connected user (currently the login catalog is the same as the system catalog).
- `CURRENT_SCHEMA()` - returns a WVARCHAR string that contains the current active schema name.

3.3.6 Function Return Codes

When an application calls a function, the driver executes the function and returns a predefined code. These return codes indicate success, warning, or failure status. The return codes are:

SQL_SUCCESS

SQL_SUCCESS_WITH_INFO

SQL_NO_DATA_FOUND

SQL_ERROR

SQL_INVALID_HANDLE

SQL_STILL_EXECUTING

SQL_NEED_DATA

If the function returns SQL_SUCCESS_WITH_INFO or SQL_ERROR, the application can call `SQLError` to retrieve additional information about the error.

3.4 Connecting to a Data Source

A data source can be a database server, a flat file, or another source of data. To access the data source, the application will use the Data Source Name, in `SQLConnect()` call. The Data Source Name may be given in one of the three following ways: a connect string, a Logical Data Source Name and an empty data source name.

Note

If you are using HotStandby, you have two connectivity types to choose from, the Basic Connectivity and the HotStandby Connectivity. The Basic Connectivity is described below. For further information about the HotStandby Connectivity see Chapter 4.2, "Using the Transparent Connectivity", in *IBM solidDB High Availability User Guide*.

3.4.1 Using a IBM solidDB Connect String

The IBM solidDB connect string consists of a *communication protocol*, a possible set of *special options*, an optional *host computer name* and a *server name*. By this combination, the client specifies the server it will establish a connection to. The communication protocol and the server name must match the ones that the server is using in its network listening name. In addition, most protocols need a specified host computer name if the client and server are running on different machines. All components of the client's network name are case insensitive.

Note

In HSB or Cluster configurations, the connect string may take a more general form of TC info (Transparent Connectivity Info). For more information, see *IBM solidDB High Availability User Guide*.

The same format of the connect string applies to both the connect configuration parameters in the `solid.ini` file and data source names used in ODBC and IBM solidDB Light Client applications.

The format of a connect string is the following:

```
protocol_name [options] [server_name] [port_number]
```

where options may be any number of:

Table 3.1. Connect String Options

Option	Meaning
-z	Data compression is enabled for this connection
-c *milliseconds*	Login timeout is specified (the default is operating-system-specific). A login request fails after the specified time has elapsed. Note: applies for the TCP protocol only.
-r *milliseconds*	Connection (or read) timeout is specified (the default is 60 s). A network request fails when no response is received during the time specified. The value 0 sets the timeout to infinite. Note: applies for the TCP protocol only.

Examples:

```
tcp localhost 1315
tcp 1315
```

```
tcp -z -c1000 1315
nmpipe host22 SOLIDDB
```

3.4.2 Using a Logical Data Source Name

If the data source name is not a valid IBM solidDB connect string, the driver assumes it is a Logical Data Source Name.

IBM solidDB clients support Logical Data Source Names. These names can be used for giving a database a descriptive name. This name can be mapped to a data source in three ways:

1. Using the parameter settings in the application's `solid.ini` file.
2. Using the Microsoft Windows operating system's registry settings.
3. Using settings in a `solid.ini` file located in the Windows directory.

This feature is available on all supported platforms. However, on non-Windows platforms, only the first method is available.

When you call the `SQLConnect()` in Windows, the IBM solidDB ODBC Driver will check all logical data sources in the ODBC registry to find a mapping between the Logical Data Source Name and a valid IBM solidDB ODBC Driver connection string. The time consumed for this operation is proportional to the amount of defined data sources. You can expect connection times as follows:

- With only few (1 to 5) data sources, the connection time will be approximately 5 ms.
- With 1000 data sources, the connection time will be approximately 200 ms.

A IBM solidDB client attempts to open the file `solid.ini` first from the directory set by the *`SOLIDDIR`* environment variable. If the file is not found from the path specified by this variable or if the variable is not set, an attempt is made to open the file from the current working directory.

To define a Logical Data Source Name using the `solid.ini` file, you need to create a `solid.ini` file containing the section *`[Data Sources]`*. In that section you need to enter the 'logical name' and 'network name' pairs that you want to define. The syntax of the parameters is the following:

```
[Data Sources]
logical_name = connect_string, Description
```

In the description field, you may enter comments on the purpose of this logical name.

Note

IBM solidDB ODBC Driver will check for existence of `solid.ini` file every time a connection is attempted. If the file system is particularly slow, for example because the working directory is mapped to a network drive, this can have a measurable performance impact. However, if the `solid.ini` file contains mappings between the Data Source Name and the network name in the *`[Data Sources]`* section, the driver does not try to access the registry for the mapping.

For example, assume you want to define a logical name for the application *My_application* and the database that you want to connect is located in a UNIX server using TCP/IP. Then you should include the following lines in the `solid.ini` file, which you need to place in the working directory of your application:

```
[Data Sources]
My_application = tcpip irix 1313, Sample data source
```

When your application now calls the Data Source 'My_application', the IBM solidDB client maps this to a call to 'tcpip irix 1313'.

On Windows platforms, the registry is typically used to map Data Sources. To setup the registry with a GUI interface, use the Windows Administrative Control Panel "Data Sources (ODBC)".

In detail, the following are the rules for mapping ODBC data sources in the registry:

The entry is searched from the path `software\odbc\odbc.ini`

1. first under the root *`HKEY_CURRENT_USER`* and if not found,
2. under the root *`HKEY_LOCAL_MACHINE`*.

The order of resolving a Data Source name in Microsoft Windows systems is the following:

1. Look for the Data Source Name from the `solid.ini` file in the current working directory, under the section *`[Data Source]`*
2. Look for the Data Source Name from the following registry path:

   `HKEY_CURRENT_USER\software\odbc\odbc.ini\DSN`
3. Look for the Data Source Name from the following registry path

   `HKEY_LOCAL_MACHINE\software\odbc\odbc.ini\DSN`

Note

The IBM solidDB ODBC Driver checks all logical data sources in the ODBC registry to find a mapping between a logical data source name and a valid IBM solidDB ODBC Driver connect string. The time consumed for this operation is proportional to the amount of defined data sources. An `SQLConnect()` connection time with 1000 data sources is approximately 200 ms.

Applications that bypass the Driver Manager to access data from IBM solidDB databases by directly linking with the driver, must connect to the server using a valid connect string. If the data source name is not a valid IBM solidDB connect string, all IBM solidDB client applications search for a valid data source name in:

a. the `solid.ini` file

b. the `ODBC.INI` or registry.

3.4.3 Empty Data Source Name

When an application uses the ODBC API directly and calls `SQLConnect()` without specifying a IBM solidDB server network name (by giving an empty string), it is read from the parameter *`Connect`* in the *`[Com]`* section of the client application's `solid.ini` file. The `solid.ini` file must reside in the current working directory of the application or in a path specified by the *`SOLIDDIR`* environment variable.

The following connect line in the `solid.ini` of the application workstation will connect an application (client) using the TCP/IP protocol to a IBM solidDB server running on a host computer named 'spiff' and listening with the name (port number in this case) '1313'.

```
[Com]
Connect = tcpip spiff 1313
```

If the *`Connect`* parameter is not found in the `solid.ini` configuration file, then the client uses the environment-dependent default instead. The defaults for the *`Listen`* and *`Connect`* parameters are selected so that the application (client) will always connect to a local IBM solidDB server listening with a default network name. So local communication (inside one machine) does not necessarily need a configuration file for establishing a connection.

3.4.4 Configuring the IBM solidDB ODBC Data Source for Windows

Note

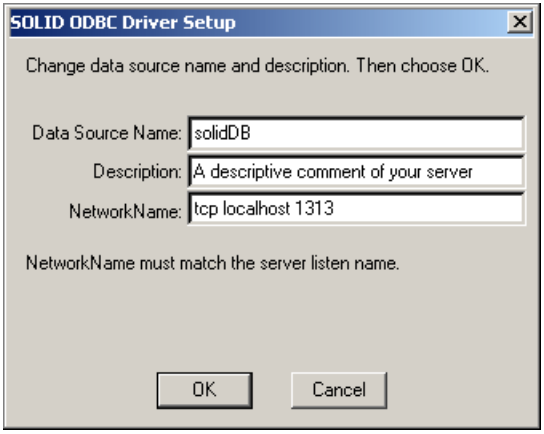
To be able to configure IBM solidDB ODBC data sources, the IBM solidDB ODBC Driver must be installed. The driver installation is discussed in Section 3.14, “Installing and Configuring ODBC Software”.

To configure an ODBC data source for Windows, users perform the following steps:

1. Invoke Data Sources (ODBC) from Control Panel→Administrative Tools.
2. Open the User DSN tab.
3. Click the Add... button.
4. Select the IBM solidDB ODBC Driver (ANSI or UNICODE according to your database requirements).
5. Enter the Data Source configuration in the IBM solidDB ODBC Driver Setup box as shown in the following example.

   Note that the NetworkName entry should be compliant with the database server listen addresses defined in `solid.ini`. The network name follows the connection string format presented in Section 2.1.3, “Format of the Connect String”.

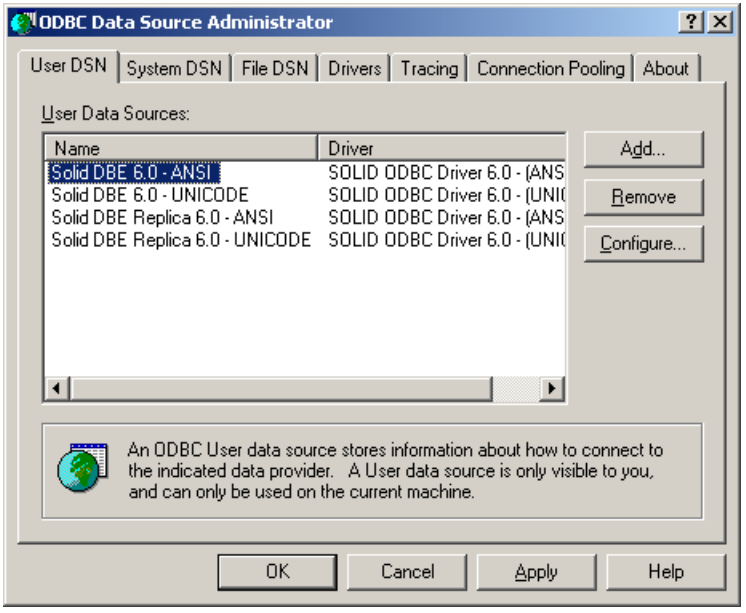
Figure 3.1. ODBC Driver Setup



3.4.5 Retrieving User Login Information

If the application calls `SQLDriverConnect()` and requests that the user be prompted for information, the Driver Manager displays a dialog box similar to the following example:

Figure 3.2. ODBC Data Source Administrator



On request from the application, the driver retrieves login information by displaying a dialog box.

3.4.6 ODBC Handle Validation

ODBC handle validation can be switched on and off. By default, it is off. The switch can be based on a `solid.ini` parameter *`Client.ODBCHandleValidation`* or it can based on the ODBC attribute `SQL_ATTR_HANDLE_VALIDATION`.

The environment attribute `SQL_ATTR_HANDLE_VALIDATION` is non-standard. It has global effect (is not bound to the environment) and should be set before any connections are made. This is because of consistency reasons; to prevent the application to allocate both validated and non-validated handles.

To switch handle validation off:

SQLSetEnvAttr(henv, SQL_ATTR_HANDLE_VALIDATION, (SQLPOINTER)0, XX);

The 4th parameter (XX) is not used (ignored).

To switch handle validation on:

SQLSetEnvAttr(henv, SQL_ATTR_HANDLE_VALIDATION, (SQLPOINTER)1, XX);

3.5 Executing Transactions

In *auto-commit* mode, each SQL statement is a complete transaction, which is automatically committed when the statement finishes executing. (Please refer to the important note below on committing read-only SELECTs.)

In *manual-commit* mode, a transaction consists of one or more statements. In manual-commit mode, when an application submits a SQL statement and no transaction is open, the driver implicitly begins a transaction. The transaction remains open until the application commits or rolls back the transaction with `SQLEndTran`.

3.5.1 Committing Read-Only Transactions

Important

When the isolation level is other than READ COMMITED, even read-only statements (e.g. SELECT) must be committed. Furthermore, the user must commit SELECT statements even if the server is in autocommit mode. Failure to commit statements can reduce performance or cause the server to run out of memory. This is explained in more detail below.

If the isolation level is READ COMMITTED, read-only statements need not be committed. In that case, the explanation below does not apply.

Even a read-only statement must be committed. The reason for this is that IBM solidDB saves the 'read-level' of each transaction and until that transaction commits, all subsequent transactions from other connections are also maintained in memory. (This behavior is part of the row versioning performed by the Bonsai Tree technology. See *IBM solidDB Administration Guide* for more details about the Bonsai Tree.) If a transaction is not committed, the server will need more and more memory as other transactions accumulate; this will reduce performance, and eventually the server may run out of available memory. For more details, read the Performance Tuning chapter in *IBM solidDB Administration Guide*.

SELECT And Autocommit

Surprisingly, using autocommit mode does not ensure that SELECT statements are committed. The server cannot automatically commit SELECTs because SELECTs do not execute as a single statement. Each SELECT involves opening a cursor, fetching rows, and then closing the cursor.

There are two possible ways that the server could automatically commit when fetching multiple rows: the server could commit after the final fetch, or the server could commit after each individual fetch. Unfortunately, neither of these is practical, and therefore the server cannot commit the SELECT statement even in autocommit mode.

The server cannot automatically commit after the final fetch because the server does not know which fetch is the final fetch — the server does not know how many rows the user will fetch. (Until the user closes the cursor, the server does not know that the user is done fetching.)

It is not practical to commit after each individual fetch because each transaction should see the data as it was at the time that the transaction started, and therefore if each fetch is in a different transaction then the data can be from a different "snapshot" of the database. Putting each fetch in a different transaction would also make REPEATABLE READ and SERIALIZABLE transaction isolation levels confusing or meaningless for the cursor, even though the cursor is for a single SELECT statement.

To commit the SELECT statement, the user may:

- Execute an explicit COMMIT WORK statement.
- Execute a statement to which autocommit does apply (i.e. a statement other than SELECT).
- If the cursor is the only open cursor, then the user may commit by explicitly closing the cursor (the server automatically commits when a cursor is closed and there are no other open cursors (and the server is in autocommit mode). This is part of why we recommend that you explicitly close every cursor as soon as you are done with it.

Note

To ensure that the data in the cursor is consistent and recent, the server actually does an automatic commit immediately prior to opening the cursor (if autocommit is on). The server then immediately starts a new transaction to contain the subsequent FETCH statement(s). Of course, this new transaction, like any other transaction, must be committed (or rolled back).

Summary

All statements must be committed, even if they are read-only statements, if an isolation level other than READ COMMITTED is used.

In most cases when you are doing SELECT statements in autocommit mode, you should explicitly close each cursor as soon as you are done with it and then explicitly COMMIT, even though you are in autocommit mode.

3.6 Retrieving Information About the Data Source's Catalog

The following functions, known as catalog functions, return information about a data source's catalog:

- `SQLTables` returns the names of tables stored in a data source.
- `SQLTablePrivileges` returns the privileges associated with one or more tables.
- `SQLColumns` returns the names of columns in one or more tables.
- `SQLColumnPrivileges` returns the privileges associated with each column in a single table.
- `SQLPrimaryKeys` returns the names of columns that comprise the primary key of a single table.
- `SQLForeignKeys` returns the names of columns in a single table that are foreign keys. It also returns the names of columns in other tables that refer to the primary key of the specified table.
- `SQLSpecialColumns` returns information about the optimal set of columns that uniquely identify a row in a single table or the columns in that table that are automatically updated when any value in the row is updated by a transaction.
- `SQLStatistics` returns statistics about a single table and the indexes associated with that table.
- `SQLProcedures` returns the names of procedures stored in a data source.
- `SQLProcedureColumns` returns a list of the input and output parameters, as well as the names of columns in the resultset, for one or more procedures.

Each function returns the information as a resultset. An application retrieves these results by calling `SQLBindCol()` and `SQLFetch()`.

3.6.1 Executing Functions Asynchronously

Note

ODBC drivers in all IBM solidDB products do not support asynchronous execution.

3.7 Using ODBC Extensions to SQL

ODBC defines extensions to SQL, which are common to most database management systems. For details on SQL extensions, refer to "Escape Sequences in ODBC" in the Microsoft ODBC API Specification (Part I PDF file that is available on the IBM Corporation Web site) which contains the introductory part of the Microsoft ODBC *Programmer's Reference*.

Included in the ODBC extensions to SQL are:

- Procedures
- Hints

Details on IBM solidDB usage for these extensions are described in the following sections.

3.7.1 Procedures

Stored procedures are procedural program code containing one or more SQL statements and program logic. They are stored in the database and executed with one call from the application or another stored procedure. Read the description of Stored Procedures in *IBM solidDB SQL Guide* for a full description of IBM solidDB stored procedures.

An application can call a procedure in place of a SQL statement. The escape clause ODBC uses for calling a procedure is:

```
{call procedure-name [([parameter][,[parameter]]...)]}
```

where procedure-name specifies the name of a procedure stored on the data source and parameter specifies a procedure parameter.

Note: The ODBC standard shows the escape clause as:

```
{[?=] call procedure-name [([parameter][,[parameter]]...)]}
```

However, IBM solidDB does not support the optional "?=" part of the syntax. (Earlier versions of *IBM solidDB Programmer Guide* stated that IBM solidDB supported the "?=" syntax, but were incorrect.)

A procedure can have zero or more parameters. For input and input/output parameters, *`parameter`* can be a literal or a parameter marker. Because some data sources do not accept literal parameter values, be sure that interoperable applications use parameter markers. For output parameters, *`parameter`* must be a parameter

marker. If a procedure call includes parameter markers, the application must bind each marker by calling `SQLBindParameter()` prior to calling the procedure.

Procedure calls do not require input and input/output parameters. Note the following rules:

- A procedure called with parentheses but with parameters omitted, such as {call *`procedure_name()`*} may cause the procedure to fail.
- A procedure called without parentheses, such as {call *`procedure_name`*}, returns no parameter values.
- Input parameters may be omitted. Omitted input or input/output parameters cause the driver to instruct the data source to use the default value of the parameter. As an option, a parameter's default value can be set using the value of the length/indicator buffer bound to the parameter to SQL_DEFAULT_PARAM.
- When a parameter is omitted, the comma delimiting it from other parameters must be present.
- Omitted input/output parameters or literal parameter values cause the driver to discard the output value.
- Omitted parameter markers for a procedure's return value cause the driver to discard the return value.
- If an application specifies a return value parameter for a procedure that does not return a value, the driver sets the value of the length/indicator buffer bound to the parameter to SQL_NULL_DATA.

To determine if a data source supports procedures, an application calls `SQLGetInfo()` with the SQL_PROCEDURES information type. For more information about procedures, read the description of Stored Procedures in *IBM solidDB SQL Guide*.

3.7.2 Hints

Within a query, Optimizer directives or *hints* can be specified to determine the query execution plan that is used. Hints are detected through a pseudo comment syntax from SQL-92. IBM solidDB provides its own extensions to hints:

```
--(* vendor (Solid), product (Engine), option(hint)
--hint
-- *)--
hint :=
    [MERGE JOIN |
    LOOP JOIN |
    JOIN ORDER FIXED |
    INTERNAL SORT |
    EXTERNAL SORT |
```

```
    INDEX [REVERSE] table_name.index_name |
    PRIMARY KEY [REVERSE] table_name |
    FULL SCAN table_name |
    [NO] SORT BEFORE GROUP BY]
```

The pseudo comment prefix is followed by identifying information. Vendor is specified as *Solid*, product as *Engine*, and the option, which is the pseudo comment class name, as a valid hint.

The terminator may be on its own line, or it may be at the end of the last line of the hint. For example, either of the following is acceptable:

```
--(* vendor (Solid), product (Engine), option(hint)
--hint
-- *)--
```

or

```
--(* vendor (Solid), product (Engine), option(hint)
--hint *)--
```

Note that spacing is sensitive. In the pseudo comment prefix --(* and postfix *)-- , there can be no space between the parenthesis and the asterisk. There must be a space prior to the *)-- terminator, i.e. prior to the asterisk (see the examples above). No space is required prior to the opening parenthesis in --(* . The terminator *)-- cannot be on a line by itself without being after the comment delimiter --.

A hint always follows the SELECT, UPDATE, or DELETE keyword that it applies to.

Note

Hints are not allowed after the INSERT keyword.

Each subselect requires its own hint; for example, the following are valid uses of hints syntax:

```
INSERT INTO ... SELECT hint FROM ...
```

```
UPDATE hint TABLE ... WHERE column = (SELECT hint ... FROM ...)
DELETE hint TABLE ... WHERE column = (SELECT hint ... FROM ...)
```

Example 3.1. Hints Example 1

```
SELECT
--(* vendor(SOLID), product(Engine), option(hint)
--MERGE JOIN
--JOIN ORDER FIXED
-- *)--
col1, col2
FROM TAB1 A, TAB2 B;
WHERE A.INTF = B.INTF;
```

Example 3.2. Hints Example 2

```
SELECT
--(* vendor(SOLID), product(Engine), option(hint)
--INDEX TAB1.INDEX1
--INDEX TAB1.INDEX1 FULL SCAN TAB2
-- *)--
*
FROM TAB1, TAB2
WHERE TAB1.INTF = TAB2.INTF;
```

Hint is a specific semantic, corresponding to a specific behavior. Following is a list of IBM solidDB-supported hints:

Table 3.2. IBM solidDB-supported Hints

Hint	Definition
MERGE JOIN	Directs the Optimizer to choose the merge join access plan in a select query for all tables listed in the FROM clause. The MERGE JOIN option is used when two tables are approximately equal in size and the data is distributed equally. It is faster than a LOOP JOIN when an equal amount of rows are joined. For joining data, MERGE JOIN supports a maximum of three tables. The joining table is ordered by joining columns and combining the results of the columns.

Hint	Definition
	You can use this hint when the data is sorted by a join key and the nested loop join performance is not adequate. The Optimizer selects the merge join only where there is an equal predicate between tables (e.g. "table1.col1 = table2.col1"). Otherwise, the Optimizer selects LOOP JOIN even if the MERGE JOIN hint is specified. Note that when data is not sorted before performing the merge operation, the IBM solidDB query executor sorts the data. Keep in mind that the merge join with a sort is more resource intensive than the merge join without the sort.
LOOP JOIN	Directs the Optimizer to pick the nested loop join in a select query for all tables listed in the FROM clause. By default, the Optimizer does not pick the nested loop join. The LOOP JOIN loops through both inner and outer tables to find matches between columns in the inner and outer tables. For better performance, the joining columns should be indexed. Using the loop join when tables are small and fit in memory may offer greater efficiency than using other join algorithms.
JOIN ORDER FIXED	Specifies that the Optimizer use tables in a join in the order listed in the FROM clause of the query. This means that the Optimizer does not attempt to rearrange the join order and does not try to find alternate access paths to complete the join. We recommend that you "test" the hint by running the EXPLAIN PLAN output to ensure that the plan generated is optimal for the given query.
INTERNAL SORT	Specifies that the query executor use the internal sorter. Use this hint if the expected resultset is small (hundreds of rows as opposed to thousands of rows); for example, if you are performing some aggregates, ORDER BY with small resultsets, or GROUP BY with small resultsets, etc. This hint avoids the use of the more expensive external sorter.
EXTERNAL SORT	Specifies that the query executor use the external sorter. Use this hint when the expected resultset is large and does not fit in memory; for example, if the expected resultset has thousands of rows.

Hint	Definition

	In addition, specify the SORT working directory in the `solid.ini` before using the external sort hint. If a working directory is not specified, you will receive a run-time error. The working directory is specified in the *`[sorter]`* section of the `solid.ini` configuration file. For example:
	
	`[sorter]`
	`TmpDir_1=c:\soldb\temp1`

INDEX [REVERSE] *`table_name.index_name`*	Forces a given index scan for a given table. In this case, the Optimizer does not proceed to evaluate if there are any other indexes that can be used to build the access plan or whether a table scan is better for the given query. We recommend that you "test" the hint by running the EXPLAIN PLAN output to ensure that the plan generated is optimal for the given query. The optional keyword REVERSE returns the rows in the reverse order. In this case, the query executor begins with the last page of the index and starts returning the rows in the descending (reverse) key order of the index. Note that in *`tablename.indexname`*, the tablename is a fully qualified table name which can include the *`catalogname`* and *`schemaname`*.
PRIMARY KEY [REVERSE] *`table_name`*	Forces a primary key scan for a given table. The optional keyword REVERSE returns the rows in the reverse order. If the primary key is not available for the given table, then you will receive a run-time error.
FULL SCAN *`table_name`*	Forces a table scan for a given table. In this case, the optimizer does not proceed to evaluate if there are any other indexes that can be used to build the access plan or whether a table scan is better for the given query.

Hint	Definition
	Before using this hint, it is recommended that you "test" the hint by running the EXPLAIN PLAN output to ensure that the plan generated is optimal for the given query.
[NO] SORT BEFORE GROUP BY	Indicates whether the SORT operation occurs before the resultset is grouped by the GROUP BY columns. If the grouped items are few (hundreds of rows) then use NO SORT BEFORE. On the other hand, if the grouped items are large (thousands of rows), then use SORT BEFORE.

3.7.3 Additional ODBC Extension Functions

ODBC provides the following functions related to SQL statements. Refer to the Microsoft ODBC API Specification (Part II PDF file that is available on the IBM Corporation Web site) for more information about these functions.

Table 3.3. Additional ODBC Extension Functions

Function	Description
`SQLDescribeParam`	Retrieves information about prepared parameters.
`SQLNumParams`	Retrieves the number of parameters in a SQL statement.

`SQLSetStmtAttr`
 	
`SQLSetConnectAttr`
 	
`SQLGetStmtAttr`
	These functions set or retrieve statement options, such as asynchronous processing, orientation for binding rowsets, maximum amount of variable length data to return, maximum number of resultset rows to return, and query timeout value. Note that `SQLSetConnectAttr` sets options for all statements in a connection.

3.7.4 IBM solidDB Extensions for ODBC API

The following functions are IBM solidDB-specific extensions to ODBC API.

Table 3.4. IBM solidDB-specific Extensions to ODBC API

Function	Description
`SQLFetchPrev`	This function is the same as the ODBC function `SQLFetch`, but for fetching previous record. For details on `SQLFetch` function, refer to the Microsoft ODBC API Specification (Part II PDF file that is available on the IBM Corporation Web site).

Function	Description
SQLSetParamValue	This function sets the value of a parameter marker in the SQL statement specified in SQLPrepare. Parameter markers are numbered sequentially from left-to-right, starting with one, and may be set in any order. For details on this function, refer to Section 5.28, “Non-ODBC IBM solidDB Light Client Functions”.
SQLGetCol	This function is the same as the ODBC function SQLGetData. For details on this function, refer to the Microsoft ODBC API Specification (Part II PDF file that is available on the IBM Corporation Web site).
SQLGetAnyData	This function is the same as the ODBC function SQLGetData. For details on this function, refer to the Microsoft ODBC API Specification (Part II PDF file that is available on the IBM Corporation Web site).

3.8 Using Cursors

The ODBC Driver uses a cursor concept to keep track of its position in the resultset, that is, in the data rows retrieved from the database. A cursor is used for tracking and indicating the current position, as the cursor on a computer screen indicates current position.

Each time an application calls SQLFetch, the driver moves the cursor to the next row and returns that row. An application can also call SQLFetchScroll or SQLExtendedFetch (ODBC 2.x), which fetches more than one row with a single fetch or call into the application buffer. This is known as "block cursor" support. Note that the actual number of rows fetched depends upon the rowset size specified by the application.

An application can call SQLSetPos to position a cursor within a fetched block of data using the SQL_POSITION option. This allows an application to refresh data in the rowset. SQLSetPos is also called to update data with the SQL_UPDATE option or delete data in the resultset with the SQL_DELETE option.

The cursor supported by the core ODBC functions only scrolls forward, one row at a time. (To re-retrieve a row of data that it has already retrieved from the resultset, the application must close the cursor by calling SQLFreeStmt with the SQL_CLOSE option, re-execute the SELECT statement, and fetch rows with SQLFetch, SQLFetch Scroll, or SQLExtendedFetch (ODBC 2.x) until the target row is retrieved.) If you need the ability to scroll backward as well as forward, please use block cursors.

3.8.1 Assigning Storage for Rowsets (Binding)

In addition to binding individual rows of data, an application can call SQLBindCol to assign storage for a *rowset* (one or more rows of data). By default, rowsets are bound in column-wise fashion. They can also be bound in row-wise fashion.

To specify how many rows of data are in a rowset, an application calls `SQLSetStmtAttr` with the SQL_ROWSET_SIZE option.

Column-Wise Binding

To assign storage for column-wise bound results, an application performs the following steps for each column to be bound:

1. Allocates an array of data storage buffers. The array has as many elements as there are rows in the rowset.

2. Allocates an array of storage buffers to hold the number of bytes available to return for each data value. The array has as many elements as there are rows in the rowset.

3. Calls `SQLBindCol` and specifies the address of the data array, the size of one element of the data array, the address of the number-of-bytes array, and the type to which the data will be converted. When data is retrieved, the driver will use the array element size to determine where to store successive rows of data in the array.

Row-Wise Binding

To assign storage for row-wise bound results, an application performs the following steps:

1. Declares a structure that can hold a single row of retrieved data and the associated data lengths. (For each column to be bound, the structure contains one field to contain data and one field to contain the number of bytes of data available to return.)

2. Allocates an array of these structures. This array has as many elements as there are rows in the rowset.

3. Calls `SQLBindCol` for each column to be bound. In each call, the application specifies the address of the column's data field in the first array element, the size of the data field, the address of the column's number-of-bytes field in the first array element, and the type to which the data will be converted.

4. Calls `SQLSetStmtAttr` with the SQL_BIND_TYPE option and specifies the size of the structure. When the data is retrieved, the driver will use the structure size to determine where to store successive rows of data in the array.

3.8.2 Cursor Support

Applications require different means to sense changes in the tables underlying a resultset. For example, when balancing financial data, an accountant needs data that appears static; it is impossible to balance books when the data is continually changing. When selling concert tickets, a clerk needs up-to-the minute, or dynamic, data on which tickets are still available. Various cursor models are designed to meet these needs, each of which requires different sensitivities to changes in the tables underlying the resultset.

IBM solidDB cursors which are set with `SQLSetStmtAttr` as "dynamic" closely resemble static cursors, with some dynamic behavior. IBM solidDB dynamic cursor behavior is static in the sense that changes made to the resultset by other users are not visible to the user, as opposed to ODBC dynamic cursors in which changes are visible to the user.

In IBM solidDB, as long as the cursor scrolls forward from block to block and never scrolls backward or the cursors move back and forth within the same block after an update is done, then the user gets the dynamic cursor behavior. This means that all changes are visible. Note, however that this behavior is affected by the IBM solidDB AUTOCOMMIT mode setting. For details, read the section called “Cursors and Autocommit”. For an example of cursor behavior when using `SQLSetPos`, read the section called “Cursors and Positioned Operations”.

Another characteristic of IBM solidDB's cursor behavior is that transactions are able to view their own data changes (with some limitations), but cannot view the changes made by other transactions that overlap in time. (For more details about the limitations on users seeing their own data changes, refer to the section called “Cursors and Positioned Operations”). For example, once Transaction_A starts, it will not see any changes made by any other transaction that did not commit work before Transaction_A started. The conditions in IBM solidDB that cause a user's own changes to be invisible to that user are:

- In a SELECT statement when an ORDER BY clause or a GROUP BY clause is used, IBM solidDB caches the resultset, which causes the user's own change to be invisible to the user.
- In applications written using ADO or OLE DB, IBM solidDB cursors are more like dynamic ODBC cursors to enable functions such as a rowset update.

Specifying the Cursor Type

To specify the cursor type, an application calls `SQLSetStmtAttr` with the SQL_CURSOR_TYPE option. The application can specify a cursor that only scrolls forward, a static cursor, or a dynamic cursor.

Unless the cursor is a forward-only cursor, an application calls `SQLExtendedFetch` (ODBC 2.x) or `SQLFetchScroll` (ODBC 3.x) to scroll the cursor backwards or forwards.

Cursor Support

Three types of cursors are defined in ODBC 3.51:

- Driver Manager supported cursors
- Server supported cursors
- Driver supported cursors

IBM solidDB cursors are server supported cursors.

Cursors and Autocommit

For general IBM solidDB-specific information on cursors and autocommit, read read Section 3.5.1, “Committing Read-Only Transactions”.

There are also some limitations in using the IBM solidDB Autocommit mode if your application uses block cursors and positioned updates and deletes. For a brief description of these cursor features, read Section 3.8, “Using Cursors”.

When using block cursors and positioned updates and deletes, you must:

- In the application, set commit mode to SQL_AUTOCOMMIT_OFF.
- Commit changes in the application only when all the fetch and positioned operations are done.
- In between positioned operations, be sure not to commit the changes.

Warning

If the application uses commit mode as SQL_AUTOCOMMIT_ON or commits the changes before it is done with all the positioned operation, then the application may experience unpredictable behavior while browsing through the resultset. Read the section below for details.

Positioned Cursor Operations and SQL_AUTOCOMMIT_ON

The IBM solidDB ODBC Driver keeps a row number/counter for every row in the rowset, which is the data rows retrieved from the database. When an application has the commit mode set to SQL_AUTOCOMMIT_ON and then executes a positioned update or a delete on a row in the rowset, the row is immediately updated in the database. Depending on the new value of the row, the row may be moved from its original position in the resultset. Since the updated row has now moved and its new position is unpredictable (since it is totally dependent on the new value), the driver loses the counter for this row.

In addition, the counter for all other rows in the rowset may also become invalid because of a change in position of the updated row. Hence the application may see incorrect behavior when it does the next fetch or `SQLSetPos` operation.

Following is an example that explains this limitation.

Assume an application performs the following steps:

1. Sets the commit mode to SQL_AUTOCOMMIT_ON.

2. Sets the rowset size to 5.

3. Executes a query to generate a resultset containing n rows.

4. Fetches the first rowset of 5 rows with `SQLFetchScroll`.

   A sample resultset is shown below. In the sample, the resultset has only 1 column (defined as varchar(32)). The first column shows the row number maintained by the driver internally. The second column shows the actual row values.

Table 3.5. A Sample Resultset

Row Counter Stored Internally by the Driver	Row Value
1	Antony
2	Ben
3	Charlie
4	David
5	Edgar

Assume now that the application calls `SQLSetPos` to update the third row with a new value of Gerard. To perform the update, the new row value is moved and positioned as shown below:

Table 3.6. A Sample Resultset

Row Counter Stored Internally by the Driver	Row Value
1	Antony
2	Ben
Empty row	
4	David
5	Edgar
New row	Gerard

Now the row counter for "David" becomes 3 and not 4, while the counter for "Edgar" becomes 4 and not 5. Since some row counters are now invalid, they will give wrong results when used by the driver to do relative or absolute positioning of the cursor.

If the commit mode had been set to SQL_AUTOCOMMIT_OFF, the database is not updated until the `SQLEndTran` function is called to commit the changes.

For IBM solidDB-specific information on cursors and autocommit, read Section 3.5.1, “Committing Read-Only Transactions”.

Cursors and Positioned Operations

When an application is performing positioned operations (such as updates and deletes when calling `SQLSetPos`), there are limitations in resultset visibility.

Case 1 illustrates cursor behavior when using `SQLSetPos`. In Case 1 the cursor scrolls back and forth within the same block after the update is applied.

Although Case 1 is intended to illustrate the visibility of updates in the resultset when using cursors, the exact circumstances under which visibility occurs depends on several factors. These include the size of the resultset relative to the size of the memory buffer, the transaction isolation level, and the frequency with which you commit data, etc.

Case 2 shows how cursor behavior is limited using `SQLSetPos` when the cursor scrolls backward within a rowset or the cursors move back and forth within a different rowset after an update is applied.

Case 1

Following is an example that shows cursor behavior using positioned operations and shows how positioned updates can be visible to users.

Assume an application performs the following steps:

1. Sets the commit mode to SQL_AUTOCOMMIT_OFF.

   This is a requirement as noted in the section called “Cursors and Autocommit”.

2. Sets the rowset size to 5.

3. Executes a query to generate a resultset of n rows.

4. Fetches the first rowset of 5 rows with `SQLFetchScroll`.

A sample resultset is shown below. In the sample, the resultset has only 1 column (defined as varchar(32)). The first column shows the row number maintained by the driver internally. The second column shows the actual row values.

Table 3.7. A Sample Resultset

Row Counter Stored Internally by the Driver	Row Value
1	Antony
2	Ben
3	Charlie
4	David
5	Edgar

Assume now that the application calls `SQLSetPos` to update the third and fourth rows of the resultset with the names Caroline and Debbie. After the updates, the actual row values now contain Caroline and Debbie, as shown below:

Table 3.8. A Sample Resultset

Row Counter Stored Internally by the Driver	Row Value
1	Antony
2	Ben
3	Caroline
4	Debbie
5	Edgar

Note

In some cases, the resultset for a SELECT statement may be too large to fit in memory. As the user scrolls back and forth within the resultset, the ODBC Driver may discard some rows from memory and read in others. This can cause a surprising effect: in some situations, updates to data in the cursor may seem to "disappear" and then "reappear" if the cursor re-reads (for example, from disk) the original values for a row that it previously modified.

Case 2

Case 2 shows the limitations when using positioned operations. The following example shows cursor behavior using positioned operations and shows when position updates are not visible to users.

Assume an application performs the following steps:

1. Sets the commit mode to SQL_AUTOCOMMIT_OFF.

This is a requirement as noted in the section called “Cursors and Autocommit”.

2. Sets the rowset size to 5.

3. Executes a query to generate a resultset of n rows.

4. Fetches the first rowset of 5 rows with `SQLFetchScroll`.

   A sample resultset is shown below. In the sample, the first two rowsets are shown. The resultset has only 1 column (defined as varchar(32)). The first column shows the row number maintained by the driver internally. The second column shows the actual row values.

Table 3.9. A Sample Resultset

Row Counter Stored Internally by the Driver	Row Value
1	Antony
2	Ben
3	Charlie
4	David
5	Edgar
6	Fred
7	Gough
8	Harry
9	Ivor
10	John

   Assume that after the application calls the first 4 steps listed above, the application calls `SQLSetPos` to perform the following tasks:

5. Updates the third row of the resultset.

6. Scrolls to the next rowset by calling `SQLFetchScroll`. This will get rows 6 to 10 and the cursor will be pointing to row 6.

7. Scrolls backward one rowset to get to the first rowset. This is done by calling `SQLScrollFetch` with the FETCH_PRIOR option.

After these tasks are performed, the value of the third row that was updated in step 5 still has the old value rather than the updated value as in "Case 1" in the section called “Cursors and Positioned Operations”. The

updated value is only visible in the Case 2 situation when the change is committed. But due to the unpredictable behavior when setting SQL_AUTOCOMMIT_ON as described in section *Positioned Cursor Operations and SQL_AUTOCOMMIT_ON* in the section called "Cursor Support", commits cannot be done until all work related to block cursors and positioned operations is completed.

3.9 Using Bookmarks

A bookmark is a 32-bit value that an application uses to return to a row. IBM solidDB provides no support for bookmarks.

3.10 Error Text Format

Error messages returned by `SQLError` come from two sources: data sources and components in an ODBC connection. Typically, data sources do not directly support ODBC. Consequently, if a component in an ODBC connection receives an error message from a data source, it must identify the data source as the source of the error. It must also identify itself as the component that received the error.

If the source of an error is the component itself, the error message must explain this. Therefore, the error text returned by `SQLError` has two different formats: one for errors that occur in a data source and one for errors that occur in other components in an ODBC connection.

For errors that do not occur in a data source, the error text must use the format:

```
[vendor_identifier][ODBC_component_identifier]
component_supplied_text
```

For errors that occur in a data source, the error text must use the format:

```
[vendor_identifier][ODBC_component_identifier]
[data_source_identifier] data_source_supplied_text
```

The following table shows the meaning of each element.

Table 3.10. Errors in a Data Source

Element	Meaning
vendor_identifier	Identifies the vendor of the component in which the error occurred or that received the error directly from the data source.

Element	Meaning
ODBC_component_identifier	Identifies the component in which the error occurred or that received the error directly from the data source.
data_source_identifier	Identifies the data source. For single-tier drivers, this is typically a file format. For multiple-tier drivers, this is the DBMS product.
component_supplied_text	Generated by the ODBC component.
data_source_supplied_text	Generated by the data source.

Note

The brackets ([ ]) are included in the error text; they do not indicate optional items.

3.10.1 Sample Error Messages

The following examples show how various components in an ODBC connection might generate the text of error messages and how IBM solidDB returns them to the application with `SQLError`.

Table 3.11. Sample Error Messages

SQLSTATE	Error Message
01000	General warning
01S00	Invalid connection string attribute
08001	Client unable to establish connection

SQLSTATE values are strings that contain five characters; the first two are a string class value, followed by a three-character subclass value. For example 01000 has 01 as its class value and 000 as its subclass value. Note that a subclass value of 000 means there is no subclass for that SQLSTATE. Class and subclass values are defined in SQL-92.

Table 3.12. SQLSTATE Values

Class value	Meaning
01	Indicates a warning and includes a return code of SQL_SUCCESS_WITH_INFO.
07, 08, 21, 22, 25, 28, 34, 3C, 3D, 3F, 40, 42, 44, HY	Indicates an error that includes a return value of SQL_ERROR.
IM	Indicates warning and errors that are derived from ODBC.

3.10.2 Processing Error Messages

Applications provide users with all the error information available through `SQLError`: the ODBC SQLSTATE, the native error code, the error text, and the source of the error. The application may parse the error text to separate the text from the information identifying the source of the error. It is the application's responsibility to take appropriate action based on the error or provide the user with a choice of actions.

The ODBC interface provides functions that terminate statements, transactions, and connections, and free statement, connection, and environment handles.

3.11 Terminating Transactions and Connections

The ODBC interface provides functions that terminate statements, transactions, and connections, and free statement (hstmt), connection (hdbc), and environment (henv) handles.

3.11.1 Terminating Statement Processing

To free resources associated with a statement handle, an application calls `SQLFreeStmt` with the following options:

- SQL_CLOSE - Closes the cursor, if one exists, and discards pending results. The application can use the statement handle again later. In ODBC 3.51, `SQLCloseCursor` can also be used.
- SQL_UNBIND - Frees all return buffers bound by `SQLBindCol` for the statement handle.
- SQL_RESET_PARAMS - Frees all parameter buffers requested by `SQLBindParameter` for the statement handle.

`SQLFreeHandle` is used to close the cursor if one exists, discard pending results, and free all resources associated with the statement handle.

3.11.2 Terminating Transactions

An application calls `SQLEndTran` to commit or roll back the current transaction.

3.11.3 Terminating Connections

To terminate a connection to a driver and data source, an application performs the following steps:

1. Calls `SQLDisconnect` to close the connection. The application can then use the handle to reconnect to the same data source or to a different data source.

2. Calls `SQLFreeHandle` to free the connection or environment handle and free all resources associated with the handle.

3.12 Constructing an Application

This section provides two examples of C-language source code for applications.

3.12.1 Sample Application Code

The following sections contain two examples that are written in the C programming language:

- An example that uses static SQL functions to create a table, add data to it, and select the inserted data.
- An example of interactive, ad-hoc query processing.

Microsoft provides two types of header files, one for ASCII data and the other for unicode data. This example can use either of the Microsoft ODBC header files.

Example 3.3. Static SQL Example

The following example constructs SQL statements within the application.

```
/************************************************************
    Sample Name: Example1.c
    Author     : IBM SOLID Information Technology Ltd.

    Location   : CONSTRUCTING AN APPLICATION-SOLID
                 Server Programmer's Guide and Reference
    Purpose    : Sample example that uses static SQL
                 functions to
                      create a table,
                      add data to it and
                      select the inserted data.

************************************************************/
#if (defined(SS_UNIX) || defined(SS_LINUX))
#include <sqlunix.h>
#else
#include <windows.h>
#endif
```

```
#if SOLIDODBCAPI
#include <sqlucode.h>
#include <wchar.h>
#else
#include <sql.h>
#include <sqlext.h>
#endif

#include <stdio.h>
#include <test_assert.h>

#define MAX_NAME_LEN 50
#define MAX_STMT_LEN 100

/************************************************************
    Function Name: PrintError
    Purpose......: To Display the error associated with
                   the handle
************************************************************/
SQLINTEGER PrintError(SQLSMALLINT handleType,SQLHANDLE handle)
{
        SQLRETURN  rc = SQL_ERROR;
        SQLWCHAR   sqlState[6];
        SQLWCHAR   eMsg[SQL_MAX_MESSAGE_LENGTH];
        SQLINTEGER nError;

        rc = SQLGetDiagRecW(handleType, handle, 1,
             (SQLWCHAR *)&sqlState, (SQLINTEGER *)&nError,
             (SQLWCHAR *)&eMsg, 255, NULL);
        if (rc == SQL_SUCCESS || rc == SQL_SUCCESS_WITH_INFO) {
            printf("\n\t Error:%ls\n",eMsg);
        }
        return(SQL_ERROR);
}


/************************************************************
        Function Name: DrawLine
        Purpose      : To Draw a specified charcter (chr) for
                       specified number of times (len)
************************************************************/
```

```
void DrawLine(SQLINTEGER len, SQLCHAR chr)
{
        printf("\n");
        while(len > 0)  {
            printf("%c",chr);
            len--;
        }
        printf("\n");

}


/************************************************************
    Function Name: example1
    Purpose      : Connect to the specified data source and
                   execute the set of SQL Statements
************************************************************/
SQLINTEGER example1(SQLCHAR *server, SQLCHAR *uid, SQLCHAR *pwd)
{
        SQLHENV     henv;
        SQLHDBC     hdbc;
        SQLHSTMT    hstmt;
        SQLRETURN   rc;

        SQLINTEGER  id;
        SQLWCHAR    drop[MAX_STMT_LEN];
        SQLCHAR     name[MAX_NAME_LEN+1];
        SQLWCHAR    create[MAX_STMT_LEN];
        SQLWCHAR    insert[MAX_STMT_LEN];
        SQLWCHAR    select[MAX_STMT_LEN];
        SQLINTEGER  namelen;


        /* Allocate environment and connection handles. */
        /* Connect to the data source. */
        /* Allocate a statement handle. */

        rc = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE,
             &henv);
        if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
            return(PrintError(SQL_HANDLE_ENV,henv));
```

```
rc = SQLSetEnvAttr(henv,SQL_ATTR_ODBC_VERSION,
     (SQLPOINTER)SQL_OV_ODBC3,SQL_NTS);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_ENV, henv));

rc = SQLAllocHandle(SQL_HANDLE_DBC,henv,&hdbc);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_ENV, henv));

rc = SQLConnect(hdbc, server, SQL_NTS, uid, SQL_NTS,
     pwd, SQL_NTS);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_DBC, hdbc));

rc = SQLAllocHandle(SQL_HANDLE_STMT,hdbc,&hstmt);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_DBC, hdbc));

    /* drop table 'nameid' if exists, else continue*/
wcscpy(drop, L"DROP TABLE NAMEID");
printf("\n%ls", drop);
DrawLine(wcslen(drop), '-');

rc = SQLExecDirectW(hstmt, drop, SQL_NTS);
if (rc == SQL_ERROR)  {
    PrintError(SQL_HANDLE_STMT, hstmt);
    }

/* commit work*/
rc = SQLEndTran(SQL_HANDLE_DBC, hdbc, SQL_COMMIT);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_DBC, hdbc));

/* create the table nameid(id integer,name varchar(50))*/
wcscpy(create,
      L"CREATE TABLE NAMEID(ID INT,NAME VARCHAR(50))");
printf("\n%ls",create);
DrawLine(wcslen(create),'-');

rc = SQLExecDirectW(hstmt,create,SQL_NTS);
if (rc == SQL_ERROR)
    return(PrintError(SQL_HANDLE_STMT,hstmt));
```

```
/* commit work*/
rc = SQLEndTran(SQL_HANDLE_DBC, hdbc, SQL_COMMIT);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_DBC, hdbc));

/* insert data through parameters*/
wcscpy(insert, L"INSERT INTO NAMEID VALUES(?,?)");
printf("\n%ls", insert);
DrawLine(wcslen(insert), '-');

rc = SQLPrepareW(hstmt, insert, SQL_NTS);
if (rc == SQL_ERROR)
    return(PrintError(SQL_HANDLE_STMT,hstmt));

/* integer(id) data binding*/
rc = SQLBindParameter(hstmt, 1, SQL_PARAM_INPUT,
         SQL_C_LONG, SQL_INTEGER, 0, 0, &id, 0, NULL);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_DBC, hdbc));


/* char(name) data binding*/
rc = SQLBindParameter(hstmt, 2, SQL_PARAM_INPUT,
        SQL_C_CHAR, SQL_VARCHAR, 0, 0, &name,
        sizeof(name), NULL);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_DBC, hdbc));

id = 100;
strcpy(name, "SOLID");

rc = SQLExecute(hstmt);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_DBC, hdbc));

/* commit work*/
rc = SQLEndTran(SQL_HANDLE_DBC, hdbc, SQL_COMMIT);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_DBC, hdbc));

/* free the statement buffers*/
```

```
rc = SQLFreeStmt(hstmt, SQL_RESET_PARAMS);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
        return(PrintError(SQL_HANDLE_STMT, hstmt));

rc = SQLFreeStmt(hstmt, SQL_CLOSE);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
        return(PrintError(SQL_HANDLE_STMT, hstmt));

/* select data from the table nameid*/
wcscpy(select, L"SELECT * FROM NAMEID");
printf("\n%ls", select);
DrawLine(wcslen(select), '-');

rc = SQLExecDirectW(hstmt, select, SQL_NTS);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
        return(PrintError(SQL_HANDLE_DBC, hdbc));

/* bind buffers for output data*/
id = 0;
strcpy(name, "");

rc = SQLBindCol(hstmt, 1, SQL_C_LONG, &id, 0, NULL);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_DBC, hdbc));

rc = SQLBindCol(hstmt, 2, SQL_C_CHAR, &name,
     sizeof(name), &namelen);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_DBC, hdbc));

rc = SQLFetch(hstmt);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_DBC, hdbc));

printf("\n Data ID      :%d", id);
printf("\n Data Name    :%s(%d)\n", name, namelen);

rc = SQLFetch(hstmt);
assert(rc == SQL_NO_DATA);


/* free the statement buffers*/
```

```
        rc = SQLFreeStmt(hstmt, SQL_UNBIND);
        if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
            return(PrintError(SQL_HANDLE_STMT, hstmt));

        rc = SQLFreeStmt(hstmt, SQL_CLOSE);
        if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
            return(PrintError(SQL_HANDLE_STMT,hstmt));

        /* Free the statement handle. */
        rc = SQLFreeHandle(SQL_HANDLE_STMT, hstmt);
        if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
            return(PrintError(SQL_HANDLE_STMT, hstmt));

        /* Disconnect from the data source. */
        rc = SQLDisconnect(hdbc);
        if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
            return(PrintError(SQL_HANDLE_DBC, hdbc));

        /* Free the connection handle. */
        rc = SQLFreeHandle(SQL_HANDLE_DBC, hdbc);
        if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
            return(PrintError(SQL_HANDLE_DBC, hdbc));

        /* Free the environment handle. */
        rc = SQLFreeHandle(SQL_HANDLE_ENV,henv);
        if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
            return(PrintError(SQL_HANDLE_ENV, henv));

        return(0);
}


/*************************************************************
        Function Name: main
        Purpose      : To Control all operations
*************************************************************/
void main(SQLINTEGER argc, SQLCHAR *argv[])
{
        puts("\n\t SOLID ODBC Driver 3.51:");
        puts("\n\t -Usage of static SQL functions");
        puts("\n\t ==============================");
```

```
        if (argc != 4){
            puts("USAGE: Example1 <DSN name> <username> <passwd>");
            exit(0);
            }
        else {
            example1(argv[1], argv[2], argv[3]);
            }
}
```

Example 3.4. Interactive Ad Hoc Query Example

The following example illustrates how an application can determine the nature of the resultset prior to retrieving results.

```
/*************************************************************
    Sample Name     : Example2.c(ad-hoc query processing)
    Author          : IBM SOLID Information Technology Ltd.

    Location        : CONSTRUCTING AN APPLICATION-SOLID Server
                      Programmer's guide and Reference
    Purpose         : To illustate how an application determines
                      the nature of the result set prior to
                      retrieving results.

*************************************************************/
#if (defined(SS_UNIX) || defined(SS_LINUX))
#include <sqlunix.h>
#else
#include <windows.h>
#endif

#if SOLIDODBCAPI
#include <sqlucode.h>
#include <wchar.h>
#else
#include <sql.h>
#include <sqlext.h>
#endif

#include <stdio.h>
```

```
#ifndef TRUE
#define TRUE 1
#endif

#define MAXCOLS 100
#define MAX_DATA_LEN 255

SQLHENV  henv;
SQLHDBC  hdbc;
SQLHSTMT hstmt;


/************************************************************
    Function Name: PrintError
    Purpose      : To Display the error associated with
                   the handle
************************************************************/
SQLINTEGER PrintError(SQLSMALLINT handleType, SQLHANDLE handle)
{
    SQLRETURN rc = SQL_ERROR;
    SQLCHAR sqlState[6];
    SQLCHAR eMsg[SQL_MAX_MESSAGE_LENGTH];
    SQLINTEGER nError;

        rc = SQLGetDiagRec(handleType, handle, 1,
             (SQLCHAR *)&sqlState, (SQLINTEGER *)&nError,
             (SQLCHAR *)&eMsg, 255, NULL);
        if (rc == SQL_SUCCESS || rc == SQL_SUCCESS_WITH_INFO)  {
            printf("\n\t Error:%s\n",eMsg);
        }
        return(SQL_ERROR);
}


/************************************************************
    Function Name: DrawLine
    Purpose      : To Draw a specified character (line) for
                   specified number of times (len)
************************************************************/
void DrawLine(SQLINTEGER len, SQLCHAR line)
{
        printf("\n");
```

```
        while(len > 0) {
            printf("%c",line);
            len--;
        }
        printf("\n");

}


/************************************************************
    Function Name: example2
    Purpose      : Connect to the specified data source and
                   execute the given SQL statement.
************************************************************/
SQLINTEGER example2(SQLCHAR *sqlstr)
{
    SQLINTEGER i;

    SQLCHAR colname[32];
    SQLSMALLINT coltype;
    SQLSMALLINT colnamelen;
    SQLSMALLINT nullable;
    SQLINTEGER collen[MAXCOLS];
    SQLSMALLINT scale;
    SQLINTEGER outlen[MAXCOLS];
    SQLCHAR data[MAXCOLS][MAX_DATA_LEN];
    SQLSMALLINT nresultcols;
    SQLINTEGER rowcount, nRowCount=0, lineLength=0;
    SQLRETURN rc;


    printf("\n%s",sqlstr);
    DrawLine(strlen(sqlstr),'=');

    /* Execute the SQL statement. */
    rc = SQLExecDirect(hstmt, sqlstr, SQL_NTS);
    if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
            return(PrintError(SQL_HANDLE_STMT, hstmt));


    /* See what kind of statement it was. If there are */
    /* no result columns, the statement is not a SELECT */
```

```
/* statement. If the number of affected rows is */
/* greater than 0, the statement was probably an */
/* UPDATE, INSERT, or DELETE statement, so print */
/* the number of affected rows. If the number of */
/* affected rows is 0, the statement is probably a */
/* DDL statement, so print that the operation was */
/* successful and commit it. */

rc = SQLNumResultCols(hstmt, &nresultcols);
if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
    return(PrintError(SQL_HANDLE_STMT, hstmt));

if (nresultcols == 0) {
    rc = SQLRowCount(hstmt, &rowcount);
    if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)  {
        return(PrintError(SQL_HANDLE_STMT, hstmt));
        }
    if (rowcount > 0 ) {
        printf("%ld rows affected.\n", rowcount);
        }
    else {
        printf("Operation successful.\n");
        }

    rc = SQLEndTran(SQL_HANDLE_DBC, hdbc, SQL_COMMIT);
    if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
        return(PrintError(SQL_HANDLE_DBC, hdbc));

    }
/* Otherwise, display the column names of the result */
/* set and use the display_size() function to */
/* compute the length needed by each data type. */
/* Next, bind the columns and specify all data will */
/* be converted to char. Finally, fetch and print */
/* each row, printing truncation messages as */
/* necessary. */
else {
    for (i = 0; i < nresultcols; i++) {
        rc = SQLDescribeCol(hstmt, i + 1, colname,
            (SQLSMALLINT)sizeof(colname),
            &colnamelen, &coltype, &collen[i],
            &scale, &nullable);
```

```
            if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO){
                return(PrintError(SQL_HANDLE_STMT, hstmt));
                }
            /* print column names */
            printf("%s\t", colname);
            rc = SQLBindCol(hstmt, i + 1, SQL_C_CHAR,
                data[i], sizeof(data[i]), &outlen[i]);
            if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO){
                return(PrintError(SQL_HANDLE_STMT, hstmt));
                }
            lineLength += 6 + strlen(colname);
            }

        DrawLine(lineLength-6,'-');

        while (TRUE) {
            rc = SQLFetch(hstmt);
            if (rc == SQL_SUCCESS || rc == SQL_SUCCESS_WITH_INFO){
                nRowCount++;
                for (i = 0; i < nresultcols; i++) {
                    if (outlen[i] == SQL_NULL_DATA) {
                        strcpy((char *)data[i], "NULL");
                        }
                    printf("%s\t",data[i]);
                    }
                printf("\n");
                }

            else {
                if (rc == SQL_ERROR)
                    PrintError(SQL_HANDLE_STMT, hstmt);
                break;
                }
            }
        printf("\n\tTotal Rows:%d\n", nRowCount);
        }

    SQLFreeStmt(hstmt, SQL_UNBIND);
    SQLFreeStmt(hstmt, SQL_CLOSE);
    return(0);

}
```

```
/*************************************************************
    Function Name: main
    Purpose      : To Control all operations
*************************************************************/
int __cdecl main(SQLINTEGER argc, SQLCHAR *argv[])
{
    SQLRETURN   rc;

    printf("\n\t SOLID ODBC Driver 3.51-Interactive");
    printf("\n\t ad-hoc Query Processing");
    printf("\n\t ================================\n");

    if (argc != 4)  {
        puts("USAGE: Example2 <DSN name> <username> <passwd>");
        exit(0);
        }


    /* Allocate environment and connection handles. */
    /* Connect to the data source. */
    /* Allocate a statement handle. */
    rc = SQLAllocHandle(SQL_HANDLE_ENV, SQL_NULL_HANDLE, &henv);
    if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
        return(PrintError(SQL_HANDLE_ENV, henv));

    rc = SQLSetEnvAttr(henv, SQL_ATTR_ODBC_VERSION,
        (SQLPOINTER)SQL_OV_ODBC3, SQL_NTS);
    if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
        return(PrintError(SQL_HANDLE_ENV, henv));

    rc = SQLAllocHandle(SQL_HANDLE_DBC, henv, &hdbc);
    if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
        return(PrintError(SQL_HANDLE_ENV, henv));

    printf("\n Connecting to %s\n ", argv[1]);
    rc = SQLConnect(hdbc, argv[1], SQL_NTS, argv[2], SQL_NTS,
        argv[3], SQL_NTS);
    if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
        return(PrintError(SQL_HANDLE_DBC, hdbc));
```

```
    rc = SQLAllocHandle(SQL_HANDLE_STMT, hdbc, &hstmt);
    if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
        return(PrintError(SQL_HANDLE_DBC, hdbc));

    /* execute the following SQL statements */
    example2("SELECT * FROM SYS_TABLES");
    example2("DROP TABLE TEST_TAB");
    example2("CREATE TABLE TEST_TAB(F1 INT, F2 VARCHAR)");
    example2("INSERT INTO TEST_TAB VALUES(10, 'SOLID')");
    example2("INSERT INTO TEST_TAB VALUES(20, 'MVP')");
    example2("UPDATE TEST_TAB SET F2='UPDATED' WHERE F1 = 20");
    example2("SELECT * FROM TEST_TAB");


    /* Free the statement handle. */
    rc = SQLFreeHandle(SQL_HANDLE_STMT, hstmt);
    if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
        return(PrintError(SQL_HANDLE_STMT, hstmt));

    /* Disconnect from the data source. */
    rc = SQLDisconnect(hdbc);
    if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
        return(PrintError(SQL_HANDLE_DBC, hdbc));

    /* Free the connection handle. */
    rc = SQLFreeHandle(SQL_HANDLE_DBC, hdbc);
    if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
        return(PrintError(SQL_HANDLE_DBC, hdbc));

    /* Free the environment handle. */
    rc = SQLFreeHandle(SQL_HANDLE_ENV, henv);
    if (rc != SQL_SUCCESS && rc != SQL_SUCCESS_WITH_INFO)
        return(PrintError(SQL_HANDLE_ENV, henv));

    return(0);

}
```

3.13 Testing and Debugging an Application

The Microsoft ODBC SDK provides the following tools for application development:

- ODBC Test, an interactive utility that enables you to perform ad hoc and automated testing on drivers. A sample test DLL (the Quick Test) is included, which covers basic areas of ODBC driver conformance.
- ODBC Spy, a debugging tool with which you can capture data source information, emulate drivers, and emulate applications.
- Sample applications, including source code and makefiles.
    - A #define, ODBCVER, to specify which version of ODBC you want to compile your application with. To use the ODBC 3.51 constants and prototypes, add the following line to your application code before providing the include files.

      ```
      #define ODBCVER 0X0352
      ```

    - For ASCII data, use the following standard Microsoft include files:

      `SQL.H` and `SQLEXT.H`

    - For Unicode data, use the following Microsoft include files:

      `SQLUCODE.H` and `WCHAR.H`

For additional information about the ODBC SDK tools, see the *Microsoft ODBC SDK Guide*.

3.14 Installing and Configuring ODBC Software

When the IBM solidDB Development Kit is installed, it automatically installs the ODBC drivers and a number of user Data Source Names (DSN). Of course, you can also add you own user DSNs.

For details about configuring and connecting to an ODBC data source, read Section 3.4, “Connecting to a Data Source”.

Application developers must decide whether to redistribute these programs or write their own setup and administration programs. For more information about the Driver Setup Toolkit and the ODBC Administrator, see the *Microsoft ODBC SDK Guide* on the Microsoft Web site.

A setup program written by an application developer uses the installer DLL to retrieve information from the ODBC.INF file, which is created by a driver developer and describes the disks on which the ODBC software is shipped. The setup program also uses the installer DLL to retrieve the target directories for the Driver Manager and the drivers, record information about the installed drivers, and install ODBC software.

Administration programs written by application developers use the installer DLL to retrieve information about the available drivers, to specify default drivers, and to configure data sources.

Application developers who write their own setup and administration programs must ship the installer DLL and the `ODBC.INF` file.

With the current version of ODBC 3.51, the Installer for Windows does not contain the Microsoft Driver Manager. To maintain compatibility with ADO, OLE DB, and ODBC, Microsoft recommends obtaining the Driver Manager and installing it. To do this, users need to download the executable mdac_typ.exe from the Microsoft Web site and install it; this executable provides users with Driver Manager 3.5 or above. For the URL to the Microsoft Web site where this executable is found, refer to the IBM Corporation Web site or the Release Notes.

Chapter 4. Using UNICODE

This chapter describes how to implement the UNICODE standard, providing the capability to encode characters used in the major languages of the world. Topics in this chapter include:

- What is UNICODE?
- UNICODE and IBM solidDB databases
- Setting up a IBM solidDB database for UNICODE data
- Using UNICODE with IBM solidDB ODBC Driver
- Using UNICODE with the IBM solidDB JDBC Driver

4.1 What Is Unicode?

The Unicode Standard is the universal character encoding standard used for representation of text for computer processing. Unicode provides a consistent way of encoding multilingual plain text making it easier to exchange text files internationally.

The version 2.0 Unicode Standard is fully compatible with the International Standard ISO/IEC 10646-1; 1993, and contains all the same characters and encoding points as ISO/IEC 10646. This code-for-code identity is true for all encoded characters in the two standards, including the East Asian (Han) ideographic characters. The Unicode Standard also provides additional information about the characters and their use. Any implementation that conforms to Unicode also conforms to ISO/IEC 10646.

Unicode uses a 16-bit encoding that provides code points for more than 65,000 characters. To keep character coding simple and efficient, the Unicode Standard assigns each character a unique 16-bit value, and does not use complex modes or escape codes.

While 65,000 characters are sufficient for encoding most of the many thousands of characters used in major languages of the world, the Unicode standard and ISO 10646 provide an extension mechanism called UTF-16 that allows for encoding as many as a million more characters, without use of escape codes. This is sufficient for all known character encoding requirements, including full coverage of all historic scripts of the world.

4.1.1 What Characters Does the Unicode Standard Include?

The Unicode Standard defines codes for characters used in the major languages written today. This includes punctuation marks, diacritics, mathematical symbols, technical symbols, arrows, dingbats, etc. In all, the

Unicode Standard provides codes for nearly 39,000 characters from the world's alphabets, ideograph sets, and symbol collections.

There are about 18,000 unused code values for future expansion in the basic 16-bit encoding, plus provision for another 917,504 code values through the UTF-16 extension mechanism. The Unicode Standard also reserves 6,400 code values for private use, which software and hardware developers can assign internally for their own characters and symbols. UTF-16 makes another 131,072 private use code values available, should 6,400 be insufficient for particular applications.

4.1.2 Encoding Forms

Character encoding standards define not only the identity of each character and its numeric value, or code position, but also how this value is represented in bits. The Unicode Standard endorses two forms that correspond to ISO 10646 transformation formats, UTF-8 and UTF-16.

The ISO/IEC 10646 transformation formats UTF-8 and UTF-16 are essentially ways of turning the encoding into the actual bits that are used in implementation. The first is known as UTF-16. It assumes 16-bit characters and allows for a certain range of characters to be used as an extension mechanism in order to access an additional million characters using 16-bit character pairs. The Unicode Standard, Version 2.0, has adopted this transformation format as defined in ISO/IEC 10646.

The other transformation format is known as UTF-8. This is a way of transforming all Unicode characters into a variable length encoding of bytes. It has the advantages that the Unicode characters corresponding to the familiar ASCII set end up having the same byte values as ASCII, and that Unicode characters transformed into UTF-8 can be used with much existing software without extensive software rewrites. The Unicode Consortium also endorses the use of UTF-8 as a way of implementing the Unicode Standard. Any Unicode character expressed in the 16-bit UTF-16 form can be converted to the UTF-8 form and back without loss of information.

The international standard ISO/IEC 10646 allows for two forms of use, a two-octet (=byte) form known as UCS-2 and a four-octet form known as UCS-4. The Unicode Standard, as a profile of ISO/IEC 10646, chooses the two-octet form, which is equivalent character representation in 16-bits per character. When extended characters are used, Unicode is equivalent to UTF-16.

4.2 Implementing Unicode

This section contains pertinent information required to implement the Unicode standard in IBM solidDB. Please note the following implementation guidelines:

- Unicode data types

SQL data types WCHAR, WVARCHAR and LONG WVARCHAR are used to store Unicode data in a IBM solidDB database. The Wide-character implementation conforms to ODBC 3.5 specification. The Unicode data types are interoperable with corresponding character data types (CHAR, VARCHAR and LONG VARCHAR), but conversions from Unicode data types to character data types fail, if the characters are beyond ISO Latin 1. All string operations are possible between Unicode and character data types with implicit type conversions.

- Internal storage format

  In IBM solidDB, the storage format for Unicode column data is UCS-2. All character information in the data dictionary are stored as Unicode.

  The wide character types require more storage space than normal character types. Therefore, use wide characters only where necessary.

- Ordering data columns

  Unicode data columns are ordered based on the binary values of the UCS-2 format. If the binary order is different than what natural language users expect, developers need to provide a separate column to store the correct ordering information.

- Unicode File Names

  A IBM solidDB server does not support using Unicode strings in any file names.

4.3 Setting Up Unicode Data

4.3.1 Creating Columns for Storing Unicode Data

In order to start storing Unicode data in a IBM solidDB database, tables with Unicode data columns need to be created first as follows:

```
CREATE TABLE customer (c_id INTEGER, c_name WVARCHAR,...)
```

4.3.2 Loading Unicode Data

You can use the data import tool Speedloader to import data to Unicode columns. The import files should contain Unicode data in UTF-8 format.

4.3.3 Using Unicode in Database Entity Names

It is possible to name tables, columns, procedures, etc. with Unicode strings, simply by enclosing the Unicode names with double quotes in all the SQL statements.

IBM solidDB tools will handle Unicode strings in UTF-8 format. In order to enter native Unicode strings, third-party database administration applications need to be used, or a special application using IBM solidDB JDBC Driver should be written for this purpose.

4.3.4 Unicode User Names and Passwords

User names and passwords can also be Unicode strings. However, to avoid access problems from different tools, the original database administrator account information must be given as pure ASCII strings.

4.3.5 IBM solidDB Data Dictionary, IBM solidDB Export, and IBM solidDB Speedloader

The IBM solidDB Tools use UTF-8 as the external representation format of Unicode strings.

IBM solidDB Speedloader (solload) accepts Unicode data in control and input files in UTF-8 format.

IBM solidDB Export (solexp) extracts Unicode data from database to output files in UTF-8 format.

IBM solidDB Data Dictionary (soldd) prints table, column, etc. names containing Unicode strings in UTF-8 format into the SQL DDL file.

Note that the teletype IBM solidDB SQL Editor (solsql) can use the SQL files output by soldd to create the tables, indices, etc. for a new database, as well as data definition entries if Unicode strings are available for them.

IBM solidDB Data Dictionary and IBM solidDB Export accept option `-8` to allow exporting data dictionary information in 8-bit format. The option `-8` is needed if there are Scandinavian or other national non-ascii characters in the data dictionary names.

4.3.6 Teletype Tools

The teletype versions of IBM solidDB SQL Editor and Remote Control, solsql and solcon, will function correctly in Unicode client environments.

4.3.7 Unicode and IBM solidDB ODBC Driver

The IBM solidDB ODBC Driver, which conforms to the Microsoft ODBC 3.51 standard, is Unicode compliant.

Note

IBM solidDB has two ODBC drivers available, one with Unicode support, and one for ASCII-only use.

4.3.8 Old Client Versions

Old clients can connect to IBM solidDB. All Unicode data is converted to ISO Latin 1 whenever possible. Thus, provided only ISO-Latin 1 data is used in the database, old clients can access IBM solidDB.

Note

To avoid problems in the future, it is recommended that you upgrade your client applications to use current client libraries.

4.3.9 Unicode Variables and Binding

Using string columns containing Unicode data work just like normal character columns. Note that the length of string buffers is given as the number of bytes required to store the value.

4.3.10 String Functions

String functions work as expected, also between ISO Latin 1 and Unicode strings. Conversions are provided implicitly, when necessary. The result is always of Unicode type, if either of the operands is Unicode.

The functions `UPPER()` and `LOWER()` work on Unicode strings when the contained characters can be mapped to ISO Latin 1 code page.

4.3.11 Translations

The character translations defined in client side `solid.ini` do not affect the data stored in Unicode columns. Translations remain in effect for character columns.

4.4 IBM solidDB Light Client

IBM solidDB Light Client does not work with Unicode since it does not support any ODBC 3.5 or later API functionality.

4.5 Unicode and IBM solidDB JDBC Driver

Unicode is supported in the IBM solidDB JDBC Driver, a IBM solidDB implementation of the JDBC 2.0 standard. It is also compatible with IBM solidDB, IBM solidDB Database Engine 4.x.

As Java uses natively Unicode strings, supporting Unicode means primarily that when accessing Unicode columns in IBM solidDB, no data type conversions are necessary. Additionally, JDBC ResultSet Class methods `getUnicodeStream` and `setUnicodeStream` are supported now for handling large Unicode texts stored in IBM solidDB.

To convert Java applications to support Unicode, the string columns in IBM solidDB need to be redefined with Unicode data types.

Chapter 5. Using IBM solidDB Light Client

This chapter describes how to use IBM solidDB Light Client, a very small footprint database client library and a subset of ODBC API, especially designed for implementing embedded solutions with limited memory resources. With IBM solidDB Light Client, lightweight client applications can use the full power of IBM solidDB databases.

The topics included in this chapter are:

- What is IBM solidDB Light Client?
- Getting started with IBM solidDB Light Client
- Running SQL statements on IBM solidDB Light Client
- IBM solidDB Light Client functions
- Sample code

5.1 What Is IBM solidDB Light Client?

The IBM solidDB Light Client library is a 20-function subset of the ODBC API (ODBC 1.0 Core), providing full SQL capabilities for application developers accessing IBM solidDB databases. It provides functions for controlling database connections, executing SQL statements, retrieving result sets, committing transactions, and other IBM solidDB functionality. IBM solidDB Light Client is suited for target environments with a small amount of memory.

5.2 Getting Started with IBM solidDB Light Client

To get started with IBM solidDB Light Client, be sure you have set up the TCP/IP infrastructure as instructed in the installation procedures and your platform specific documentation.

5.2.1 Setting Up the Development Environment and Building a Sample Program

Building a program using IBM solidDB Light Client library is identical to building any normal C/C++ program:

- Insert the library file to your project.

- Include the header file(s).
- Compile the source code.
- Link the program.

The first two issues are described in more detail in the following sections.

5.2.1.1 Insert the Library File into Your Project

Check your development environment's documentation on how to link a library to a program. Link the correct Light Client library to your program.

On some platforms, you may choose whether to use dynamic or static libraries. A library is "static" if its code is linked to the application at the time that the application is compiled and linked. A library is "dynamic" if it is linked to the application at the time that the application code is loaded and run.

On unix-based platforms, the library names fit the following pattern:

`slcPPPvv.EEE`

where

- "slc" = "IBM solidDB Light Client".
- "PPP is a platform-specific identifier, such as
  - "l2x" for multi-threaded Linux,
  - "s9x" for Solaris 2.9,
  - "h1x" for HP-UX (on PA-RISC), etc.
- "vv" is a version indicator, e.g. version "41" for version 4.1.
- EEE is a platform-related extension, such as
  - ".so" for unix Shared Object files (dynamic),
  - ".a" for unix library files (static).

Thus, for example, `slcs8x41.a` is the IBM solidDB 4.1 Light Client library for Solaris 8.

```
slc s8x 41.a
  ^^^ ^^^ ^^ ^^^
   |   |   |  |
   |   |   |  |
   |   |   |  |
   |   |   |  -----> .a is a static library, e.g. for Solaris 8
   |   |   -------->  version 4.1
   |   ------------>  Solaris 8
   ---------------->  IBM solidDB's mnemonic for the Light Client library.
```

On Microsoft Windows, we provide Light Client as a static library.

5.2.1.2 Include Header Files

The following line needs to be included in a Light Client program:

```
#include "cli0lcli.h"
```

Insert the directory containing all the other necessary Light Client headers into your development environment's include directories setting.

5.2.2 Verifying the Development Environment Setup

The easiest way to verify the development setup is to build a Light Client sample program. This enables you to verify your development environment without writing any code. Please note the following that applies to your development environment:

- In the Windows environment, the TCP/IP services are provided by standard DLL `wsock32.dll`. To link these services into your project, add `wsock32.lib` into linker's lib file list.
- In the Windows environment, some development tools link `odbc32.lib` providing the standard ODBC service as a default library to any project. Because the functions in ODBC have similar names and interfaces as the IBM solidDB Light Client, the program may be linked to use ODBC instead of Light Client. Remove `odbc32.lib` from the linker's file list.
- On ChorusOS and VxWorks target machines, you should run a kernel that has a working TCP/IP stack running. Usually you can verify this by checking that the target machine responds to ping requests. For example, if you have configured your target machine to have an IP address 192.168.1.111, you would run "ping 192.168.1.111"from another workstation in your LAN for a response that proves the target is alive:

  ```
  C:\>ping 192.168.1.111
  ```

```
Pinging 192.168.1.111 with 32 bytes of data:
Reply from 192.168.1.111: bytes=32 time=260ms TTL=62
```

After verification, your Light Client application should work on that target machine.

5.2.3 Connecting to a Database by Using the Sample Application

Establishing a connection to a database using IBM solidDB Light Client library is similar to establishing connections using ODBC. An application needs to obtain an environment handle, allocate space for a connection and establish a connection. Run the sample program to check whether it can obtain a connection to a IBM solidDB database in your environment.

Example 5.1. Establishing a Connection to IBM solidDB

The following code establishes a connection to a IBM solidDB database running in a machine 192.168.1.111 and listening to TCP/IP at port 1313. User account DBA with password DBA has been defined in the database.

```
HENV henv;          /* pointer to environment object */
HDBC hdbc;          /* pointer to database connection object */
RETCODE rc;         /* variable for return code */

rc = SQLAllocEnv(&henv);
if (SQL_SUCCESS != rc)
{
    printf("SQLAllocEnv fails.\n");
    return;
}

rc = SQLAllocConnect(&henv, &hdbc);
if (SQL_SUCCESS != rc)
{
    printf("SQLAllocConnect fails.\n");
    return;
}

rc = SQLConnect(hdbc, (UCHAR*)"192.168.1.111 1313", SQL_NTS,
(UCHAR*)"DBA", SQL_NTS, (UCHAR*)"DBA", SQL_NTS);
if (SQL_SUCCESS != rc)
{
    printf("SQLConnect fails.\n");
```

```
    return;
}
```

The connection established above can be cleared using the code below. To make it easier to read, no return code checking is included.

```
SQLDisconnect(hdbc);
SQLFreeConnect(hdbc);
SQLFreeEnv(henv);
```

5.3 Running SQL Statements on IBM solidDB Light Client

This section describes briefly how to do basic database operations with SQL. The following operations are presented here:

- Executing statements through IBM solidDB Light Client
- Reading result sets
- Transactions and autocommit mode
- Handling database errors

5.3.1 Executing Statements with IBM solidDB Light Client

The code below executes a simple SQL statement

```
INSERT INTO TESTTABLE (I,C) VALUES (100, 'HUNDRED');
```

The code expects a valid HENV *henv* and a valid HDBC *henv* to exist and variable rc of type RETCODE to be defined. The code also expects a table `TESTTABLE` with columns I and C to exist in the database.

```
rc = SQLAllocStmt(hdbc, &hstmt);

if (SQL_SUCCESS != rc)
{
    printf("SQLAllocStmt failed \n");
}
```

```
rc = SQLExecDirect(hstmt,
    (UCHAR*)"INSERT INTO TESTTABLE (I,C) VALUES (100, 'HUNDRED')",
    SQL_NTS);
if (SQL_SUCCESS != rc)
{
    printf("SQLExecDirect failed \n");
}

rc = SQLTransact(SQL_NULL_HENV, hdbc, SQL_COMMIT);
if (SQL_SUCCESS != rc)
{
    printf("SQLTransact failed \n");
}

rc = SQLFreeStmt(hstmt, SQL_DROP);
if (SQL_SUCCESS != rc)
{
    printf("SQLFreeStmt failed \n");
}
```

Statement with Parameters

The code example below prepares a simple statement INSERT INTO TESTTABLE (I,C) VALUES (?,?) to be executed several times with different parameter values. Not that the Light Client does not provide ODBC-like parameter binding. Instead, the values for parameters need to be assigned using the `SQLSetParamValue` function. The following variable definitions are expected:

```
#include "cli0lcli"
int i;
char buf[255];
SDWORD dwPar;
```

As above, the code also expects a valid HENV *henv* and a valid HDBC *henv* to exist and variable rc of type RETCODE to be defined and a table TESTTABLE with columns I and C to exist in the database.

```
rc = SQLAllocStmt(hdbc, &hstmt);

if (SQL_SUCCESS != rc) {
    printf("Alloc statement failed. \n");
}
```

```
rc = SQLPrepare(hstmt,
    (UCHAR*)"INSERT INTO TESTTABLE(I,C)VALUES   (?,?)", SQL_NTS);

    if (SQL_SUCCESS != rc) {
         printf("Prepare failed. \n");
    }

    for (i=1; i<100; i++)
    {
    dwPar = i;
    sprintf(buf,"line%i",i);

    rc = SQLSetParamValue(
    hstmt,1,SQL_C_LONG,SQL_INTEGER,0,0,&dwPar,NULL );
    if (SQL_SUCCESS != rc) {
        printf("(SetParamValue 1 failed) \n");
        return 0;
    }
    rc = SQLSetParamValue(
    hstmt,2,SQL_C_CHAR,SQL_CHAR,0,0,buf,NULL );
    if (SQL_SUCCESS != rc) {
        printf("(SetParamValue 1 failed) \n");
        return 0;
    }

    rc = SQLExecute(hstmt);

    if (SQL_SUCCESS != rc) {
        printf("SQLExecute failed \n");
    }
}
rc = SQLFreeStmt(hstmt,SQL_DROP);
if (SQL_SUCCESS != rc) {
    printf("SQLFreeStmt failed. \n");
}
```

Reading Result Sets

The following code excerpt prepares the SQL Statement SELECT I,C FROM TESTTABLE, executes it and fetches all the rows the database returns. The example code below expects valid definitions for *rc*, *henv*, *hstmt*, *henv*.

```
    rc = SQLAllocStmt(hdbc, &hstmt);

    if (SQL_SUCCESS != rc) {
         printf("SQLAllocStmt failed. \n");
         }

    rc = SQLPrepare(hstmt,(UCHAR*)"SELECT I,C FROM TESTTABLE", SQL_NTS);
    if (SQL_SUCCESS != rc) {
         printf("SQLPrepare failed. \n");
    }

    rc = SQLExecute(hstmt);

    if (SQL_SUCCESS != rc) {
         printf("SQLExecute failed. \n");
    }

    rc = SQLFetch(hstmt);

if ((SQL_SUCCESS != rc) &&SQL_NO_DATA_FOUND != rc)) {
    printf("SQLFetch returned an unexpected error code . \n");
}

while (SQL_NO_DATA_FOUND != rc)
{
    rc = SQLGetCol(hstmt, 1, SQL_C_LONG, &lbuf, sizeof(lbuf), NULL);
    if (rc == SQL_SUCCESS)
    {
        printf("LC_SQLGetCol(1) returns %d \n", lbuf);
        }
        else printf("Error in SQLGetCol(1) \n");
        rc = SQLGetCol(hstmt, 2, SQL_C_CHAR, buf, sizeof(buf), NULL);
        if (rc == SQL_SUCCESS)
        {
            printf("SQLGetCol(2) returns %s \n",buf);
         }
         else printf("Error in SQL_GetCol(2) \n");

         rc = SQLFetch(hstmt);
    }
```

```
    rc = SQLFreeStmt(hstmt,SQL_DROP);
    if (SQL_SUCCESS != rc)
    {
         printf("SQLFreeStmt failed. ");
    }
```

Also the following Light Client API functions may be useful when processing result sets:

- `SQLDescribeCol`
- `SQLGetCursorName`
- `SQLNumResultCols`
- `SQLSetCursorName`

Transactions and Autocommit Mode

All IBM solidDB Light Client connections have the `autocommit` option set off. There is no method in Light Client to set the option on. Every transaction has to be committed explicitly.

To commit the transaction, call the `SQLTransact` function as follows:

```
rc = SQLTransact(SQL_NULL_HENV, hdbc, SQL_COMMIT);
```

To roll the transaction back, call the `SQLTransact` as follows.

```
rc = SQLTransact(SQL_NULL_HENV, hdbc, SQL_ROLLBACK);
```

Handling Database Errors

When a Light Client API function returns SQL_ERROR or SQL_SUCCESS_WITH_INFO more information about the error or warning can be obtained by calling the `SQLError` function. If the following code is run against a database where no table TESTTABLE is defined, it will produce the appropriate error information.

As usual, the code expects a valid HENV *`henv`* and a valid HDBC *`henv`* to exist and variable *`rc`* of type *`RETCODE`* to be defined.

```
rc = SQLPrepare(hstmt,(UCHAR*)"SELECT I,C FROM TESTTABLE", SQL_NTS);
if (SQL_SUCCESS != rc)
{
```

```
    char buf[255];
    RETCODE rc;

    char szSQLState[255];
    char szErrorMsg[255];
    SDWORD nativeerror = 0;
    SWORD maxerrmsg = 0;

    memset(szSQLState,0,sizeof(szSQLState));
    memset(szErrorMsg,0,sizeof(szErrorMsg));

    rc = SQLError(
    SQL_NULL_HENV, hdbc, hstmt, (UCHAR*)szSQLState, &nativeerror,
    (UCHAR*)szErrorMsg, sizeof(szErrorMsg), &maxerrmsg);

    if (rc == SQL_ERROR)
    {
        printf("SQLError failed \n.");
    }
    else
    {
            printf("Error information dump begins:-------------\n");
            printf("SQLState '%s' \n",szSQLState);
    printf("nativeerror %i \n", nativeerror);
    printf("Errormsg '%s' \n", szErrorMsg);
printf("maxerrmsg %i \n", maxerrmsg);
printf("Error information dump ends:---------------\n");
    }
}
```

5.4 Special Notes about Using IBM solidDB Light Client

5.4.1 Network Traffic in Fetching Data

IBM solidDB Light Client communication does not support IBM solidDB's *RowsPerMessage* setting. Every Light Client call to SQLFetch causes a network message to be sent between client and server. This affects performance when fetching large amounts of data.

5.4.2 Unicode and ODBC Support

IBM solidDB Light Client does not work with Unicode and any ODBC 3.51 API functionality. Only ODBC API versions prior to 3.5 are supported.

5.4.3 BIGINT Not Supported

IBM solidDB Light Client does not support the BIGINT data type.

5.4.4 Notes for Programmers Familiar with ODBC

Migrating ODBC Applications to Light Client API

If you are using ODBC functions not provided by the Light Client API, migrating to IBM solidDB Light Client from the standard ODBC database interface requires some programming. Roughly, the migration steps are:

1. Review how your application uses ODBC and estimate whether Light Client API functionality is sufficient. You can expect to make some minor changes to your own code, basically:
   - Calls to ODBC Extension Level 1 functions should be converted to ODBC Core level functions
   - Rewriting the application without `SQLBindParameter`
2. Verify your environment using IBM solidDB Light Client samples.
3. Modify the ODBC calls in your own code, rebuild and test your program.

5.5 IBM solidDB Light Client Function Summary

This section lists the functions in IBM solidDB Light Client API, which is a subset of the ODBC API. For actual function descriptions, refer to the reference section at the end of this chapter.

Note

IBM solidDB Light Client does not provide any ODBC Extension Level functionality for setting parameter values (for example, `SQLBindParameter`) or data binding (for example, `SQLBindCol`). Instead IBM solidDB Light Client provides SAG CLI compliant functions `SQLSetParamValue`, for setting parameter values, and `SQLGetCol`, for reading data from result sets. Read Section 5.28, “Non-ODBC IBM solidDB Light Client Functions” for descriptions of these functions.

5.5.1 Summary of Functions

For a complete example program on how to use IBM solidDB Light Client API, see Section 5.6, “IBM solidDB Light Client Samples”.

Table 5.1. Summary of Functions

Task	Function
Connecting to a data source	Section 5.9, “SQLAllocEnv (ODBC 1.0, Core)” Section 5.8, “SQLAllocConnect (ODBC 1.0, Core)” Section 5.11, “SQLConnect (ODBC 1.0, Core)”
Preparing SQL statements	Section 5.10, “SQLAllocStmt (ODBC 1.0, Core)” Section 5.24, “SQLPrepare (ODBC 1.0, Core)” `SqlSetParamValue` in Section 3.7.4, “IBM solidDB Extensions for ODBC API” Note this function is unique to IBM solidDB Light Client. For details on this function, see the section which follows this table. Section 5.26, “SQLSetCursorName (ODBC 1.0, Core)” Section 5.21, “SQLGetCursorName (ODBC 1.0, Core)”
Submitting Requests	Section 5.16, “SQLExecute (ODBC 1.0, Core)” Section 5.15, “SQLExecDirect (ODBC 1.0, Core)”
Retrieving Results and Information about Results	Section 5.25, “SQLRowCount (ODBC 1.0, Core)” Section 5.23, “SQLNumResultCols (ODBC 1.0, Core)” Section 5.12, “SQLDescribeCol (ODBC 1.0, Core)” SqlGetCol in Section 5.28, “Non-ODBC IBM solidDB Light Client Functions” Note that this function is identical to the ODBC compliant function `SQLGetData`. Section 5.17, “SQLFetch (ODBC 1.0, Core)”

Task	Function
	Section 5.22, “SQLGetData (ODBC 1.0, Level 1)” Note that this function is identical to its SAG CLI counterpart `SQLGetCol`. Section 5.14, “SQLError (ODBC 1.0, Core)”
Terminating a Statement	Section 5.20, “SQLFreeStmt (ODBC 1.0, Core)” Section 5.27, “SQLTransact (ODBC 1.0, Core)”
Terminating a Connection	Section 5.13, “SQLDisconnect (ODBC 1.0, Core)” Section 5.11, “SQLConnect (ODBC 1.0, Core)” Section 5.19, “SQLFreeEnv (ODBC 1.0, Core)”

5.6 IBM solidDB Light Client Samples

Example 5.2. IBM solidDB Light Client Sample 1:

```
#include "sample1.h"

/*************************************************************************
 *
 * File:           SAMPLE1.C
 *
 * Description:    Sample program for Solid Light Client API
 *
 * Author:         Solid
 *
 *
 * Solid Light Client sample program does the following.
 *
 * 1. Checks that there are enough input parameters to contain
sufficient
 *    connect information
 * 2. Prepares to connect Solid through Light Client by
 *    allocating memory for HENV and HDBC objects
 * 3. Connects to Solid using Light Client Library
```

```
 * 4. Creates a statement for one query,
 *    'SELECT TABLE_SCHEMA,TABLE_NAME,TABLE_TYPE FROM TABLES' for
       reading data from one of SOLID system tables.
 * 5. Executes the query
 * 6. Fetches and outputs all the rows of a result set.
 * 7. Closes the connection gracefully.
 *
 * ********************************************************************/
void __cdecl main(int argc, char *argv[])
{
  HENV henv;      /* pointer to environment object            */
  HDBC hdbc;      /* pointer to database connection object    */
  RETCODE rc;     /* variable for return code                 */
  HSTMT hstmt;    /* pointer to database statement object     */
  char buf[255];  /* buffer for data to be obtained from db   */
  char buf2[255]; /* buffer for a printable row to be created */
  int iCount = 0; /* counter for rows to be fetched.          */


  /* 1. Checks that there are enough input parameters to contain
  /*    sufficient connect information                        */
  if (argc != 4)
  {
    printf("Proper usage \"connect string\" uid pwd \n");
    printf("argc %i \n",argc);
    return;
  }
  printf("Will connect SOLID at %s with uid %s and pwd%s.\n", argv[1],
    argv[2], argv[3]);


  /* 2. Prepares to connect SOLID through Light Client   /*
  /*    by allocating memory for HENV and HDBC objects */

  rc = SQLAllocEnv(&henv);
  if (SQL_SUCCESS != rc)
  {
    printf("SQLAllocEnv fails.\n");
    return;
  }

  rc = SQLAllocConnect(henv, &hdbc);
```

```
if (SQL_SUCCESS != rc)
{
  printf("SQLAllocConnect fails.\n");
  return;
}

/* 3. Connects to SOLID using Light Client Library */
rc = SQLConnect(hdbc, (UCHAR*)argv[1], SQL_NTS, (UCHAR*)argv[2],
  SQL_NTS, (UCHAR*)argv[3], SQL_NTS);
if (SQL_SUCCESS != rc)
{
  printf("SQLConnect fails.\n");
  return;
}
else printf("Connect ok.\n");


/* 4. Creates a statement for one query,
  /*    data from one of SOLID system tables. */
rc = SQLAllocStmt(hdbc, &hstmt);
if (SQL_SUCCESS != rc) {
  printf("SQLAllocStmt failed. \n");
 }

rc = SQLPrepare(hstmt,
  (UCHAR*)"SELECT TABLE_SCHEMA,TABLE_NAME,TABLE_TYPE FROM TABLES",
 SQL_NTS);

if (SQL_SUCCESS != rc) {
  printf("SQLPrepare failed. \n");
}
else printf("SQLPrepare succeeded. \n");


/* 5. Executes the query */
rc = SQLExecute(hstmt);
if (SQL_SUCCESS != rc) {
  printf("SQLExecute failed. \n");
}
else printf("SQLExecute succeeded. \n");
```

```
/* 6. Fetches and outputs all the rows of a result set. */
rc = SQLFetch(hstmt);
if ((SQL_SUCCESS != rc) && (SQL_NO_DATA_FOUND != rc)) {
  printf("SQLFetch returned an unexpected error code . \n");
}
else printf("Starting to fetch data.\n");

while (SQL_NO_DATA_FOUND != rc)
{
  iCount++;
  sprintf(buf2, "Row %i :", iCount);

  rc = SQLGetCol(hstmt, 1, SQL_C_CHAR, buf, sizeof(buf), NULL);
  if (rc == SQL_SUCCESS)
  {
    strcat(buf2, buf);
    strcat(buf2, ",");
  }
  else printf("Error in SQL_GetCol(1) \n");

  rc = SQLGetCol(hstmt, 2, SQL_C_CHAR, buf, sizeof(buf), NULL);
  if (rc == SQL_SUCCESS)
  {
    strcat(buf2, buf);
    strcat(buf2, ",");
  }
  else printf("Error in SQL_GetCol(2) \n");

  rc = SQLGetCol(hstmt, 3, SQL_C_CHAR, buf, sizeof(buf), NULL);
  if (rc == SQL_SUCCESS)
  {
    strcat(buf2, buf);
  }
  else printf("Error in SQL_GetCol(3) \n");

  printf("%s \n", buf2);


  rc = SQLFetch(hstmt);
}

rc = SQLFreeStmt(hstmt, SQL_DROP);
```

```
  if ((SQL_SUCCESS != rc))
  {
    printf("SQLFreeStmt failed. ");
  }

  /* 7. Closes the connection gracefully.                          */
  SQLDisconnect(hdbc);
  SQLFreeConnect(hdbc);
  SQLFreeEnv(henv);

  printf("Sample program ends successfully.\n");

}
```

Example 5.3. IBM solidDB Light Client Sample 2

```
#ifndef SAMPLE1_H
#define SAMPLE1_H

/*****************************************************************
 *
 * File:           SAMPLE1.H
 *
 * Description:    Sample program for Solid Light Client API, header
 *                 file
 *
 * Author:         Solid
 *
 *  ****************************************************************
/


#include <stdio.h>
#include <string.h>

#include "cli0lcli.h"
```

```
#endif
```

Example 5.4. IBM solidDB Light Client Sample 3

```
C:\solid\lcli\samples>sample1 "fb1 1313" DBA DBA
Will connect Solid at fb1 1313 with uid DBA and pwd DBA.
Connect ok.
SQLPrepare succeeded.
SQLExecute succeeded.
Starting to fetch data.
Row 1 :_SYSTEM,SYS_TABLES,BASE TABLE
Row 2 :_SYSTEM,SYS_COLUMNS,BASE TABLE
Row 3 :_SYSTEM,SYS_USERS,BASE TABLE
Row 4 :_SYSTEM,SYS_UROLE,BASE TABLE
Row 5 :_SYSTEM,SYS_RELAUTH,BASE TABLE
Row 6 :_SYSTEM,SYS_ATTAUTH,BASE TABLE
Row 7 :_SYSTEM,SYS_VIEWS,BASE TABLE
Row 8 :_SYSTEM,SYS_KEYPARTS,BASE TABLE
Row 9 :_SYSTEM,SYS_KEYS,BASE TABLE
Row 10 :_SYSTEM,SYS_CARDINAL,BASE TABLE
Row 11 :_SYSTEM,SYS_INFO,BASE TABLE
Row 12 :_SYSTEM,SYS_SYNONYM,BASE TABLE
Row 13 :_SYSTEM,TABLES,VIEW
Row 14 :_SYSTEM,COLUMNS,VIEW
Row 15 :_SYSTEM,SQL_LANGUAGES,BASE TABLE
Row 16 :_SYSTEM,SERVER_INFO,VIEW
Row 17 :_SYSTEM,SYS_TYPES,BASE TABLE
Row 18 :_SYSTEM,SYS_FORKEYS,BASE TABLE
Row 19 :_SYSTEM,SYS_FORKEYPARTS,BASE TABLE
Row 20 :_SYSTEM,SYS_PROCEDURES,BASE TABLE
Row 21 :_SYSTEM,SYS_TABLEMODES,BASE TABLE
Row 22 :_SYSTEM,SYS_EVENTS,BASE TABLE
Row 23 :_SYSTEM,SYS_SEQUENCES,BASE TABLE
```

```
Row 24 :_SYSTEM,SYS_TMP_HOTSTANDBY,BASE TABLE
Sample program ends successfully.
```

5.7 IBM solidDB Light Client Function Reference

The following pages describe each ODBC function supported by IBM solidDB Light Client in alphabetic order. Each function is defined as a C programming language function.

5.8 SQLAllocConnect (ODBC 1.0, Core)

`SQLAllocConnect` allocates memory for a connection handle within the environment identified by *`henv`*.

5.8.1 Synopsis

```
RETCODE SQLAllocConnect(henv, phenv)
```

The `SQLAllocConnect` function accepts the following arguments.

Table 5.2. SQLAllocConnect Arguments

Type	Argument	Use	Description
henv	*henv*	Input	Environment handle.
HDBC FAR *	*phenv*	Output	Pointer to storage for the connection handle

5.8.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_ERROR, or SQL_INVALID_HANDLE.

If `SQLAllocConnect` returns SQL_ERROR, it will set the *`henv`* referenced by *`phenv`* to SQL_NULL_HDBC. To obtain additional information, the application can call `SQLError` with the specified *`henv`* and with *`henv`* and *`hstmt`* set to SQL_NULL_HDBC and SQL_NULL_HSTMT, respectively.

5.9 SQLAllocEnv (ODBC 1.0, Core)

`SQLAllocEnv` allocates memory for an environment handle and initializes the ODBC call level interface for use by an application. An application must call `SQLAllocEnv` prior to calling any other ODBC function.

5.9.1 Synopsis

```
RETCODE SQLAllocEnv(phenv)
```

The SQLAllocEnv function accepts the following argument.

Table 5.3. SQLAllocEnv Argument

Type	Argument	Use	Description
HENV FAR *	*phenv*	Output	Pointer to storage for the environment handle

5.9.2 Returns

SQL_SUCCESS or SQL_ERROR.

If SQLAllocEnv returns SQL_ERROR, it will set the *henv* referenced by *phenv* to SQL_NULL_HENV. In this case, the application can assume that the error was a memory allocation error.

5.10 SQLAllocStmt (ODBC 1.0, Core)

SQLAllocStmt allocates memory for a statement handle and associates the statement handle with the connection specified by *henv*. An application must call SQLAllocStmt prior to submitting SQL statements.

5.10.1 Synopsis

```
RETCODE SQLAllocStmt(henv, phstmt)
```

The SQLAllocStmt function accepts the following arguments.

Table 5.4. SQLAllocStmt Arguments

Type	Argument	Use	Description
HDBC	*henv*	Input	Connection handle
HSTMT FAR *	*phstmt*	Output	Pointer to storage for the statement handle

5.10.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_INVALID_HANDLE, or SQL_ERROR.

If `SQLAllocStmt` returns SQL_ERROR, it will set the *`hstmt`* referenced by phstmt to SQL_NULL_HSTMT. The application can then obtain additional information by calling `SQLError` with the *`henv`* and SQL_NULL_HSTMT.

5.11 SQLConnect (ODBC 1.0, Core)

`SQLConnect` loads a driver and establishes a connection to a data source. The connection handle references storage of all information about the connection, including status, transaction state, and error information.

5.11.1 Synopsis

```
RETCODE SQLConnect(henv, szDSN, cbDSN, szUID, cbUID, szAuthStr, cbAuthStr)
```

The `SQLConnect` function accepts the following arguments.

Table 5.5. SQLConnect Arguments

Type	Argument	Use	Description
HDBC	*`henv`*	Input	Connection handle.
UCHAR FAR *	*`szDSN`*	Input	Data source name.
SWORD	*`cbDSN`*	Input	Length of *`szDSN`*.
UCHAR FAR *	*`szUID`*	Input	User identifier.
SWORD	*`cbUID`*	Input	Length of *`szUID`*.
UCHAR FAR *	*`szAuthStr`*	Input	Authentication string (typically the password).
SWORD	*`cbAuthStr`*	Input	Length of *`szAuthStr`*.

5.11.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_ERROR, or SQL_INVALID_HANDLE.

5.12 SQLDescribeCol (ODBC 1.0, Core)

`SQLDescribeCol` returns the result descriptor — column name, type, precision, scale, and nullability — for one column in the result set; it cannot be used to return information about the bookmark column (column 0).

5.12.1 Synopsis

```
RETCODE SQLDescribeCol(hstmt, icol, szColName,
cbColNameMax, pcbColName, pfSqlType, pcbColDef,
pibScale, pfNullable)
```

The `SQLDescribeCol` function accepts the following arguments.

Table 5.6. SQLDescribeCol Arguments

Type	Argument	Use	Description
HSTMT	*hstmt*	Input	Statement handle.
UWORD	*icol*	Input	Column number of result data, ordered sequentially left to right, starting at 1.
UCHAR FAR *	*szColName*	Output	Pointer to storage for the column name. If the column is unnamed or the column name cannot be determined, the driver returns an empty string.
SWORD	*cbColNameMax*	Input	Maximum length of the *szColName* buffer.
SWORD FAR *	*pcbColName*	Output	Total number of bytes (excluding the null termination byte) available to return in *szColName*. If the number of bytes available to return is greater than or equal to *cbColNameMax*, the column name in *szColName* is truncated to *cbColNameMax* - 1 bytes.
SWORD FAR *	*pfSqlType*	Output	The SQL data type of the column. This must be one of the following values: SQL_BIGINT (note: IBM solidDB Light Client does not support BIGINT/SQL_BIGINT) SQL_BINARY SQL_BIT (note: IBM solidDB, IBM solidDB Light Client, IBM solidDB ODBC Driver, and IBM solidDB JDBC Driver do not support BIT/SQL_BIT) SQL_CHAR

Type	Argument	Use	Description
			SQL_DATE SQL_DECIMAL SQL_DOUBLE SQL_FLOAT SQL_INTEGER SQL_LONGVARBINARY SQL_LONGVARCHAR SQL_NUMERIC SQL_REAL SQL_SMALLINT SQL_TIME SQL_TIMESTAMP SQL_TINYINT SQL_VARBINARY SQL_VARCHAR or a driver-specific SQL data type. If the data type cannot be determined, the driver returns 0. For more information, see Section E.4, “SQL Data Types”. For information about driver-specific SQL data types, see the driver's documentation.
UDWORD FAR *	*pcbColDef*	Output	The precision of the column on the data source. If the precision cannot be determined, the driver returns 0.
SWORD FAR *	*pibScale*	Output	The scale of the column on the data source. If the scale cannot be determined or is not applicable, the driver returns 0.

Type	Argument	Use	Description
SWORD FAR *	*pfNullable*	Output	Indicates whether the column allows NULL values. One of the following values: • SQL_NO_NULLS: The column does not allow NULL values. • SQL_NULLABLE: The column allows NULL values. • SQL_NULLABLE_UNKNOWN: The driver cannot determine if the column allows NULL values.

5.12.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_STILL_EXECUTING, SQL_ERROR, or SQL_INVALID_HANDLE.

5.13 SQLDisconnect (ODBC 1.0, Core)

`SQLDisconnect` closes the connection associated with a specific connection handle.

5.13.1 Synopsis

```
RETCODE SQLDisconnect(henv)
```

The `SQLDisconnect` function accepts the following argument.

Table 5.7. SQLDisconnect Arguments

Type	Argument	Use	Description
HDBC	*henv*	Input	Connection handle

5.13.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_ERROR, or SQL_INVALID_HANDLE.

5.14 SQLError (ODBC 1.0, Core)

`SQLError` returns error or status information.

5.14.1 Synopsis

```
RETCODE SQLError(henv, henv, hstmt, szSqlState,
pfNativeError, szErrorMsg, cbErrorMsgMax, pcbErrorMsg)
```

The `SQLError` function accepts the following arguments.

Table 5.8. SQLError Arguments

Type	Argument	Use	Description
HENV	*henv*	Input	Environment handle or SQL_NULL_HENV.
HDBC	*henv*	Input	Connection handle or SQL_NULL_HDBC.
HSTMT	*hstmt*	Input	Statement handle or SQL_NULL_HSTMT.
UCHAR FAR *	*szSqlState*	Output	SQLSTATE as null-terminated string. For a list of SQLSTATEs, see Appendix A, "ODBC Error Codes."
SDWORD FAR *	*pfNativeError*	Output	Native error code (specific to the data source).
UCHAR FAR *	*szErrorMsg*	Output	Pointer to storage for the error message text.
SWORD	*cbErrorMsgMax*	Input	Maximum length of the szErrorMsg buffer. This must be less than or equal to SQL_MAX_MESSAGE_ LENGTH - 1.
SWORD FAR *	*pcbErrorMsg*	Output	Pointer to the total number of bytes (excluding the null termination byte) available to return in *szErrorMsg*. If the number of bytes available to return is greater than or equal to *cbErrorMsgMax*, the error message text in *szErrorMsg* is truncated to *cbErrorMsgMax* - 1 bytes.

5.14.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_NO_DATA_FOUND, SQL_ERROR, or SQL_INVALID_HANDLE.

5.15 SQLExecDirect (ODBC 1.0, Core)

`SQLExecDirect` executes a preparable statement, using the current values of the parameter marker variables if any parameters exist in the statement. `SQLExecDirect` is the fastest way to submit a SQL statement for one-time execution.

5.15.1 Synopsis

```
RETCODE SQLExecDirect(hstmt, szSqlStr, cbSqlStr)
```

The `SQLExecDirect` function uses the following arguments.

Table 5.9. SQLExecDirect Arguments

Type	Argument	Use	Description
HSTMT	*hstmt*	Input	Statement handle.
UCHAR FAR *	*szSqlStr*	Input	Input SQL statement to be executed.
SDWORD	*cbSqlStr*	Input	Input Length of *szSqlStr*.

5.15.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_NEED_DATA, SQL_STILL_EXECUTING, SQL_ERROR, or SQL_INVALID_HANDLE.

5.16 SQLExecute (ODBC 1.0, Core)

`SQLExecute` executes a prepared statement, using the current values of the parameter marker variables if any parameter markers exist in the statement.

5.16.1 Synopsis

```
RETCODE SQLExecute(hstmt)
```

The `SQLExecute` statement accepts the following argument.

Table 5.10. SQLExecute Argument

Type	Argument	Use	Description
HSTMT	*hstmt*	Input	Statement handle

5.16.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_NEED_DATA, SQL_STILL_EXECUTING, SQL_ERROR, or SQL_INVALID_HANDLE.

5.17 SQLFetch (ODBC 1.0, Core)

`SQLFetch` fetches a row of data from a result set. The driver returns data for all columns that were bound to storage locations with `SQLGetCol`.

5.17.1 Synopsis

```
RETCODE SQLFetch(hstmt)
```

The `SQLFetch` function accepts the following argument.

Table 5.11. SQLFetch Argument

Type	Argument	Use	Description
HSTMT	*hstmt*	Input	Statement handle.

5.17.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_NO_DATA_FOUND, SQL_STILL_EXECUTING, SQL_ERROR, or SQL_INVALID_HANDLE.

5.18 SQLFreeConnect (ODBC 1.0, Core)

`SQLFreeConnect` releases a connection handle and frees all memory associated with the handle.

5.18.1 Synopsis

```
RETCODE SQLFreeConnect(henv)
```

The `SQLFreeConnect` function accepts the following argument.

Table 5.12. SQLFreeConnect Argument

Type	Argument	Use	Description
HDBC	*henv*	Input	Connection handle.

5.18.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_ERROR, or SQL_INVALID_HANDLE.

5.19 SQLFreeEnv (ODBC 1.0, Core)

`SQLFreeEnv` frees the environment handle and releases all memory associated with the environment handle.

5.19.1 Synopsis

```
RETCODE SQLFreeEnv(henv)
```

The `SQLFreeEnv` function accepts the following argument.

Table 5.13. SQLFreeEnv Argument

Type	Argument	Use	Description
HDBC	*henv*	Input	Connection handle

5.19.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_ERROR, or SQL_INVALID_HANDLE.

5.20 SQLFreeStmt (ODBC 1.0, Core)

`SQLFreeStmt` stops processing associated with a specific *`hstmt`*, closes any open cursors associated with the *`hstmt`*, discards pending results, and, optionally, frees all resources associated with the statement handle.

5.20.1 Synopsis

```
RETCODE SQLFreeStmt(hstmt, fOption)
```

The `SQLFreeStmt` function accepts the following arguments.

Table 5.14. SQLFreeStmt Arguments

Type	Argument	Use	Description
HSTMT	*`hstmt`*	Input	Statement handle
UWORD	*`fOption`*	Input	One of the following options: `SQL_CLOSE`: Close the cursor associated with *`hstmt`* (if one was defined) and discard all pending results. The application can reopen this cursor later by executing a SELECT statement again with the same or different parameter values. If no cursor is open, this option has no effect for the application. `SQL_DROP`: Release the *`hstmt`*, free all resources associated with it, close the cursor (if one is open), and discard all pending rows. This option terminates all access to the *`hstmt`*. The *`hstmt`* must be reallocated to be reused. `SQL_UNBIND`: Release all column buffers bound by SQLGetCol for the given *`hstmt`*. `SQL_RESET_PARAMS`: Release all parameter buffers set by *`SQLParamValue`* for the given *`hstmt`*.

5.20.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_ERROR, or SQL_INVALID_HANDLE.

5.21 SQLGetCursorName (ODBC 1.0, Core)

SQLGetCursorName returns the cursor name associated with a specified *hstmt*.

5.21.1 Synopsis

```
RETCODE SQLGetCursorName(hstmt, szCursor, cbCursorMax, pcbCursor)
```

The SQLGetCursorName function accepts the following arguments.

Table 5.15. SQLGetCursorName Arguments

Type	Argument	Use	Description
HSTMT	*hstmt*	Input	Statement handle.
UCHAR FAR *	*szCursor*	Output	Pointer to storage for the cursor name.
SWORD	*cbCursorMax*	Input	Length of *szCursor*.
SWORD FAR *	*pcbCursor*	Output	Total number of bytes (excluding the null termination byte) available to return in *szCursor*. If the number of bytes available to return is greater than or equal to *cbCursorMax*, the cursor name in *szCursor* is truncated to *cbCursorMax* - 1 bytes.

5.21.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_ERROR, or SQL_INVALID_HANDLE.

5.22 SQLGetData (ODBC 1.0, Level 1)

SQLGetData returns result data for a single unbound column in the current row. The application must call SQLFetch to position the cursor on a row of data before it calls SQLGetData. This function can be used to retrieve character or binary data values in parts from a column with a character, binary, or data source-specific data type (for example, data from SQL_LONGVARBINARY or SQL_LONGVARCHAR columns).

5.22.1 Synopsis

`RETCODE SQLGetData(hstmt, icol, fCType, rgbValue, cbValueMax, pcbValue)`

The `SQLGetData` function accepts the following arguments:

Table 5.16. SQLGetData Arguments

Type	Argument	Use	Description
HSTMT	*hstmt*	Input	Statement handle.
UWORD	*icol*	Input	Column number of result data, ordered sequentially left to right, starting at 1. A column number of 0 is used to retrieve a bookmark for the row; bookmarks are not supported by ODBC 1.0 drivers or SQLFetch.
SWORD	*fCType*	Input	The C data type of the result data. This must be one of the following values: SQL_C_BINARY SQL_C_BIT SQL_C_BOOKMARK SQL_C_CHAR SQL_C_DATE SQL_C_DEFAULT SQL_C_DOUBLE SQL_C_FLOAT SQL_C_SLONG SQL_C_SSHORT SQL_C_STINYINT SQL_C_TIME

Type	Argument	Use	Description
			SQL_C_TIMESTAMP SQL_C_ULONG SQL_C_USHORT SQL_C_UTINYINT SQL_C_DEFAULT specifies that data be converted to its default C data type. Note: Drivers must also support the following values of fCType from ODBC 1.0. Applications must use these values, rather than the ODBC 2.0 values, when calling an ODBC 1.0 driver: SQL_C_LONG SQL_C_SHORT SQL_C_TINYINT For information about how data is converted, see Section E.12, “Converting Data from SQL to C Data Types”.
PTR	*rgbValue*	Output	Pointer to storage for the data.
SDWORD	*cbValueMax*	Input	Maximum length of the *rgbValue* buffer. For character data, *rgbValue* must also include space for the null-termination byte. For character and binary C data, *cbValueMax* determines the amount of data that can be received in a single call to SQLGetData. For all other types of C data, *cbValueMax* is ignored; the driver assumes that the size of *rgbValue* is the size of the C data type specified with *fCType* and returns the entire data value.
SDWORD FAR *	*pcbValue*	Output	SQL_NULL_DATA, the total number of bytes (excluding the null termination byte for character data) available to return in *rgbValue* prior to the

Type	Argument	Use	Description
			current call to SQLGetData, or SQL_NO_TOTAL if the number of available bytes cannot be determined. For character data, if *pcbValue* is SQL_NO_TOTAL or is greater than or equal to *cbValueMax*, the data in *rgbValue* is truncated to cbValueMax - 1 bytes and is null-terminated by the driver. For binary data, if *pcbValue* is SQL_NO_TOTAL or is greater than *cbValueMax*, the data in *rgbValue* is truncated to *cbValueMax* bytes. For all other data types, the value of *cbValueMax* is ignored and the driver assumes the size of *rgbValue* is the size of the C data type specified with *fCType*.

5.22.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_NO_DATA_FOUND, SQL_STILL_EXECUTING, SQL_ERROR, or SQL_INVALID_HANDLE.

5.23 SQLNumResultCols (ODBC 1.0, Core)

SQLNumResultCols returns the number of columns in a result set.

5.23.1 Synopsis

```
RETCODE SQLNumResultCols(hstmt, pccol)
```

The SQLNumResultCols function accepts the following arguments.

Table 5.17. SQLNumResultCols Arguments

Type	Argument	Use	Description
HSTMT	*hstmt*	Input	Statement handle.

Type	Argument	Use	Description
SWORD FAR *	*pccol*	Output	Number of columns in the result set.

5.23.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_STILL_EXECUTING, SQL_ERROR, or SQL_INVALID_HANDLE.

5.24 SQLPrepare (ODBC 1.0, Core)

`SQLPrepare` prepares a SQL string for execution.

5.24.1 Synopsis

```
RETCODE SQLPrepare(hstmt, szSqlStr, cbSqlStr)
```

The `SQLPrepare` function accepts the following arguments.

Table 5.18. SQLPrepare Arguments

Type	Argument	Use	Description
HSTMT	*hstmt*	Input	Statement handle.
UCHAR FAR *	*szSqlStr*	Input	SQL text string.
SDWORD	*cbSqlStr*	Input	Length of *szSqlStr*.

5.24.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_STILL_EXECUTING, SQL_ERROR, or SQL_INVALID_HANDLE.

5.25 SQLRowCount (ODBC 1.0, Core)

`SQLRowCount` returns the number of rows affected by an UPDATE, INSERT, or DELETE statement or by a SQL_UPDATE, SQL_ADD, or SQL_DELETE operation in `SQLSetPos`.

5.25.1 Synopsis

```
RETCODE SQLRowCount(hstmt, pcrow)
```

The `SQLRowCount` function accepts the following arguments.

Table 5.19. SQLRowCount Arguments

Type	Argument	Use	Description
HSTMT	*hstmt*	Input	Statement handle.
SDWORD FAR *	*pcrow*	Output	For UPDATE, INSERT, and DELETE statements, *pcrow* is the number of rows affected by the request or -1 if the number of affected rows is not available. For other statements and functions, the driver may define the value of pcrow. For example, some data sources may be able to return the number of rows returned by a SELECT statement or a catalog function before fetching the rows. Note: Many data sources cannot return the number of rows in a result set before fetching them; for maximum interoperability, applications should not rely on this behavior.

5.25.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_ERROR, or SQL_INVALID_HANDLE.

5.26 SQLSetCursorName (ODBC 1.0, Core)

`SQLSetCursorName` associates a cursor name with an active *hstmt*. If an application does not call `SQLSetCursorName`, the driver generates cursor names as needed for SQL statement processing.

5.26.1 Synopsis

```
RETCODE SQLSetCursorName(hstmt, szCursor, cbCursor)
```

The `SQLSetCursorName` function accepts the following arguments.

Table 5.20. SQLSetCursorName Arguments

Type	Argument	Use	Description
HSTMT	*hstmt*	Input	Statement handle.
UCHAR FAR *	*szCursor*	Input	Cursor name.
SWORD	*cbCursor*	Input	Length of *szCursor*.

5.26.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_ERROR, or SQL_INVALID_HANDLE.

5.27 SQLTransact (ODBC 1.0, Core)

`SQLTransact` requests a commit or rollback operation for all active operations on all *hstmt*s associated with a connection. `SQLTransact` can also request that a commit or rollback operation be performed for all connections associated with the *henv*.

5.27.1 Synopsis

```
RETCODE SQLTransact(henv, henv, fType)
```

The `SQLTransact` function accepts the following arguments.

Table 5.21. SQLTransact Arguments

Type	Argument	Use	Description
HENV	*henv*	Input	Environment handle.
HDBC	*henv*	Input	Connection handle.
UWORD	*fType*	Input	One of the following two values: SQL_COMMIT

Type	Argument	Use	Description
			SQL_ROLLBACK

5.27.2 Returns

SQL_SUCCESS, SQL_SUCCESS_WITH_INFO, SQL_ERROR, or SQL_INVALID_HANDLE.

5.28 Non-ODBC IBM solidDB Light Client Functions

This section describes the four non-ODBC functions supported in IBM solidDB Light Client:

1. `SQLFetchPrev`

   `SQLFetchPrev` fetches a previous row of data from a result set. Its functionality is identical to its ODBC API counterpart SQLFetch (for previous record). For details, read Section 5.17, “SQLFetch (ODBC 1.0, Core)”.

2. `SQLGetAnyData`

   `SQLGetAnyData` returns result data for a single unbound column in the current row. `SQLGetAnyData` functionality is identical to its ODBC API counterpart `SQLGetData`. For details on this function, read Section 5.22, “SQLGetData (ODBC 1.0, Level 1)”.

3. `SQLGetCol`

   `SQLGetCol` gets result data for a single column in the current row. This function allows the application to retrieve the data one column at a time. It may also be used to retrieve large data values in easily manageable blocks. `SQLGetCol` functionality is identical to its ODBC API counterpart `SQLGetData`. For details, read Section 5.22, “SQLGetData (ODBC 1.0, Level 1)”.

4. `SQLSetParamValue`

   Sets the value of a parameter marker in the SQL statement specified in `SQLPrepare`. Parameter markers are numbered sequentially from left-to-right, starting with one, and may be set in any order. The value of argument rgbValue will be used for the parameter marker when `SQLExecute` is called.

5.28.1 Synopsis

```
RETCODE SQLSetParamValue(hstmt, ipar, fCType, fSqlType,
cbColDef, ibScale, rgbValue, pcbValue)
```

The `SQLSetParamValue` function accepts the following arguments:

Table 5.22. SQLSetParamValue Arguments

Type	Argument	Use	Description
HSTMT	*hstmt*	Input	Statement handle.
UWORD	*ipar*	Input	Parameter number, ordered sequentially left to right, starting at 1.
SWORD	fCType	Input	The C data type of the result data. Check the allowed data type conversions at the end of this chapter. This must be one of the following values: SQL_C_BINARY SQL_C_CHAR SQL_C_DOUBLE SQL_C_FLOAT SQL_C_LONG SQL_C_SHORT
SDWORD	*fSqlType*	Input	The SQL data type of the parameter. Check the allowed data type conversions following this table. This must be one of the following values: SQL_C_BINARY SQL_C_CHAR SQL_DATE SQL_DECIMAL

Type	Argument	Use	Description
			SQL_C_DOUBLE SQL_C_FLOAT SQL_INTEGER SQL_LONGVARBINARY SQL_LONGVARCHAR SQL_NUMERIC SQL_REAL SQL_SMALLINT SQL_TIME SQL_TIMESTAMP SQL_TINYINT SQL_VARBINARY SQL_VARCHAR
UDWORD	*cbColDef*	Input	The precision of the column or expression of the corresponding parameter marker.
SWORD	*ibScale*	Input	The scale of the column or expression of the corresponding parameter marker.
PTR	*rgbValue*	Input	Output data.
SDWORD *	*pcbValue*	Input	Length of data in rgbValue

fCType describes the contents of *rgbValue*. *fCType* must either be SQL_C_CHAR or the C equivalent of argument *fSqlType*. If *fCType* is SQL_C_CHAR and *fSqlType* is a numeric type, *rgbValue* will be converted from a character string to the type specified by *fSqlType*.

fSqlType is the data type of the column or expression referenced by the parameter marker. At execute time, the value in *rgbValue* will be read and converted from *fCType* to *fSqlType*, and then sent to IBM solidDB. Note that the value of *rgbValue* remains unchanged.

cbColDef is the length or precision of the column definition for the column or expression referenced. *cbColDef* differs depending on the class of data as follows:

Table 5.23. cbColDef Differentiation

Type	Description
SQL_CHAR SQL_VARCHAR	maximum length of the column
SQL_DECIMAL SQL_NUMERIC	maximum decimal precision (that is, total number of digits possible)

ibScale is the total number of digits to the right of the decimal point for the column referenced. *ibScale* is defined only for the SQL_DECIMAL and SQL_NUMERIC data types. *rgbValue* is a character string that must contain the actual data for the parameter marker. The data must be of the form specified by the *fCType* argument.

pcbValue is an integer that is the length of the parameter marker value in *rgbValue*. It is only used when *fCType* is SQL_C_CHAR or when specifying a null database value. The variable must be set to SQL_NULL_DATA if a null value is to be specified for the parameter marker. If the variable is set to SQL_NTS then *rgbValue* will be treated as a null terminated string.

5.28.2 Returns

SQL_SUCCESS, SQL_ERROR, or SQL_INVALID_HANDLE.

5.28.3 Diagnostics

- If the data identified by the *fcType* argument cannot be converted to the data value identified by the *fSqlType* argument, SQL_ERROR is returned:

```
07006 - Restricted data type attribute violation
```

- If the *fcType* argument is not valid, SQL_ERROR is returned:

```
S1003 - Program type out of range
```

- If the *fSqlType* argument is not valid, SQL_ERROR is returned:

```
S1004 - SQL data type out of range
```

- If the *ipar* argument is less than 1, SQL_ERROR is returned:

```
S1009 - Invalid argument value
```

5.28.4 Comments

All parameters set by this function remain in effect until either SQLFreeStmt is called with the SQL_UNBIND_PARAMS or SQL_DROP option or SQLSetParamValue is called again for the same parameter number. When a SQL statement containing parameters is executed, the set values of the parameters are sent to IBM solidDB.

Note that the number of parameters must match exactly the number of parameter markers present in the statement that was prepared. If less parameter values are set than there were parameter markers in the SQL statement, NULL values will be used instead.

5.28.5 Code Example

The code example below prepares a simple statement INSERT INTO TESTTABLE (I,C) VALUES (?,?) to be executed several times with different parameter values.

```
...
    char buf[255];
    SDWORD dwPar;
...
    rc = SQLPrepare(hstmt,(UCHAR*)"INSERT INTO TESTTABLE(I,C)
    VALUES (?,?)",SQL_NTS);
    if (SQL_SUCCESS != rc) {
         printf("Prepare failed. \n");
    }
    for (i=1;i<100;i++)
    {
```

```
    dwPar = i;
    sprintf(buf,"line%i",i);

rc = SQLSetParamValue(
hstmt,1,SQL_C_LONG,SQL_INTEGER,0,0,&dwPar,NULL );
if (SQL_SUCCESS != rc) {
    printf("(SetParamValue 1 failed) \n");
            return 0;
        }

rc = SQLSetParamValue(
hstmt,2,SQL_C_CHAR,SQL_CHAR,0,0,buf,NULL );
if (SQL_SUCCESS != rc) {
    printf("(SetParamValue 1 failed) \n");
            return 0;> >
    }
```

5.28.6 Related Functions

Table 5.24. Related Functions

For information about	See
Preparing a statement for execution	SQLPrepare
Executing a prepared SQL statement	`SQLExecute`
Executing a SQL statement	`SQLExecDirect`

5.28.7 IBM solidDB Light Client Type Conversion Matrix

The table below describes the type conversions provided by the IBM solidDB Light Client functions `SQLGetCol` and `SQLSetParamValue`.

Abbreviations used in the tables for the C variable data types are as follows:

Table 5.25. Abbreviations in C Variable Data Types

Abbreviation	API parameter definition	C variable data types
Bin	SQL_C_BINARY	void*
Char	SQL_C_CHAR	char[ ], char*
Long	SQL_C_LONG	long int (*), 32 bits

Abbreviation	API parameter definition	C variable data types
Short	SQL_C_SHORT	short int (*), 16 bits
Float	SQL_C_FLOAT	float (*)
Double	SQL_C_DOUBLE	double (*)

(*) Note that when variables of these data types are used as parameters in Light Client functions calls, actually the pointer to the variable must be passed instead.

Refer to Section 3.3.4, “Data Types” for a description of SQL data types.

Functions `SQLGetCol` and `SQLGetData` perform the following data type conversions between database column types and C variable data types:

Table 5.26. Conversions between Database Column Types and C Variable Data Types

SQL data type \ C variable data type	Bin	Char	Long	Short	Float	Double
TINYINT	*	*	*	*	*	*
LONG VARBINARY	*	*				
VARBINARY	*	*				
BINARY	*	*				
LONG VARCHAR	*	*				
CHAR	*	*				
NUMERIC		*	*	*	*	*
DECIMAL		*	*	*	*	*
INTEGER	*	*	*	*	*	*
SMALLINT	*	*	*	*	*	*
FLOAT	*	*	*	*	*	*
REAL	*	*	*	*	*	*
DOUBLE	*	*	*	*	*	*
DATE		*				
TIME		*				
TIMESTAMP		*				
VARCHAR	*	*				

Function `SQLSetParamValue` provides the following type conversions between C data types and the database column types.

Table 5.27. Conversions between Database Column Types and C Variable Data Types

SQL data type \ C variable data type	Bin	Char	Long	Short	Float	Double
TINYINT		*	*	*		
LONG VARBINARY	*					
VARBINARY	*					
BINARY	*					
LONG VARCHAR		*				
CHAR		*				
NUMERIC		*	*	*	*	*
DECIMAL		*	*	*	*	*
INTEGER		*	*	*		
SMALLINT		*	*	*		
FLOAT		*	*	*	*	*
REAL		*	*	*	*	*
DOUBLE		*	*	*	*	*
DATE		*				
TIME		*				
TIMESTAMP		*				
VARCHAR		*				

Chapter 6. Using the IBM solidDB JDBC Driver

This chapter describes how to use the IBM solidDB JDBC Driver. The IBM solidDB JDBC Driver 2.0 is a JDBC type 4 driver for IBM solidDB Database Engine 4.0 and later. "Type 4" means that this is a 100% Pure JavaTM implementation of the Java Database Connectivity (JDBCTM) 2.1 standard. It has been tested with JDK versions 1.3 and above.

This chapter covers the following information:

- What is IBM solidDB JDBC Driver?
- Getting started with IBM solidDB JDBC Driver
- Running SQL statement with IBM solidDB JDBC Driver
- Connecting to a IBM solidDB server through JDBC
- Solid JDBC Driver interfaces and methods
- Sample code

6.1 What Is IBM solidDB JDBC Driver?

The JDBC API defines Java classes to represent database connections, SQL statements, result sets, database metadata, etc. It allows a Java programmer to issue SQL statements and process the results. JDBC is the primary API for database access in Java. More information on the JDBC technology can be found at the JDBC Technology Homepage (http://java.sun.com/products/jdbc/).

IBM solidDB's JDBC driver is written entirely in Java and communicates directly with the IBM solidDB server using the TCP/IP network protocol. The IBM solidDB driver does not require any additional database access libraries, such as ODBC. The driver does, of course, require that a JRE (Java Run-time Environment) or JDK be available.

The IBM solidDB JDBC Driver is a Solid implementation of the JDBC 2.1 standard. It is usable in all Java environments supporting JDK 1.3 and above.

IBM solidDB JDBC Driver offers JDBC standard compliance and is 100% pure Java certified. It is compatible with IBM solidDB Database Engine 4.0 and later.

6.2 Getting Started with IBM solidDB JDBC Driver

To get started with IBM solidDB JDBC Driver, be sure you have:

1. Installed the JDBC Driver and verified the installation. For details, follow the instructions on the IBM solidDB JDBC Driver Web site.

2. Set up the development environment so that it supports JDBC properly. IBM solidDB JDBC Driver expects support for JDBC version 2.0x. The JDBC interface is included in the `java.sql` package. To import this package, be sure to include the following line in the application program:

```
import java.sql.*;
```

6.2.1 Registering IBM solidDB JDBC Driver

The JDBC driver manager handles loading and unloading drivers and interfacing connection requests with the appropriate driver. The driver can be registered as shown below. After execution of this code, the driver registers itself in the *`DriverManager`*.

```
// registration using Class.forName service
Class.forName("solid.jdbc.SolidDriver");
```

See the source code for the Sample 1 application in Section 6.7, “Code Examples”.

6.2.2 Connecting to the Database

Once the driver is successfully registered with the driver manager, a connection is established by creating an instance of `java.sql.Connection` with the following code. The parameter required by the `DriverManager.getConnection` function is the JDBC connection string. The JDBC connection string identifies which computer the database server is running on; the string also contains other information required to connect to the server.

```
Connection conn = null;
// sCon is the JDBC connection string
(jdbc:solid://hostname:port/login/password)
String sCon = "jdbc:solid://fb9:1314/dba/dba";
try {
```

```
    conn =  DriverManager.getConnection(sCon);
} catch (SQLException e) {
    System.out.println("Connect failed : " + e.getMessage());
}
```

The connect string structure is:

```
jdbc:solid://machine_name:port/user name/password
```

The string

```
"jdbc:solid://fb9:1314/dba/dba"
```

attempts to connect to a IBM solidDB server in machine fb9 listening to the tcp/ip protocol at port 1314.

The application can establish multiple connections to the database by using multiple Connection objects. Developers should manage connection lifecycle in a very accurate way, otherwise there can be a lot of conflicts between concurrent users and applications trying to access the database. You can find details and instructions in the Code Examples.

In this reference, we describe issues related to the IBM solidDB products, and generic information about the JDBC usage may be found at the Sun Java Developers' website: http://java.sun.com/developer/onlineTraining/distributed/index.html

See the source code for the Sample 1 application in Section 6.7, “Code Examples”.

Note

The IBM solidDB JDBC Driver only supports a connection for administration options, with no queries allowed. For this type of connection, set the *`java.util.Properites name ADMIN_USER`* to true. After it is set to true and a connection is established, then only ADMIN commands are allowed.

Transactions and Autocommit Mode

As the JDBC specification defines, a connection to the IBM solidDB database can be in either autocommit or non-autocommit mode. When not in autocommit mode, each transaction needs to be explicitly committed before the modifications it made can be seen by other database connections. The autocommit state can be monitored by `Connection.getAutoCommit()` method. The state can be set by `Connection.setAutoCommit()`. A IBM solidDB server's default setting for autocommit state is *`true`*. If autocommit mode is off, then the transactions can be committed in two ways.

- calling the `Connection.commit()` method, or
- executing a statement for SQL 'COMMIT WORK'

Handling Database Errors

Database errors in JDBC are handled and managed by the exception mechanism, which is one of the Java language's strengths. Most of the methods, specified in JDBC interfaces, may throw an instance of SQLException. As these errors may appear in the normal application workflow (representing concurrency conflicts, for instance) your code should be tolerant to such and errors. Basically, you must not leave your connections in any other state than "closed" regardless of the result of your code's execution. This approach allows avoiding situations where all available connections remain open due to unhandled exceptions.

You can get an exception's error code by calling `e.getErrorCode()`. For native error codes, see the appendix, "Error Codes" in *IBM solidDB Administration Guide*.

The following code example shows a proper way of handling errors coming from the database:

```
Public void listTablesExample() {
    try {
        Class.forName("solid.jdbc.SolidDriver");
    } catch (ClassNotFoundException e) {
        System.err.println("Solid JDBC driver is not registered
    in the classpath");
        return; //exit from the method
    }
    Connection conn = null;
    Statement stmt = null;
    ResultSet rs = null;
    try {
        conn = DriverManager.getConnection("jdbc:solid://
        localhost:1313", "dba", "dba");
        stmt = conn.createStatement();
        rs = stmt.executeQuery("SELECT * FROM tables");
        while (rs.next()) {
            System.out.println(rs.getObject(0));//printing
        out results
        }
    } catch (SQLException e) {
        e.printStackTrace();
    } finally {
```

```
        /* It's a good idea to release
    resources in a finally{} block
    in reverse-order of their creation
    if they are no-longer needed
    */
        if (rs != null) {
            try {
                rs.close();
            } catch (SQLException sqlEx) { // ignore
                rs = null;
            }
        }
        if (stmt != null) {
            try {
                stmt.close();
            } catch (SQLException sqlEx) { // ignore
                stmt = null;
            }
        }
    }
    if (conn != null)
        try {
            conn.close();
        } catch (SQLException e) {
            e.printStackTrace();
        } finally {
            conn = null;
        }
}
```

6.3 Special Notes About IBM solidDB and JDBC

JDBC does not really specify what SQL dialect you can use; it simply passes the SQL on to the driver and lets the driver either pass it on directly to the database, or parse the SQL itself. Because of this, the IBM solidDB JDBC Driver behavior is particular to IBM solidDB. In some functions the JDBC specification leaves some details open. Check Section 6.4, “JDBC Driver Interfaces and Methods” for the details particular to IBM solidDB's implementation of the methods.

The IBM solidDB JDBC Driver provides support for catalogs and schemas in IBM solidDB.

6.3.1 Executing Stored Procedures

In a IBM solidDB database, stored procedures can be called by executing statements 'CALL *proc_name* [(*parameter* ...)]' as in any other SQL statement. Procedures can also be used in JDBC in the same way, through a standard `CallableStatement` interface.

Note

IBM solidDB stored procedures can return result sets. Calling procedures through the JDBC `CallableStatement` interface is not necessary. For an example of calling IBM solidDB procedures using JDBC, see the source code for the Sample 3 application in Section 6.7, “Code Examples”.

6.4 JDBC Driver Interfaces and Methods

IBM solidDB provides the JDBC 2.1 and the driver Javadoc with the Solid JDBC driver v. 2.1 or higher. There you can find some IBM solidDB-specific differences from the standard API. You can browse standard packages and interfaces in the `java.sql` and `javax.sql` packages, and see details of a particular implementation by checking the list of "All Known Implementing Classes".

For a description of how different data types are supported by IBM solidDB JDBC Driver, see the JDBC Driver Type Conversion Matrix at the end of this chapter.

6.4.1 Array

The `java.sql.Array` interface is not supported. This interface is used to map SQL type Array in the Java programming language. It reflects the SQL-99 standard that is currently unavailable in IBM solidDB.

6.4.2 Blob

The `java.sql.Blob` interface is not supported. This interface is used to map SQL type Blob in the Java programming language. It reflects the SQL-99 standard that is currently unavailable in IBM solidDB.

6.4.3 CallableStatement

A `java.sql.CallableStatement` interface is intended to support calling database stored procedures. Thus, IBM solidDB stored procedures are used in JDBC in the same way as any statement; the use of class `CallableStatement` is not necessary when you are writing applications on a IBM solidDB server only. However, for portability reasons, using `CallableStatement` is a wise choice.

Note that the JDBC Driver allows for the creation of a Statement object that generates `ResultSet` objects with the given type and concurrency. This differs from the `createStatement` method in JDBC 1.0 because it allows the default result set type and result set concurrency type to be overridden.

Differences with the standard API

Following are the differences from the standard `CallableStatement` interface defined in the JDBC API.

Table 6.1. Differences to the Standard CallableStatement Interface

Method name	Notes
getArray(int i)	Not supported by IBM solidDB.
getBlob(int i)	Not supported by IBM solidDB.
getClob(int i)	Not supported by IBM solidDB.
getDate(int parameterIndex, Calendar cal)	Works as specified in Java API. NOTE: Uses a given Calendar object to specify time zone and locale, different from default ones. The same rule corresponds to other similar methods operating with Calendar instances.
getObject (int i, Map map)	Not supported by IBM solidDB.
getRef(int i)	Not supported by IBM solidDB.
registerOutParameter(int parameterIndex, int sqlType, String typeName)	Not supported by IBM solidDB. This method throws an exception with the following message: "This method is not supported"

6.4.4 Clob

The `java.sql.Clob` interface is not supported. This interface is used to map SQL type Clob in the Java programming language. It reflects the SQL-99 standard that is currently unavailable in IBM solidDB.

6.4.5 Connection

The `java.sql.Connection` interface is a public interface. It is used to establish a connection (session) with a specified database. SQL statements are executed and results are returned within the context of a connection.

Differences with the standard API

Following are the differences from the standard `Connection` interface defined in the JDBC API.

Table 6.2. Differences to the Standard Connection Interface

Method name	Notes
getTypeMap()	IBM solidDB provides this method, but it always returns null.
isReadOnly()	IBM solidDB only supports read-only connections and read-only transactions if the database is declared as read-only. This method always returns false.
nativeSQL(String sql)	Works as specified in Java API. IBM solidDB JDBC Driver does not change the SQL passed to the IBM solidDB server. The SQL query the user passes is returned.
prepareCall(String sql)	Works as specified in Java API. Note that the escape call syntax is not supported.
setReadOnly(boolean readOnly)	IBM solidDB only supports read-only database and read-only transactions if the database is declared as read-only. This method exists but does not affect the connection behavior.
setTransactionIsolation(int level)	Works as specified in Java API.
setTypeMap(Map map)	Not supported by IBM solidDB.

6.4.6 DatabaseMetaData

The `java.sql.DatabaseMetaData` interface is a public abstract interface. It provides general, comprehensive information about the database.

All methods for this interface are supported by IBM solidDB.

For a description of how different data types are supported by IBM solidDB JDBC Driver, see Section 6.8, “IBM solidDB JDBC Driver Type Conversion Matrix” at the end of this chapter.

6.4.7 Driver

The `java.sql.Driver` interface is a public abstract interface. Every driver class implements this interface and all methods for this interface are supported by IBM solidDB.

6.4.8 PreparedStatement

The `java.sql.PreparedStatement` interface is a public abstract interface. It extends the statement interface. It provides an object that represents a precompiled SQL statement.

Note that the JDBC Driver allows for the creation of a PreparedStatement object that generates `ResultSet` objects with the given type and concurrency. This differs from the prepareStatement method in JDBC 1.0 because it allows the default result set type and result set concurrency type to be overridden.

Subinterfaces:

CallableStatement

Differences with the standard API

Following are the differences from the standard `PreparedStatement` interface defined in the JDBC API.

Table 6.3. Differences to the Standard PreparedStatement Interface

Method name	Notes
setArray(int i, Array x)	Not supported by IBM solidDB.
setBlob(int I, Blob x)	Not supported by IBM solidDB.
setClob(int I, Clob x)	Not supported by IBM solidDB.
setObject(int parameterIndex, Object x)	Works as specified in Java API. NOTE: following objects are not supported by IBM solidDB: BLOB, CLOB, ARRAY, REF, and object (USING java.util.Map).
setObject(int parameterIndex, Object x, int targetSql-Type))	Not supported by IBM solidDB. This method throws an exception with the following message: "This method is not supported"
setObject(int parameterIndex, Object x, int targetSQL-Type, int scale)	Not supported by IBM solidDB. This method throws an exception with the following message: "This method is not supported"
setRef(int I, Ref x)	Not supported by IBM solidDB.

6.4.9 Ref

The `java.sql.Ref` interface is a public abstract interface.

This interface is a reference to an SQL structured type value in the database. This interface is not supported by IBM solidDB.

6.4.10 ResultSet

The `java.sql.ResultSet` interface is a table of data that represents a database result set from a query statement. This object includes a cursor that points to its current row of data. The cursor's initial position is before the first row. It is moved to the next row by the next method. When there are no more rows left in the result set, the method returns false; this allows the use of a WHILE loop to iterate through the result set.

Differences with the standard API

Following are the differences from the standard `ResultSet` interface defined in the JDBC API.

Table 6.4. Differences to the Standard ResultSet Interface

Method name	Notes
getArray(int i)	Not supported by IBM solidDB.
getArray(String ColName)	Not supported by IBM solidDB.
getBigDecimal(String columnName)	Works as specified in Java API.
getCharacterStream(int columnIndex)	Works as specified in Java API. NOTE: The JDBC Driver sets the designated parameter to the given Reader object at the given character length. When a large UNICODE value is input to a LONG VARCHAR/LONG WVARCHR parameter, for convenience, you can send it via a java.io.Reader. The JDBC Driver reads the data from the stream as needed, until it reaches end-of-file. The driver does all the necessary conversion from UNICODE to the database CHAR format.
getCharacterStream(String columnName)	Works as specified in Java API. The note above also applies to this method.
getFetchSize()	Not supported by IBM solidDB.
getObject(int columnIndex)	Works as specified in Java API. NOTE: following objects are not supported by IBM solidDB: BLOB, CLOB, ARRAY, REF, and object (USING java.util.Map).

Method name	Notes
getObject(int i, Map map)	Not supported by IBM solidDB.
getObject(String colName, Map map)	Not supported by IBM solidDB. This method throws an exception with the following message: "This method is not supported"
getRef(int i)	Not supported by IBM solidDB.
getRef(String colName)	Not supported by IBM solidDB.
refreshRow()	Not supported by IBM solidDB.
setFetchSize(int rows)	No operation in IBM solidDB. Sets the value for the number of rows to be fetched from the database each time. The value a user sets with this method is ignored.

6.4.11 ResultSetMetaData

The `java.sql.ResultSetMetaData` interface is a public abstract interface. This interface is used to find out about the types and properties of the columns in a ResultSet.

6.4.12 SQLData

The `java.sql.SQLData` interface is not supported. This interface is used to custom map SQL user-defined types. It reflects the SQL-99 standard that is currently unavailable in IBM solidDB.

6.4.13 SQLInput

The `java.sql.SQLInput` interface is not supported. This interface is an input stream that represents an instance of an SQL structured or distinct type. It reflects the SQL-99 standard that is currently unavailable in IBM solidDB.

6.4.14 SQLOutput

The `java.sql.SQLOutput` interface is not supported. This interface is an output stream used to write the attributes of a user-defined type back to the database. It reflects the SQL-99 standard that is currently unavailable in IBM solidDB.

6.4.15 Statement

The `java.sql.Statement` interface is a public abstract interface. It is the object used to execute a static SQL statement and obtain the results of the execution.

Note that the JDBC Driver allows for the creation of a Statement object that generates ResultSet objects with the given type and concurrency. This differs from the `CreateStatement` method in JDBC 1.0 because it allows the default result set type and result set concurrency type to be overridden.

Subinterfaces:

`CallableStatement`, `PreparedStatement`

Differences with the standard API

Following are the differences from the standard Statement interface defined in the JDBC API.

Table 6.5. Differences to the Standard Statement Interface

Method name	Notes
getFetchSize()	No operation in IBM solidDB.
getMaxFieldSize()	Maxfield size does not affect the IBM solidDB server's behavior.
getMoreResults()	IBM solidDB does not support multiple result sets.
getResultSetType()	Not supported by IBM solidDB.
setFetchSize(int rows)	No operation in IBM solidDB. Sets the value for the number of rows to be fetched from the database each time. The value a user sets with this method is ignored.
setMaxFieldSize(int max)	Maxfield size does not affect the IBM solidDB server's behavior.

6.4.16 Struct

The `java.sql.Struct` interface is not supported. This interface represents the standard mapping in the Java programming language for an SQL structured type. It reflects the SQL-99 standard that is currently unavailable in IBM solidDB.

6.4.17 ResultSet (updateable)

The `java.sql.Resultset` interface contains methods for producing `ResultSet` objects that are updateable. A result set is updateable if its concurrency type is CONCUR_UPDATABLE. Rows in the result set may be updated, deleted, or new rows inserted using methods update xxx, where xxx refers to the datatype and methods `updateRow` and `deleteRow`.

Differences with the standard API

Following are the differences from the standard `ResultSet` interface defined in the JDBC API.

Table 6.6. Differences to the Standard ResultSet Interface

Method name	Notes
getRef(int i)	This method is not supported.
getRef(String colName)	This method is not supported.
refreshRow()	This method is not supported.
rowDeleted()	This method is not supported.
rowInserted()	This method is not supported.
setFetchSize(int rows)	This method is not supported.

6.5 JDBC Driver Enhancements

6.5.1 WebSphere Compatibility

IBM solidDB Data Store Helper Class in WebSphere

WebSphere needs an adapter class for those JDBC data sources that are to be used within WebSphere. The base class for these adapters is class:

com.ibm.websphere.rsadapter.GenericDataStoreHelper

and IBM solidDB implements its own version of this adapter inside a class called:

com.ibm.websphere.rsadapter.SolidDataStoreHelper

This class, in turn, is provided within the IBM solidDB product as a separate archive file called `SolidDataStoreHelper.jar` You can find this file in the same directory with the JDBC driver jar file in the IBM solidDB product distribution directory tree.

When you are configuring a new IBM solidDB data source in WebSphere, you need to give the class

com.ibm.websphere.rsadapter.SolidDataStoreHelper

in the data store helper field of the configuration. Also, you need to specify the full path to the `SolidDataStoreHelper.jar` file in the data source configuration of WebSphere. See IBM's documentation for further

details how to define new data sources in WebSphere and Solid 'websphere' sample section for how to install the IBM solidDB's WebSphere sample application in the Websphere Studio Application Developer's workspace.

IBM solidDB Data Source Properties and WebSphere

You need to define the following properties when configuring a new data source in the WebSphere:

URL

- type: java.lang.String
- value should be something like: 'jdbc:solid://<hostname>:<port>'

user

- type: java.lang.String
- value should be a valid user name

password

- type: java.lang.String
- value should be a valid password

6.5.2 Connection Timeout in JDBC

By connection timeout we mean response timeout of any JDBC call invoking data transmission over a connection socket. If the response message is not received within the time specified, an I/O exception is thrown. The JDBC standard (2.0/3.0) does not support setting of the connection timeout. IBM solidDB has introduced two ways for doing that: one using a non-standard driver manager extension method and the other one using the property mechanisms. The time unit in either case is one millisecond.

Driver Manager Method get/setConnectionTimeout()

The following example illustrates the solution. The effect of the setting is immediate. This allows to set the timeout to zero if you want to force-disconnect.

```
//Import Solid JDBC:
import solid.jdbc.*;

//Define the connection:
```

```
solid.jdbc.SolidConnection conn = null;

//Cast to SolidConnection in order to use Solid-specific methods:
conn = (SolidConnection)java.sql.DriverManager.getConnection(sCon);

//Set connection timeout in milliseconds:
conn.setConnectionTimeout(3000);
```

6.5.3 Statement Cache Property

IBM solidDB JDBC driver introduces a property for setting the value of the connection's statement cache. The name of the property is "StatementCache" and the default size of the cache is 8. Below is a small example how to use the property.

```
// create a Solid JDBC driver instance
Class.forName("solid.jdbc.SolidDriver");

// create a new Properties instance and insert a value for
// StatementCache property
java.util.Properties props = new java.util.Properties();
props.put("StatementCache","32");

// define the connection string to be used
String sCon="jdbc:solid://localhost:1315/uname1/pwd1";

// get the Connection object with a statement cache of 32
java.sql.Connection conn = java.sql.DriverManager.getConnection(sCon, props);
```

6.5.4 Timeout Setting as a Connection Property

In IBM solidDB, you can set the timeout value by using a property called CONNECTION_TIMEOUT_MS. The property must be set before getting a new connection. Once a connection object is created, changing the property value has no effect. See below for a code example:

```
// Set connection timeout with CONNECTION_TIMEOUT_MS property //
public class Test {

  public static void main( String args[] ){

    // create property object
```

```
    Properties props = new Properties();

    // put username and password in the properties
    props.put("user", "MYUSERNAME");
    props.put("password", "MYPASSWORD");

    //
    // Put connection timeout in the property object
    //
    props.put("CONNECTION_TIMEOUT_MS", "10000");

    try {

      // create driver
      Driver d = (Driver)(
          Class.forName("solid.jdbc.SolidDriver").newInstance());

      // get connection with url and property info
      Connection c = DriverManager.getConnection(
          "jdbc:solid://localhost:1313", props );

      // close connection
      c.close();

    } catch ( Exception e ) {
      ; // save the day
    }
  }
}
```

6.6 JDBC 2.0 Optional Package API Support

The IBM solidDB JDBC 2.1 Driver supports some features of the JDBC 2.0 specification optional package (known before as Standard Extension). Currently these features are part of the JDBC 3.0 standard API, but we still regard them as an "optional package", because these functionalities have not been officially certified.

6.6.1 JDBC Connection Pooling

The JDBC 2.0 Standard Extension API specifies that users can implement a pooling technique by using specific caching or pooling algorithms that best suit their needs. A JDBC driver vendor must provide classes that

implement the standard ConnectionPoolDataSource and PooledConnection interfaces. IBM solidDB implements these classes as follows:

- ConnectionPoolDataSource

  A `javax.sql.ConnectionPoolDataSource` interface serves as a resource manager connection factory for pooled `java.sql.Connection` objects. IBM solidDB provides the implementation for that interface in class `SolidConnectionPoolDataSource`. For API functions, see *ConnectionPoolDataSource API functions* in Section 6.6.1, "JDBC Connection Pooling".

- PooledConnection

  A `javax.sql.PooledConnection` interface encapsulates the physical connection to a database. IBM solidDB provides the implementation for that interface in class `SolidPooledConnection`. For API functions, see the section called "PooledConnection API Functions".

Note

IBM solidDB does not provide an implementation for the actual connection pool (i.e. the data structure and the logic to actually pool the PooledConnection instances). In other words, users must implement their own connection pooling logic (that is, a class that actually pools the connections).

ConnectionPoolDataSource API Functions

The public class `SolidConnectionPoolDataSource` implements `javax.sql.ConnectionPoolDataSource`. The API functions for `javax.sql.ConnectionPoolDataSource` interface are:

Table 6.7. Constructor

Description type	Description
Function Name	Constructor
Function Type	IBM solidDB proprietary API
Description	Initializes class variables
Parameters	None
Return value	None
Syntax and exceptions	public SolidConnectionPoolDataSource()

Table 6.8. Constructor

Description type	Description
Function Name	Constructor
Function Type	IBM solidDB proprietary API
Description	Initializes class variables
Parameters	url As String which identifies the DB server
Return value	None
Syntax and exceptions	public SolidConnectionPoolDataSource(String urlStr)

Table 6.9. setDescription

Description type	Description
Function Name	setDescription
Function Type	IBM solidDB proprietary API
Description	This function sets the description string.
Parameters	description string (descString)
Return value	None
Syntax and exceptions	public void setDescription(String descString)

Table 6.10. getDescription

Description type	Description
Function Name	getDescription
Function Type	IBM solidDB proprietary API
Description	This function returns the description string.
Parameters	None
Return value	returns a String (description)
Syntax and exceptions	public String getDescription()

Table 6.11. setURL

Description type	Description
Function Name	setURL

Description type	Description
Function Type	IBM solidDB proprietary API
Description	This function sets the url string which points to a IBM solidDB server.
Parameters	url string (urlStr)
Return value	None
Syntax and exceptions	public void setURL(String urlStr)

Table 6.12. getURL

Description type	Description
Function Name	getURL
Function Type	IBM solidDB proprietary API
Description	This function returns the DB url string.
Parameters	None
Return value	returns a String (url)
Syntax and exceptions	public String getURL()

Table 6.13. setUser

Description type	Description
Function Name	setUser
Function Type	IBM solidDB proprietary API
Description	This function sets the username string. (WebSphere compatibility)
Parameters	username string
Return value	None
Syntax and exceptions	public void setUser(String newUser)

Table 6.14. getUser

Description type	Description
Function Name	getUser
Function Type	IBM solidDB proprietary API
Description	This function returns the username string. (WebSphere compatibility)

Description type	Description
Parameters	None
Return value	returns a String (username)
Syntax and exceptions	public String getUser()

Table 6.15. setPassword

Description type	Description
Function Name	setPassword
Function Type	IBM solidDB proprietary API
Description	This function sets the password string. (WebSphere compatibility)
Parameters	password string
Return value	None
Syntax and exceptions	public void setPassword(String newPassword)

Table 6.16. getPassword

Description type	Description
Function Name	getPassword
Function Type	IBM solidDB proprietary API
Description	This function returns the password string. (WebSphere compatibility)
Parameters	None
Return value	returns a String (password)
Syntax and exceptions	public String getPassword()

Table 6.17. setConnectionURL

Description type	Description
Function Name	setConnectionURL
Function Type	IBM solidDB proprietary API
Description	This function sets the url string which points to a IBM solidDB server.
Parameters	url string
Return value	None

Description type	Description
Syntax and exceptions	public void setConnectionURL(String newUrl)

Table 6.18. getConnectionURL

Description type	Description
Function Name	getConnectionURL
Function Type	IBM solidDB proprietary API
Description	This function returns the url string.
Parameters	None
Return value	returns a String (url)
Syntax and exceptions	public String getConnectionURL()

Table 6.19. getLoginTimeout

Description type	Description
Function Name	getLoginTimeout
Function Type	javax.sql.ConnectionPoolDataSource API
Description	This function returns the login timeout value.
Parameters	None
Return value	returns a timeout value as an integer (seconds)
Syntax and exceptions	public int getLoginTimeout() throws java.sql.SQLException

Table 6.20. getLogWriter

Description type	Description
Function Name	getLogWriter
Function Type	javax.sql.ConnectionPoolDataSource API
Description	This function returns the handle to a writer used for printing debugging messages.
Parameters	None
Return value	returns a handle to java.io.PrintWriter
Syntax and exceptions	public java.io.PrintWriter getLogWriter() throws java.sql.SQLException

Table 6.21. getPooledConnection

Description type	Description
Function Name	getPooledConnection
Function Type	javax.sql.ConnectionPoolDataSource API
Description	This function returns a PooledConnection object from the connection pool. This object has a valid connection to the database server.
Parameters	None
Return value	returns a PooledConnection object.
Syntax and exceptions	public javax.sql.PooledConnection getPooledConnection() throws java.sql.SQLException

Table 6.22. getPooledConnection

Description type	Description
Function Name	getPooledConnection
Function Type	javax.sql.ConnectionPoolDataSource API
Description	This function returns a PooledConnection object from the connection pool. This object has a valid connection to the database server.
Parameters	user (username as String), password (password as String)
Return value	returns a PooledConnection object.
Syntax and exceptions	public javax.sql.PooledConnection getPooledConnection(String user, String password) throws java.sql.SQLException

Table 6.23. setLoginTimeout

Description type	Description
Function Name	setLoginTimeout
Function Type	javax.sql.ConnectionPoolDataSource API
Description	This function sets the login timeout value in seconds
Parameters	seconds (as integer)
Return value	None

Description type	Description
Syntax and exceptions	public void setLoginTimeout(int seconds)

Table 6.24. setLogWriter

Description type	Description
Function Name	setLogWriter
Function Type	javax.sql.ConnectionPoolDataSource API
Description	This function sets the handle to a writer object that will be used to print/log debug messages.
Parameters	handle to java.io.PrintWriter
Return value	None
Syntax and exceptions	public void setLogWriter(java.io.PrintWriter out) throws java.sql.SQLException

PooledConnection API Functions

The public class `SolidPooledConnection` implements `javax.sql.PooledConnection`. The API functions for `javax.sql.PooledConnection` interface are:

Table 6.25. addConnectionEventListener

Description type	Description
Function Name	addConnectionEventListener
Function Type	javax.sql.PooledConnection API
Description	Adds an event listener to whom this object should notify when it wants to release the connection. This listener is generally the connection pooling module.
Parameters	listener (handle to javax.sql.ConnectionEventListener)
Return value	None
Syntax and exceptions	public void addConnectionEventListener(javax.sql.ConnectionEventListener listener)

Table 6.26. close

Description type	Description
Function Name	close
Function Type	javax.sql.PooledConnection API
Description	This function closes the physical connection.
Parameters	None
Return value	None
Syntax and exceptions	public void close() throws java.sql.SQLException

Table 6.27. getConnection

Description type	Description
Function Name	getConnection
Function Type	javax.sql.PooledConnection API
Description	returns a handle to java.sql.Connection
Parameters	None
Return value	java.sql.Connection
Syntax and exceptions	public java.sql.Connection getConnection() throws java.sql.SQLException

Table 6.28. removeConnectionEventListener

Description type	Description
Function Name	removeConnectionEventListener
Function Type	javax.sql.PooledConnection API
Description	This function removes the reference to the listener
Parameters	listener
Return value	None
Syntax and exceptions	public void removeConnectionEventListener(javax.sql.ConnectionEventListener listener)

6.6.2 IBM solidDB Connected RowSet Class: SolidJDBCRowSet

This RowSet extends solid.jdbc.SolidBaseRowSet (which implements javax.sql.RowSet) constructors:

```
/**
 * Create a SolidJDBCRowSet with an existing Connection handle  */
public SolidJDBCRowSet(java.sql.Connection conn)

/**
 * Create a SolidJDBCRowSet with an existing ResultSet handle  */
public SolidJDBCRowSet(java.sql.ResultSet rset)

/**
 * Create a new SolidJDBCRowSet with given url, username and
 * password.
 */
public SolidJDBCRowSet(String url, String uname, String pwd)

/**
 * Create a new SolidJDBCRowSet with given url, username,
 * password and JNDI naming context.
 */
public SolidJDBCRowSet(String dsname,
                       String username,
                       String password,
                       Context namingcontext)
```

(see the method interface in, for example: http://java.sun.com/j2se/1.4.2/docs/api/javax/sql/RowSet.html

Notes about the Use of SolidJDBCRowSet

There are certain methods that you can call (usually for setting parameters for commands to be executed or setting the properties of the RowSet instance) before a Connection to the database has been made. However, most of the RowSet interface methods can be called only after a connection to the database has been made. In essence this means that method a command has been set with method `setCommand(String)` and method `execute()` has been called. If the SolidJDBCRowSet instance has no previous java.sql.Connection handle, the connection will be established during `execute()` call. After the `execute()` call the row set instance contains a java.sql.Connection object, a java.sql.PreparedStatement object and if the command execute was a query kind of statement, also a java.sql.ResultSet handle. It also contains all parameter setting methods: setString, setObject etc...

The following example sheds a little light to the proper use of SolidJDBCRowSet class.

```
/**
 * A simple example on how to use SolidJDBCRowSet
 * First: create  an instance of a connected RowSet class.
 * Naturally, you can give the url, username and password
 * right away in the constructor below, but null parameters
 * for the corresponding values have bee given in the example
 * just to show how to use setUrl, setUsername etc. methods of the
 * RowSet class.
 */
SolidJDBCRowSet rs = new SolidJDBCRowSet(null, null, null);

// Set the url for the connection
rs.setUrl("jdbc:solid://localhost:1313");

// set the username
rs.setUsername("user1");

// set the passwd
rs.setPassword("pwd1");


/**
 * Note! You can set command parameters and other properties
 * in any order you like, for example, you can set the parameters
 * before you have defined the command to be executed. You can
 * also define the command parameters in any order, since the
 * command statement as well as the given parameters won't be
 * parsed until a connection to the database has been made in
 * the execute() method call.
 */

// set parameter #2 for the command
rs.setString(2,"'SYS_SYNC%'");

// set the command string
rs.setCommand("select table_name from tables where table_name like ?
and table_name not like ?;");

// set the parameter #1
```

```
rs.setString(1,"'SYS_%'");

// execute the command. The connection to the database is not
// established before this call.
rs.execute();

// now you can browse the ResultSet
while( rowset.next() ){
   // do stuff
}

// close the result set. This method call closes the connection
// to the database as well.
rs.close()
```

6.6.3 Java Naming and Directory Interface (JNDI)

The Solid JDBC 2.0 Driver supports the Java Naming and Directory Interface (JNDI). JNDI allows applications to access naming and directory services through a common interface. JNDI is not a service, but a set of interfaces. These interfaces allow applications to access many different directory services including: file systems, directory services such as Lightweight Directory Access Protocol (LDAP), Network Information System (NIS), and distributed object systems such as the Common Object Request Broker Architecture (CORBA), Java Remote Method Invocation (RMI), and Enterprise JavaBeans (EJB).

6.7 Code Examples

Example 6.1. Java Code Example 1

```
/**
 *      sample1 JDBC sample application
 *
 *
 *      This simple JDBC application does the following using
 *      Solid JDBC driver.
 *
 *  1. Registers the driver using JDBC driver manager services
 *  2. Prompts the user for a valid JDBC connect string
 *  3. Connects to Solid using the driver
 *  4. Creates a statement for one query,
 *     'SELECT TABLE_SCHEMA,TABLE_NAME,TABLE_TYPE FROM TABLES'
```

```
 *     for reading data from one of the Solid system tables.
 *  5. Executes the query
 *  6. Fetches and dumps all the rows of a result set.
 *  7. Closes connection
 *
 *  To build and run the application
 *
 *  1. Make sure you have a working Java Development environment
 *  2. Install and start Solid to connect. Ensure that the
 *     server is up and running.
 *  3. Append SolidDriver2.0.jar into the CLASSPATH definition used
 *     by your development/running environment.
 *  4. Create a java project based on the file sample1.java.
 *  5. Build and run the application.
 *
 *  For more information read the readme.txt file contained in the
 *  solidDB package.
 *
 */

import java.io.*;

public class sample1 {

  public static void main (String args[]) throws Exception
  {
    java.sql.Connection conn;
    java.sql.ResultSetMetaData meta;
    java.sql.Statement stmt;
    java.sql.ResultSet result;
    int i;

    System.out.println("JDBC sample application starts...");
    System.out.println("Application tries to register the driver.");

    // this is the recommended way for registering Drivers
    java.sql.Driver d =
       (java.sql.Driver)Class.forName("solid.jdbc.SolidDriver").newInstance();

    System.out.println("Driver succesfully registered.");

    // the user is asked for a connect string
```

```
System.out.println(
    "Now sample application needs a connectstring in format:\n"
    );
System.out.println(
    "jdbc:solid://<host>:<port>/<user name>/<password>\n"
    );
System.out.print("\nPlease enter the connect string >");
BufferedReader reader =
    new BufferedReader(new InputStreamReader(System.in));
String sCon = reader.readLine();

// next, the connection is attempted
System.out.println("Attempting to connect :" + sCon);
conn = java.sql.DriverManager.getConnection(sCon);

System.out.println("SolidDriver succesfully connected.");

String sQuery = "SELECT TABLE_SCHEMA,TABLE_NAME,TABLE_TYPE FROM TABLES";

stmt= conn.createStatement();

result = stmt.executeQuery(sQuery);
System.out.println("Query executed and result set obtained.");

// we get a metadataobject containing information about the
// obtained result set
System.out.println("Obtaining metadata information.");
meta = result.getMetaData();
int cols = meta.getColumnCount();

System.out.println("Metadata information for columns is as follows:");
// we dump the column information about the result set
for (i=1; i <= cols; i++)
{
    System.out.println("Column i:"+i+"  "+meta.getColumnName(i)+ "," +
         meta.getColumnType(i) + "," + meta.getColumnTypeName(i));
}

// and finally, we dump the result set
System.out.println("Starting to dump result set.");
int cnt = 1;
while(result.next())
```

```
    {
        System.out.print("\nRow "+cnt+" : ");
        for (i=1; i <= cols; i++) {
            System.out.print(result.getString(i)+"\t");
        }
        cnt++;
    }

    stmt.close();

    conn.close();
    // and not it is all over
    System.out.println("\nResult set dumped. Sample application finishes.");
  }
}
```

Example 6.2. Java Code Example 1 Output

```
Solid\DatabaseEngine4.1\jdbc\samples>java sample1.java
JDBC sample application starts...
Application tries to register the driver.
Driver succesfully registered.
Now sample application needs a connectstring in format:

jdbc:solid://<host>:<port>/<user name>/<password>

Please enter the connect string >jdbc:solid://localhost:1313/dba/dba
Attempting to connect :jdbc:solid://localhost:1313/dba/dba
SolidDriver succesfully connected.
Query executed and result set obtained.
Obtaining metadata information.
Metadata information for columns is as follows:
Column i:1  TABLE_SCHEMA,12,VARCHAR
Column i:2  TABLE_NAME,12,VARCHAR
Column i:3  TABLE_TYPE,12,VARCHAR
Starting to dump result set.

Row 1 : _SYSTEM SYS_TABLES      BASE TABLE
Row 2 : _SYSTEM SYS_COLUMNS     BASE TABLE
Row 3 : _SYSTEM SYS_USERS       BASE TABLE
```

```
Row 4 : _SYSTEM SYS_UROLE       BASE TABLE
Row 5 : _SYSTEM SYS_RELAUTH     BASE TABLE
Row 6 : _SYSTEM SYS_ATTAUTH     BASE TABLE
Row 7 : _SYSTEM SYS_VIEWS       BASE TABLE
Row 8 : _SYSTEM SYS_KEYPARTS    BASE TABLE
Row 9 : _SYSTEM SYS_KEYS        BASE TABLE
Row 10 : _SYSTEM        SYS_CARDINAL    BASE TABLE
Row 11 : _SYSTEM        SYS_INFO        BASE TABLE
Row 12 : _SYSTEM        SYS_SYNONYM     BASE TABLE
Row 13 : _SYSTEM        TABLES  VIEW
Row 14 : _SYSTEM        COLUMNS VIEW
Row 15 : _SYSTEM        SQL_LANGUAGES   BASE TABLE
Row 16 : _SYSTEM        SERVER_INFO     VIEW
Row 17 : _SYSTEM        SYS_TYPES       BASE TABLE
Row 18 : _SYSTEM        SYS_FORKEYS     BASE TABLE
Row 19 : _SYSTEM        SYS_FORKEYPARTS BASE TABLE
Row 20 : _SYSTEM        SYS_PROCEDURES  BASE TABLE
Row 21 : _SYSTEM        SYS_TABLEMODES  BASE TABLE
Row 22 : _SYSTEM        SYS_EVENTS      BASE TABLE
Row 23 : _SYSTEM        SYS_SEQUENCES   BASE TABLE
Row 24 : _SYSTEM        SYS_TMP_HOTSTANDBY      BASE TABLE
Result set dumped. Sample application finishes.
```

Example 6.3. Java Code Example 2

```
/**
 *      sample2 JDBC sample applet
 *
 *
 *      This simple JDBC applet does the following using
 *      Solid native JDBC driver.
 *
 *  1. Registers the driver using JDBC driver manager services
 *  2. Connects to Solid using the driver.
 *     Used url is read from sample2.html
 *  3. Executes given SQL statements
 *
 *  To build and run the application
 *
 *  1. Make sure you have a working Java Development environment
```

```
 *  2. Install and start Solid to connect. Ensure that
 *  the server is up and running.
 *  3. Append SolidDriver2.0.jar into the CLASSPATH definition used
 *     by your development/running environment.
 *  4. Create a java project based on the file sample2.java.
 *  5. Build and run the application. Check that sample2.html
 *     defines valid url to your environment.
 *
 *  For more information read the readme.txt file contained
 *  in the solidDB Development Kit package.
*
 */

import java.util.*;
import java.awt.*;
import java.applet.Applet;
import java.net.URL;
import java.sql.*;

public class sample2 extends Applet {
  TextField textField;
  static TextArea textArea;

  String url = null;
  Connection con = null;

  public void init() {
      // a valid value for url could be
      // url = "jdbc:solid://localhost:1313/dba/dba";

      url = getParameter("url");

      textField = new TextField(40);
      textArea = new TextArea(10, 40);
      textArea.setEditable(false);

      Font font = textArea.getFont();
      Font newfont = new Font("Monospaced", font.PLAIN, 12);
      textArea.setFont(newfont);

      // Add Components to the Applet.
      GridBagLayout gridBag = new GridBagLayout();
```

```
setLayout(gridBag);
GridBagConstraints c = new GridBagConstraints();
c.gridwidth = GridBagConstraints.REMAINDER;

c.fill = GridBagConstraints.HORIZONTAL;
gridBag.setConstraints(textField, c);
add(textField);

c.fill = GridBagConstraints.BOTH;
c.weightx = 1.0;
c.weighty = 1.0;
gridBag.setConstraints(textArea, c);
add(textArea);

validate();

try {
    // Load the Solid JDBC Driver
    Driver d =
       (Driver)Class.forName ("solid.jdbc.SolidDriver").newInstance();

    // Attempt to connect to a driver.
    con = DriverManager.getConnection (url);

    // If we were unable to connect, an exception
    // would have been thrown.  So, if we get here,
    // we are successfully connected to the url

    // Check for, and display and warnings generated
    // by the connect.
    checkForWarning (con.getWarnings ());

    // Get the DatabaseMetaData object and display
    // some information about the connection
    DatabaseMetaData dma = con.getMetaData ();

    textArea.appendText("Connected to " + dma.getURL() + "\n");
    textArea.appendText("Driver       " + dma.getDriverName() + "\n");
    textArea.appendText("Version      " + dma.getDriverVersion() + "\n");
}
catch (SQLException ex) {
    printSQLException(ex);
```

```
    }
    catch (Exception e) {
        textArea.appendText("Exception:  " + e + "\n");
    }
}

public void destroy() {
    if (con != null) {
        try {
            con.close();
        }
        catch (SQLException ex) {
            printSQLException(ex);
        }
        catch (Exception e) {
            textArea.appendText("Exception:  " + e + "\n");
        }
    }
}

public boolean action(Event evt, Object arg) {
    if (con != null) {
        String sqlstmt = textField.getText();
        textArea.setText("");
        try {
            // Create a Statement object so we can submit
            // SQL statements to the driver
            Statement stmt = con.createStatement ();
            // set row limit
            stmt.setMaxRows(50);
            // Submit a query, creating a ResultSet object
            ResultSet rs = stmt.executeQuery (sqlstmt);

            // Display all columns and rows from the result set
            textArea.setVisible(false);
            dispResultSet (stmt,rs);
            textArea.setVisible(true);

            // Close the result set
            rs.close();

            // Close the statement
```

```
            stmt.close();
        }
        catch (SQLException ex) {
            printSQLException(ex);
        }
        catch (Exception e) {
            textArea.appendText("Exception:  " + e + "\n");
        }
        textField.selectAll();
    }
    return true;
}

  //-----------------------------------------------------------------------
  // checkForWarning
  // Checks for and displays warnings.  Returns true if a warning
  // existed
  //-----------------------------------------------------------------------

  private static boolean checkForWarning (SQLWarning warn)
          throws SQLException
  {
      boolean rc = false;

      // If a SQLWarning object was given, display the
      // warning messages.  Note that there could be
      // multiple warnings chained together

      if (warn != null) {
          textArea.appendText("\n*** Warning ***\n");
          rc = true;
          while (warn != null) {
              textArea.appendText("SQLState: " +
                  warn.getSQLState () + "\n");
              textArea.appendText("Message:  " +
                  warn.getMessage () + "\n");
              textArea.appendText("Vendor:   " +
                  warn.getErrorCode () + "\n");
              textArea.appendText("\n");
              warn = warn.getNextWarning ();
          }
      }
```

```
        return rc;
    }

    //---------------------------------------------------------------------
    // dispResultSet
    // Displays all columns and rows in the given result set
    //---------------------------------------------------------------------

    private static void dispResultSet (Statement sta, ResultSet rs)
        throws SQLException
    {
        int i;

        // Get the ResultSetMetaData.  This will be used for
        // the column headings
        ResultSetMetaData rsmd = rs.getMetaData ();

        // Get the number of columns in the result set
        int numCols = rsmd.getColumnCount ();
        if (numCols == 0) {
            textArea.appendText("Updatecount is "+sta.getUpdateCount());
            return;
        }

        // Display column headings
        for (i=1; i<=numCols; i++) {
            if (i > 1) {
                textArea.appendText("\t");
            }
            try {
                textArea.appendText(rsmd.getColumnLabel(i));
            }
            catch(NullPointerException ex) {
                textArea.appendText("null");
            }
        }
        textArea.appendText("\n");

        // Display data, fetching until end of the result set
        boolean more = rs.next ();
        while (more) {
```

```
            // Loop through each column, get the
            // column datza and display it
            for (i=1; i<=numCols; i++) {
                if (i > 1) {
                    textArea.appendText("\t");
                }
                try {
                    textArea.appendText(rs.getString(i));
                }
                catch(NullPointerException ex) {
                    textArea.appendText("null");
                }
            }
            textArea.appendText("\n");

            // Fetch the next result set row
            more = rs.next ();
        }
    }

    private static void printSQLException(SQLException ex)
    {
            // A SQLException was generated.  Catch it and
            // display the error information.  Note that there
            // could be multiple error objects chained
            // together

            textArea.appendText("\n*** SQLException caught ***\n");

            while (ex != null) {
                textArea.appendText("SQLState: " +
                    ex.getSQLState () + "\n");
                textArea.appendText("Message:  " +
                    ex.getMessage () + "\n");
                textArea.appendText("Vendor:   " +
                    ex.getErrorCode () + "\n");
                textArea.appendText("\n");
                ex = ex.getNextException ();
            }
    }
```

```
}
```

Example 6.4. Java Code Example 3

```
/**
 *      sample3 JDBC sample application
 *
 *
 *      This simple JDBC application does the following using
 *      Solid JDBC driver.
 *
 *  1. Registers the driver using JDBC driver manager services
 *  2. Prompts the user for a valid JDBC connect string
 *  3. Connects to Solid using the driver
 *  4. Drops and creates a procedure sample3. If the procedure
 *     does not exist dumps the related exception.
 *  5. Calls that procedure using java.sql.Statement
 *  6. Fetches and dumps all the rows of a result set.
 *  7. Closes connection
 *
 *  To build and run the application
 *
 *  1. Make sure you have a working Java Development environment
 *  2. Install and start Solid to connect. Ensure that the
 *     server is up and running.
 *  3. Append SolidDriver2.0.jar into the CLASSPATH definition used
 *     by your development/running environment.
 *  4. Create a java project based on the file sample3.java.
 *  5. Build and run the application.
 *
*  For more information read the readme.txt
*  file contained in the solidDB Development Kit package.
*/

import java.io.*;
import java.sql.*;

public class sample3 {
```

```
static Connection conn;
public static void main (String args[]) throws Exception
{
    System.out.println("JDBC sample application starts...");
    System.out.println("Application tries to register the driver.");

    // this is the recommended way for registering Drivers
    Driver d = (Driver)Class.forName("solid.jdbc.SolidDriver").newInstance();

    System.out.println("Driver succesfully registered.");

    // the user is asked for a connect string
    System.out.println(
        "Now sample application needs a connectstring in format:\n"
        );
    System.out.println(
        "jdbc:solid://<host>:<port>/<user name>/<password>\n"
        );
    System.out.print("\nPlease enter the connect string >");
    BufferedReader reader =
    new BufferedReader(new InputStreamReader(System.in));
    String sCon = reader.readLine();

    // next, the connection is attempted
    System.out.println("Attempting to connect :" + sCon);
    conn = DriverManager.getConnection(sCon);

    System.out.println("SolidDriver succesfully connected.");

    DoIt();

    conn.close();
    // and now it is all over
    System.out.println(
        "\nResult set dumped. Sample application finishes."
        );
}


static void DoIt() {
    try {
        createprocs();
```

```
            PreparedStatement pstmt = conn.prepareStatement("call sample3(?)");
            // set parameter value
            pstmt.setInt(1,10);

            ResultSet rs = pstmt.executeQuery();
            if (rs != null) {
                ResultSetMetaData md = rs.getMetaData();
                int cols = md.getColumnCount();
                int row = 0;
                while (rs.next()) {
                    row++;
                    String ret = "row "+row+": ";
                    for (int i=1;i<=cols;i++) {
                        ret = ret + rs.getString(i) + " ";
                    }
                    System.out.println(ret);
                }
            }
            conn.commit();
        }
        catch (SQLException ex) {
            printexp(ex);
        }
        catch (java.lang.Exception ex) {
            ex.printStackTrace ();
        }

    }

    static void createprocs() {
        Statement stmt = null;
        String proc = "create procedure sample3 (limit integer)" +
                      "returns (c1 integer, c2 integer) " +
                      "begin " +
                      "  c1 := 0;" +
                      "  while c1 < limit loop " +
                      "    c2 := 5 * c1;" +
                      "    return row;" +
                      "    c1 := c1 + 1;" +
                      "  end loop;" +
                      "end";
```

```
        try {
            stmt = conn.createStatement();
            stmt.execute("drop procedure sample3");
        } catch (SQLException ex) {
            printexp(ex);
        }

        try {
            stmt.execute(proc);
        } catch (SQLException ex) {
            printexp(ex);
            System.exit(-1);
        }
    }

    public static void printexp(SQLException ex) {
        System.out.println("\n*** SQLException caught ***");
        while (ex != null) {
            System.out.println("SQLState: " + ex.getSQLState());
            System.out.println("Message:  " + ex.getMessage());
            System.out.println("Vendor:   " + ex.getErrorCode());
            ex = ex.getNextException ();
        }
    }

}
```

Example 6.5. Java Code Example 4

```
/**
 *      sample4 JDBC sample application
 *
 *
 *      This simple JDBC application does the following using
 *      Solid JDBC driver.
 *
 *  1. Registers the driver using JDBC driver manager services
 *  2. Prompts the user for a valid JDBC connect string
 *  3. Connects to Solid using the driver
 *  4. Drops and creates a table sample4. If the table
```

```
 *     does not exist dumps the related exception.
 *  5. Inserts file given as an argument to database (method Store)
 *  6. Reads this 'blob' back to file out.tmp (method Restore)
 *  7. Closes connection
 *
 *  To build and run the application
 *
 *  1. Make sure you have a working Java Development environment
 *  2. Install and start Solid to connect. Ensure that
 *   the server is up and running.
 *  3. Append SolidDriver2.0.jar into the CLASSPATH definition used
 *     by your development/running environment.
 *  4. Create a java project based on the file sample4.java.
 *  5. Build and run the application.
 *
 *  For more information read the readme.txt file
 *  contained in the solidDB Development Kit package.
*
 */

import java.io.*;
import java.sql.*;

public class sample4 {

    static Connection conn;
    public static void main (String args[]) throws Exception
    {
        String filename = null;
        String tmpfilename = null;

        if (args.length < 1) {
            System.out.println("usage: java sample4 <infile>");
            System.exit(0);
        }
        filename = args[0];
        tmpfilename = "out.tmp";
        System.out.println("JDBC sample application starts...");
        System.out.println("Application tries to register the driver.");

        // this is the recommended way for registering Drivers
        Driver d = (Driver)Class.forName("solid.jdbc.SolidDriver").newInstance();
```

```
    System.out.println("Driver succesfully registered.");

    // the user is asked for a connect string
    System.out.println(
        "Now sample application needs a connectstring in format:\n"
        );
    System.out.println(
        "jdbc:solid://<host>:<port>/<user name>/<password>\n"
        );
    System.out.print("\nPlease enter the connect string >");
    BufferedReader reader =
    new BufferedReader(new InputStreamReader(System.in));
    String sCon = reader.readLine();

    // next, the connection is attempted
    System.out.println("Attempting to connect :" + sCon);
    conn = DriverManager.getConnection(sCon);

    System.out.println("SolidDriver succesfully connected.");

    // drop and create table sample4
    createsample4();
    // insert data into it
    Store(filename);
    // and restore it
    Restore(tmpfilename);

    conn.close();
    // and it is all over
    System.out.println("\nSample application finishes.");
}


static void Store(String filename) {
    String sql = "insert into sample4 values(?,?)";
    FileInputStream inFileStream ;
    try {
        File f1 = new File(filename);
        int blobsize = (int)f1.length();
        System.out.println("Inputfile size is "+blobsize);
        inFileStream = new FileInputStream(f1);
```

```
            PreparedStatement stmt = conn.prepareStatement(sql);
            stmt.setLong(1, System.currentTimeMillis());
            stmt.setBinaryStream(2, inFileStream, blobsize);
            int rows = stmt.executeUpdate();
            stmt.close();
            System.out.println(""+rows+" inserted.");
            conn.commit();
        }
        catch (SQLException ex) {
            printexp(ex);
        }
        catch (java.lang.Exception ex) {
            ex.printStackTrace ();
        }

    }

    static void Restore(String filename) {
        String sql = "select id,blob from sample4";
        FileOutputStream outFileStream ;
        try {
            File f1 = new File(filename);
            outFileStream = new FileOutputStream(f1);

            PreparedStatement stmt = conn.prepareStatement(sql);
            ResultSet rs = stmt.executeQuery();
            int readsize = 0;
            while (rs.next()) {
                InputStream in = rs.getBinaryStream(2);
                byte bytes[] = new byte[8*1024];
                int nRead = in.read(bytes);
                while (nRead != -1) {
                    readsize = readsize + nRead;
                    outFileStream.write(bytes,0,nRead);
                    nRead = in.read(bytes);
                }

            }
            stmt.close();
            System.out.println("Read "+readsize+" bytes from database");
        }
```

```
        catch (SQLException ex) {
            printexp(ex);
        }
        catch (java.lang.Exception ex) {
            ex.printStackTrace ();
        }

    }


    static void createsample4() {
        Statement stmt = null;
        String proc = "create table sample4 (" +
                      "id numeric not null primary key,"+
                      "blob long varbinary)";

        try {
            stmt = conn.createStatement();
            stmt.execute("drop table sample4");
        } catch (SQLException ex) {
            printexp(ex);
        }

        try {
            stmt.execute(proc);
        } catch (SQLException ex) {
            printexp(ex);
            System.exit(-1);
        }
    }

    static void printexp(SQLException ex) {
        System.out.println("\n*** SQLException caught ***");
        while (ex != null) {
            System.out.println("SQLState: " + ex.getSQLState());
            System.out.println("Message:  " + ex.getMessage());
            System.out.println("Vendor:   " + ex.getErrorCode());
            ex = ex.getNextException ();
        }
    }
```

```
}
```

6.8 IBM solidDB JDBC Driver Type Conversion Matrix

The following conversion matrix shows how the java data type to SQL data type conversion is supported by IBM solidDB JDBC Driver. Note that this matrix applies to both ResultSet.getXXX and ResultSet.setXXX methods for getting and setting data. An X indicates that the method is supported by IBM solidDB JDBC Driver.

Table 6.29. Java Data Type to SQL Data Type Conversion

Java Data Type **applies to getting and setting data**	TINYINT	SMALLINT	INTEGER	REAL	FLOAT	DOUBLE	DECIMAL	NUMERIC	CHAR	VARCHAR	LONGVARCHAR	WCHAR	WVARCHAR	LONGWVARCHAR	BINARY	VARBINARY	LONGVARBINARY	DATE	TIME	TIMESTAMP
getArray/setArray																				
getBlob/setBlob																				
getByte/setByte	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
getCharacterStream/ setCharacterStream									X	X	X	X	X	X	X	X	X	X	X	X
getClob/setClob																				
getShort/setShort	X	X	X	X	X	X	X	X	X	X	X									
getInt/setInt	X	X	X	X	X	X	X	X	X	X	X									
getlong/setLong	X	X	X	X	X	X	X	X	X	X	X									
getfloat/setfloat	X	X	X	X	X	X	X	X	X	X	X									
getDouble/setDouble	X	X	X	X	X	X	X	X	X	X	X									
getBigDecimal/setBigDecimal	X	X	X	X	X	X	X	X	X	X	X									
getRef/setRef																				
getBoolean/setBoolean	X	X	X	X	X	X	X	X	X	X	X									
getString/setString	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
getBytes/setBytes									X	X	X	X	X	X	X	X	X			
getDate/setDate									X	X	X	X	X	X				X		X
getTime/setTime									X	X	X	X	X	X					X	X
getTimestamp/setTimestamp									X	X	X	X	X	X				X		X
getAsciiStream/setAsciiStream									X	X	X	X	X	X	X	X	X			

Java Data Type **applies to getting and setting data**	**TINYINT**	**SMALLINT**	**INTEGER**	**REAL**	**FLOAT**	**DOUBLE**	**DECIMAL**	**NUMERIC**	**CHAR**	**VARCHAR**	**LONGVARCHAR**	**WCHAR**	**WVARCHAR**	**LONGWVARCHAR**	**BINARY**	**VARBINARY**	**LONGVARBINARY**	**DATE**	**TIME**	**TIMESTAMP**
getUnicodeStream/setUnicodeStream									X	X	X	X	X	X	X	X	X			
getBinaryStream/setBinaryStream									X	X	X	X	X	X	X	X	X			
getObject/setObject	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Chapter 7. Using IBM solidDB SA

This chapter describes how to use the IBM solidDB Application Programming Interface (API) also known as IBM solidDB SA. IBM solidDB SA is a low level C-language client library to access IBM solidDB database management products. IBM solidDB SA is a layer that resides internally in IBM solidDB products. Normally, the use of an industry standards based interface, such as ODBC or JDBC, is recommended. However, in environments with heavy write load (BATCH INSERTS AND UPDATES), IBM solidDB SA can provide a significant performance advantage.

The topics included in this chapter are:

- What is IBM solidDB SA
- Getting started with IBM solidDB SA
- Writing data using the IBM solidDB SA without SQL
- Reading data using the IBM solidDB SA without SQL
- Running SQL statements using IBM solidDB SA

7.1 What Is IBM solidDB SA?

IBM solidDB SA is a C-language client library to connect IBM solidDB database products. This library is used internally in IBM solidDB products and provides access to data in IBM solidDB database tables. The library contains 90 functions providing low-level mechanisms for connecting the database and running cursor-based operations.

Compared to industry standard interfaces, such as ODBC or JDBC, IBM solidDB SA offers better flexibility in constructing network messages that are sent to the database server. In applications whose read or write performance (for example, batch inserts or primary key lookups) needs to be optimized, using IBM solidDB SA can provide a significant performance advantage. For example, if your site experiences performance bottlenecks during batch inserts, IBM solidDB SA can reduce the bottleneck because IBM solidDB SA lets you pass several rows for insertion inside a single network message or remote procedure call.

Note

If the performance bottleneck is in read, using IBM solidDB SA will provide only minor improvement in performance.

The IBM solidDB SA interface bypasses the SQL parser, interpreter, and optimizer. With IBM solidDB SA you can access result sets, as long as you are not using SQL through IBM solidDB SA. If retrieval of result sets is necessary through SQL, then you must use industry standard APIs such as ODBC or IBM solidDB's own Light Client based on ODBC.

To use IBM solidDB SA requires that you convert your existing interface. This is why we recommend that you use IBM solidDB SA only after you have already attempted (with little success) to use other means for improving performance, which include:

- Writing or indexing columns by primary key for the most appropriate row order. IBM solidDB, otherwise, stores rows on disk in the order they are inserted into the database.
- Eliminating unnecessary indexes. For example, a query that selects more than 15% of a table's rows may be performed faster by a full table scan.
- Optimizing the transaction size by committing transactions after every 100-200 rows inserted.
- Using stored procedures.

7.2 Getting Started with IBM solidDB SA

Before getting started with Solid SA, be sure you have:

1. Obtained the IBM solidDB with linked library access library. This library includes:
    - Linkable libraries that provide local Solid SA and server functionality
    - Sample IBM solidDB SA files to help you get started. These files include a ready-to-link C sample application to help you get started, along with a readme text file (`readme.txt`).
2. If you are building a remote user application, you will need the following library so that you can link it into your application: `solidimpsa.lib`. Note that the filename extension may vary by platform.
3. Checked the latest system requirements for using IBM solidDB SA on the IBM Corporation Web site.
4. Started IBM solidDB. If necessary, create a new database before using IBM solidDB SA.

7.2.1 Setting up the Development Environment and Building a Sample Program

Building an application program using the IBM solidDB SA library in the linked library access or the SA client library is identical to building any normal C/C++ program:

1. Insert the linked library access library file or SA client library into your project. Refer to chapter Linking Applications for the linked library access in IBM solidDB Linked Library Access User Guide for the correct filenames.

2. Include the following IBM solidDB SA header file, which is required in applications using IBM solidDB SA library in the linked library access or the IBM solidDB SA client library:

   ```
   #include "sa.h"
   ```

   Insert the directory containing all the other necessary IBM solidDB SA headers into your development environment's include directories setting.

3. Compile the source code.

4. Link the program.

7.2.2 Verifying the Development Environment Setup

The easiest way to verify the development setup is to use a IBM solidDB SA sample program. This enables you to verify your development environment without writing any code. Please note the following that applies to your development environment:

- In the Windows environment, the TCP/IP services are provided by standard DLL `wsock32.dll`. To link these services into your project, add `wsock32.lib` into linker's lib file list.

- On VxWorks target machines, you should run a kernel that has a working TCP/IP stack running. Usually you can verify this by checking that the target machine responds to ping requests. For example, if you have configured your target machine to have an IP address 192.168.1.111, you would run ping 192.168.1.111 from another workstation in your LAN for a response that proves the target is alive:

  ```
  C:\>ping 192.168.1.111
  Pinging 192.168.1.111 with 32 bytes of data:
  Reply from 192.168.1.111: bytes=32 time=260ms TTL=62
  ```

  After verification, your IBM solidDB SA application should work on that target machine.

7.2.3 Connecting to a Database by Using the Sample Application

In IBM solidDB SA, a connection to a database is represented by the `SaConnectT` structure. This structure is established by calling the function `SaConnect`. The following sample code establishes a connection to a

database listening TCP/IP protocol at local machine port 1313. User account DBA with password DBA has been defined in the database.

```
SaConnectT* scon;

scon = SaConnect("tcp localhost 1313", "dba", "dba");
if (scon == NULL)
{
    /* Connect failed, display connect error text. */
    char* errstr;
    SaErrorInfo(NULL, &errstr, NULL);
    printf("%s\n", errstr);
    return(1);
}
```

7.3 Writing Data by Using IBM solidDB SA without SQL

With IBM solidDB SA, data is written using cursors. For delete and update operations, after the cursor is created, a search is performed so that the cursor points to the row that is to be updated and deleted. For insert operations, after the cursor is created, the insertion row(s) are immediately written to the cursor. IBM solidDB SA also enables passing several rows for insertion inside a single network message.

7.3.1 Performing Insert Operations

IBM solidDB SA functions required for insert operations are listed in the table below.

After IBM solidDB creates a cursor to a certain table, variables are bound to columns, row(s) are written to the cursor, and then the cursor is closed. Note that if you use `SaArrayInsert` to insert more than one row in a single message, then you must perform an explicit flush to send the rows to the database.

Table 7.1. Insert Operation Steps

Steps	SA Function(s)	Comment
1. Create a cursor	SaCursorCreate	
2. Binding variables to cursor	SaCursorColData, SaCursorColDate, SaCursorColDate-Format, SaCursorColDFloat, SaCursorColDouble, SaCursorColDynData, SaCursorColDynstr, SaCursor-	

Steps	SA Function(s)	Comment
	ColFloat, SaCursorColInt, SaCursorColLong, SaCursorColStr, SaCursorColTime, SaCursorColTimestamp	
3. Open the cursor	SaCursorOpen	
4. Write a row(s) to the cursor	SaArrayInsert for more than one row or SaCursorInsert for a single row	Perform this in a loop if necessary
5. Free the cursor	SaCursorFree	
6. Flush the network message to the server	SaArrayFlush	Necessary only if using SaArrayInsert.

The following code sample excerpt demonstrates how to write four rows of data in a single network message using the `SaArrayInsert` function. In the code, a call to `SaArrayFlush` flushes all rows to the server so they are passed in the same network message.

```
scur = SaCursorCreate(scon, "SAEXAMPLE");

/* Bind variables to columns. */
SaCursorColInt(scur, "INTC", &intc);
SaCursorColStr(scur, "CHARC", &str);

/* Open the cursor. */
SaCursorOpen(scur);

/* Insert values to the table. The column values are taken
 * from the user variables that are bound to columns.
 */
for (intc = 2; intc <= 5; intc++) {
    switch (intc) {
        case 2:
            str = "B";
            break;
        case 3:
            str = "C";
            break;
        case 4:
            str = "D";
            break;
        case 5:
            str = "E";
```

```
            break;
        }
        SaArrayInsert(scur);
    }

    /* Close the cursor. */
    SaCursorFree(scur);

    /* Flush the inserts to the server. */
    SaArrayFlush(scon, NULL);
```

7.3.2 Performing Update and Delete Operations

IBM solidDB SA functions required for basic update and delete operations are listed in the table below.

After IBM solidDB creates a cursor to a specific table, variables are bound to columns of the table, and the cursor is opened. Before the actual search begins, the constraints for finding the row for deletion are set. If there are more rows to be updated, each of the rows requires a separate fetch before they are updated or deleted. After the operation, the cursor is freed.

Table 7.2. Update and Delete Operation Steps

Steps	SA Function(s)	Comment
1. Create a cursor	`SaCursorCreate`	
2. Binding variables to cursor	`SaCursorColData, SaCursorColDate, SaCursorColDateFormat, SaCursorColDFloat, SaCursorColDouble, SaCursorColDynData, SaCursorColDynstr, SaCursorColFloat, SaCursorColInt, SaCursorColLong, SaCursorColStr, SaCursorColTime, SaCursorColTimestamp`	
3. Open the cursor	`SaCursorOpen`	
4. Set the search constraint for the row to be updated or deleted	`SaCursorEqual`, `SaCursorAtleast`, `SaCursorAtmost`	
5. Start a search for the row to be updated or deleted	`SaCursorSearch`	
6. Fetch the row to be updated or deleted	`SaCursorNext`	

Steps	SA Function(s)	Comment
7. Perform actual update or delete	`SaCursorUpdate` or `SaCursorDelete`	For updates, the new values need to be in variables bound in step 2.
8. Free the cursor	`SaCursorFree`	

The following code sample excerpt demonstrates how to update a row in a table using `SaCursorUpdate`. Note that in the code, the new values for the update are in variables which are bound to the columns of the table using `SaCursorColInt` and `SaCursorColStr` after the cursor is created.

```
scur = SaCursorCreate(scon, "SAEXAMPLE");

/* Bind variables to columns INTC and CHARC of test table. */
SaCursorColInt(scur, "INTC", &intc);
SaCursorColStr(scur, "CHARC", &str);

/* Open the cursor. */
SaCursorOpen(scur);

/* Set search constraint. */
str = "D";
SaCursorEqual(scur, "CHARC");

/* Start a search. */
SaCursorSearch(scur);

/* Fetch the column. */
SaCursorNext(scur);

/* Update the current row in the cursor. */
intc = 1000;
str = "D Updated";
SaCursorUpdate(scur);
```

```
/* Close the cursor. */
SaCursorFree(scur);
```

7.4 Reading Data by Using IBM solidDB SA without SQL

IBM solidDB SA functions required for query operations are listed in the table below.

With IBM solidDB SA, data is queried using cursors. The query data is found in a way similar to update and delete operations. A cursor is created to a specific table, variables are bound to columns of the table, and the cursor is then opened. The constraints for finding the rows for the query are set before starting the actual search. If more than one row is found, each row must be fetched separately. After all the rows are fetched, the cursor needs to be freed.

Basically, all IBM solidDB SA queries use the IBM solidDB optimizer in a way similar to SQL-based queries. The index selection strategy is the same as in SQL. The only exception is that the IBM solidDB SA search uses ORDER BY for selecting an index. This means that an index that best fits ORDER BY is the one selected. If two indices are equally good, then the one with a smaller cost is selected. The query is optimized each time `SaCursorSearch` is called.

Note

There is no way to use optimizer hints functionality when Solid SA is used.

Table 7.3. Query Operation Steps

Steps	SA Function(s)	Comment
1. Create a cursor	`SaCursorCreate`	
2. Binding variables to cursor	`SaCursorColInt`, `SACursorColStr` and others for other data types	
3. Open the cursor	`SaCursorOpen`	
4. Set the search constraint for the row to be queried	`SaCursorEqual`, `SaCursorAtleast`, `SaCursor-Atmost`	
5. Start a search for the row to be queried	`SaCursorSearch`	
6. Fetch the row(s) that match the given criteria	`SaCursorNext`	Perform this in a loop if necessary
7. Free the cursor	`SaCursorFree`	

```
/* Create cursor to a database table. */
scur = SaCursorCreate(scon, "SAEXAMPLE");

/* Bind variables to columns of test table. */
rc = SaCursorColInt(scur, "INTC", &intc);
rc = SaCursorColStr(scur, "CHARC", &str);

/* Open the cursor. */
rc = SaCursorOpen(scur);
assert(rc == SA_RC_SUCC);

/* Set search constraints. */
str = "A";
rc = SaCursorAtleast(scur, "CHARC");
str = "C";
rc = SaCursorAtmost(scur, "CHARC");

/* Set ordering criteria. */
rc = SaCursorAscending(scur, "CHARC");

/* Start a search. */
rc = SaCursorSearch(scur);

/* Fetch the rows. */
for (i = 1; i <= 3; i++) {
    rc = SaCursorNext(scur);
    switch (intc) {
        case 1:
            assert(strcmp(str, "A") == 0);
            break;
        case 2:
            assert(strcmp(str, "B") == 0);
            break;
        case 3:
            assert(strcmp(str, "C") == 0);
            break;
    }

 }
```

```
    /* Close the cursor. */
    SaCursorFree(scur);
}
```

7.5 Running SQL Statements by Using IBM solidDB SA

In addition to bypassing SQL Parser and SQL interpretation, IBM solidDB SA also allows limited execution of SQL statements directly using function `SaSQLExecDirect`. This function is designed to execute simple SQL statements, such as CREATE TABLE, etc. If you need to retrieve SQL result sets, you must use another programming interface such as ODBC or IBM solidDB Light Client.

```
/* Create test table and index. */
SaSQLExecDirect(scon,
        "CREATE TABLE SAEXAMPLE(INTC INTEGER, CHARC VARCHAR)");
SaSQLExecDirect(scon,
        "CREATE INDEX SAEXAMPLE_I1 ON SAEXAMPLE (CHARC)");
```

7.6 Transactions and Autocommit Mode

By default, IBM solidDB SA runs in autocommit mode.

Autocommit mode is switched off by calling the function SaTransBegin, which explicitly begins a transaction. In this mode, the transaction is committed using the SaTransCommit function or rolled back using SaTrans-Rollback. Note that after the transaction is committed, IBM solidDB SA returns to its autocommit mode setting.

In autocommit mode, the transaction is committed immediately after an insert (`SaCursorInsert`), update (`SaCursorUpdate`), or delete (`SaCursorDelete`). Note that even when using `SaArrayInsert`, each individual record is inserted in a separate transaction if autocommit is used (see Section 7.11, “SaArrayInsert” for more details). To improve performance when inserting multiple rows with the `SaArrayInsert` function, put multiple inserts into a single transaction by using `SaTransBegin` and `SaTransCommit`.

7.7 Handling Database Errors

IBM solidDB SA does not provide sophisticated ODBC-like error processing capability. Generally, IBM solidDB SA functions return SA_RC_SUCC or a pointer to the requested object if successful. If not successful, then the return value is either one of the IBM solidDB SA error codes (see table below) or NULL. If the error is a database error, the error text is returned by the SaErrorInfo function.

```
if (scon == NULL) {
        /* Connect failed, display connect error text. */
        char* errstr;
        SaErrorInfo(NULL, &errstr, NULL);
        printf("%s\n", errstr);
        return(1);
    }
```

The function `SaCursorErrorInfo` returns error text if the last cursor operation failed. Note that `SaErrorInfo` has a connection parameter and thus returns the last error applicable to that connection, while `SaCursorErrorInfo` has a cursor parameter and thus returns the last error of that cursor.

7.7.1 Error Code and Messages for IBM solidDB SA Functions

Following are the possible return codes for IBM solidDB SA functions. All of these error codes are defined in the `sa.h` file.

Table 7.4. IBM solidDB SA Function Return Codes

Error Code	Meaning
SA_RC_SUCC	Operation was successful
SA_RC_END	Operation has completed
SA_ERR_FAILED	Operation failed
SA_ERR_CURNOTOPENED	Cursor is not open
SA_ERR_CUROPENED	Cursor is open
SA_ERR_CURNOSEARCH	No active search in cursor
SA_ERR_CURSEARCH	There is active search in cursor
SA_ERR_ORDERBYILL	Illegal "order by" specification
SA_ERR_COLNAMEILL	Illegal column name
SA_ERR_CONSTRILL	Illegal constraint
SA_ERR_TYPECONVILL	Illegal type conversion
SA_ERR_UNIQUE	Unique constraint violation
SA_ERR_LOSTUPDATE	Concurrency conflict, two transactions updated or deleted the same row
SA_ERR_SORTFAILED	Failed to sort the search result set

Error Code	Meaning
SA_ERR_CHSETUNSUPP	Unsupported character set
SA_ERR_CURNOROW	No current row in cursor
SA_ERR_COLISNOTNULL	NULL value given for a NOT NULL column
SA_ERR_LOCALSORT	Result set is sorted locally, cannot update or delete the row
SA_ERR_COMERROR	Communication error, connection is lost
SA_ERR_NOSTRCONSTR	String for constraint is missing.
SA_ERR_ILLENUMVAL	Illegal numeric value
SA_ERR_COLNOTBOUND	Column is not bound
SA_ERR_CALLNOSUP	Operation is not supported*
SA_ERR_RPCPARAM	RPC parameter error
SA_ERR_TABLENOTFOUND	Table not found
SA_ERR_READONLY	Connection is read only
SA_ERR_ILLPARAMCOUNT	Wrong number of parameters
SA_ERR_INVARG	Invalid argument
SA_ERR_INVCALLSEQ	Invalid call sequence

Note: SaArray* functions are not supported in linked library access; they work only with the network client library. They return SA_ERR_CALLNOSUP with linked library access.

7.8 Special Notes about IBM solidDB SA

7.8.1 IBM solidDB SA and Binary Large Objects (BLOBs)

Currently, IBM solidDB SA does not support BLOB streams and the maximum size of an attribute value is limited to 32K.

7.8.2 SaCursorCol* Functions and IBM solidDB SQL Supported Datatypes

The `SaCursorColXXX()` functions bind a variable of type XXX to a specified column. For example, the `SaCursorColInt` function binds a variable of type int to a specified column. When you bind a variable to a column, the variable and column usually have corresponding types; for example, you usually bind an int C variable to an INT SQL column. However, it is not absolutely required that the data type of the column and

the data type of the bound variable be equivalent. For example, you could bind a C int variable to an SQL FLOAT, but you would risk losing precision (or even overflowing or underflowing) as data was transferred back and forth.

The SaCursorCol* functions support the SQL datatypes listed in the following table.

Table 7.5. Supported SQL Datatype

SaCursolCol* **Function**	**TINYINT**	**SMALLINT**	**INTEGER**	**REAL**	**FLOAT**	**DOUBLE**	**DECIMAL**	**NUMERIC**	**CHAR**	**VARCHAR**	**LONGVARCHAR**	**WCHAR**	**WVARCHAR**	**LONGWVARCHAR**	**BINARY**	**VARBINARYR**	**LONGVARBINARY**	**DATE**	**TIME**	**TIMESTAMP**
SaCursorColInt	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
SaCursor ColLong	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
SaCursor ColFloat	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
SaCursor ColDouble	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
SaCursorColStr									X	X	X									
SaCursorCol Date									X	X	X	X	X	X				X		X
SaCursor ColTime									X	X	X	X	X	X					X	X
SaCursor ColTimestamp									X	X	X	X	X	X					X	X
SaCursor ColData															X	X	X			
SaCursor ColDynData		X	X	X	X	X	X	X	X	X	X				X	X	X			
SaCursor ColFixStr		X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X
SaCursor ColDynStr		X	X	X	X	X	X	X	X	X	X	X	X							

Note

Keep in mind that, as in other APIs, the success of some conversions in IBM solidDB SA depend on declared values. For example, SaCursorCollInt is only able to handle the SQL datatype CHAR (as in 'foo') if the actual value of the field is an integer (as in '123').

7.9 IBM solidDB SA Function Reference

The following pages describe each IBM solidDB SA function in alphabetic order. Each description includes the purpose, synopsis, parameters, return value, and comments.

7.9.1 Function Synopsis

The declaration synopsis for the function is:

```
SA_EXPORT_H function(modifier parameter [,...]);
```

where modifier can be:

```
SaConnectT*
SaColSearchT*
SaCursorT*
SaDataTypeT*
SaDateT*
SaDfloatT*
SaDynDataT*
SaDynStrT*
SaChSetT
char*
char**
double*
long*
float*
int
int*
unsigned*
void
```

Parameters are in italics and are described below.

Parameter Description

In each function description, parameters are described in a table format. Included in the table is the general usage type of the parameter (described below), as well as the use of the parameter variable in the specific function.

Parameter Usage Type

The table below shows the possible usage type for IBM solidDB SA parameters. Note that if a parameter is used as a pointer, it contains a second category of usage to specify the ownership of the parameter variable after the call.

Table 7.6. IBM solidDB SA Parameter Usage Types

Usage Type	Meaning
in	Indicates the parameter is input.
output	Indicates the parameter is output.
in out	Indicates the parameter is input/output.
take	Applies only to a pointer parameter. It means that the parameter value is taken by the function. The caller cannot reference to the parameter after the function call. The function or an object created in the function is responsible for releasing the parameter when it is no longer needed.
hold	Applies only to a pointer parameter. It means that the function holds the parameter value even after the function call. The caller can reference to the parameter value after the function call and is responsible for releasing the parameter. Typically, this kind of parameter is passed to the constructor of some object which holds the pointer value inside a local data structure. The caller cannot release the parameter until the object that holds the parameter is deleted.
use	Applies only to a pointer parameter. It means that the parameter is just used during the function call. The caller can do whatever it wants with the parameter after the function call. This is the most common type of parameter passing.
ref	Applies only to out parameters. See "Return Value" below for details.
give	Applies only to out parameters. See "Return Value" below for details.

7.9.2 Return Value

Each function description indicates if the function returns a value and the type of value that is returned. Return Values can be:

- Boolean (TRUE, FALSE),
- int (such as 1, 0),
- SaRetT (error return codes) such as SA_RC_SUCC. Refer to Section 7.7, “Handling Database Errors” for a list of valid error codes.
- Pointer (out parameter)

The possible return usage types for pointers are:

Table 7.7. Return Usage Types for Pointers

Usage Type	Meaning
ref	Indicates the caller can only reference the returned value, but cannot release it. Take care that the returned value is not used after it is released by the object that returned it.
give	Indicates the function gives the returned value to the caller. The caller is responsible for releasing the returned value.

7.10 SaArrayFlush

`SaArrayFlush` flushes the array operation buffer (that is, it sends the data to the server) after a series of calls to `SaArrayInsert` fills that buffer.

Note

1. By default, all SA operations, even `SaArrayFlush` operations, are done in autocommit mode. In autocommit mode, the `SaArrayFlush` function does not automatically insert all of the array's records in a single transaction; instead, when `SaArrayFlush` is called, each record's insertion is treated as a separate transaction. To maximize performance, you may want to do an explicit `SaTransBegin` before you call `SaArrayFlush`, and do an explicit `SaTransCommit` after you call `SaArrayFlush`.
2. `SaArray*` functions are not supported in linked library access; they work only with the network client library. They return SA_ERR_CALLNOSUP with linked library access.

7.10.1 Synopsis

```
SaRetT SA_EXPORT_H SaArrayFlush(SaConnectT* scon, SaRetT* rctab)
```

The `SaArrayFlush` function accepts the following parameters:

Table 7.8. SaArrayFlush Parameters

Parameters	Usage Type	Description
scon	use	Pointer to a connection object
rctab	use	Array of return codes for each array operation If this parameter is non-NULL, the return code of each array operation is returned in rctab[i], where i is the order number of the array operation since the last `SaArrayFlush`.

7.10.2 Return Value

SA_RC_SUCC or error code of first failed array operation.

7.10.3 See Also

Section 7.11, “SaArrayInsert”.

7.11 SaArrayInsert

`SaArrayInsert` inserts an array of values on one network message. This function places the inserted value in the array insert buffer. You can flush the buffer (that is, send the data to the server) using function `SaArrayFlush`.

`SaArrayInsert` may also perform an implicit flush if the internal cache becomes full. However, to ensure that all rows are sent to the server, you should call `SaArrayFlush` after you insert the last record using `SaArrayInsert`.

Note

1. By default, all SA operations, even `SaArrayInsert` and `SaArrayFlush` operations, are done in autocommit mode. See Section 7.10, “SaArrayFlush” for an important note about performance.

2. `SaArray*` functions are not supported in linked library access; they work only with the network client library. They return SA_ERR_CALLNOSUP with linked library access.

7.11.1 Synopsis

```
SaRetT SA_EXPORT_H SaArrayInsert(SaCursorT* scur)
```

The `SaArrayInsert` function accepts the following parameters:

Table 7.9. SaArrayInsert Parameters

Parameters	Usage Type	Description
scur	use	Pointer to a cursor object

7.11.2 Return Value

SA_RC_SUCC or error code

7.11.3 See Also

Section 7.10, “SaArrayFlush”.

7.12 SaColSearchCreate

`SaColSearchCreate` starts a column information search for a specified table.

7.12.1 Synopsis

```
SaColSearchT* SA_EXPORT_H SaColSearchCreate(
    SaConnectT* scon,
    char* tablename)
```

The `SaColSearchCreate` function accepts the following parameters:

Table 7.10. SaColSearchCreate Parameters

Parameters	Usage Type	Description
scon	In	Pointer to a connection object
tablename	In	Table name

7.12.2 Return Value

Pointer to the column search object, or NULL if table does not exist.

7.13 SaColSearchFree

`SaColSearchFree` releases the column search object.

7.13.1 Synopsis

```
void SA_EXPORT_H SaColSearchFree(SaColSearchT* colsearch)
```

The `SaColSearchCreate` function accepts the following parameters:

Table 7.11. SaColSearchCreate Parameters

Parameters	Usage Type	Description
colsearch	In, take	Column search pointer

7.13.2 Return Value

None

7.14 SaColSearchNext

`SaColSearchNext` returns information about the next column in the table.

7.14.1 Synopsis

```
int SA_EXPORT_H SaColSearchNext(
    SaColSearchT* colsearch,
```

```
    char** p_colname,
    SaDataTypeT* p_coltype)
```

The SaColSearchNext function accepts the following parameters:

Table 7.12. SaColSearchNext Parameters

Parameters	Usage Type	Description
colsearch	in, use	Column search pointer
p_colname	out, ref	Pointer to the local copy of the column name is stored into * p_colname
p_coltype	out	Type of column is stored into * p_coltype. See the sa.h file for a description of the SaDataTypeT data type and the valid values that it can hold.

7.14.2 Return Value

Table 7.13. SaColSearchNext Return Value

Value	Description
1	Next column found, parameters updated.
0	0 No more columns, parameters not updated. The function also will return 0 if the input parameters are invalid.

7.15 SaConnect

SaConnect creates a connection to the IBM solidDB server.

Several connections can be active at the same time, but operations in different connections are executed in separate transactions.

7.15.1 Synopsis

```
SaConnectT* SA_EXPORT_H SaConnect(
    char* servername,
```

```
    char* username,
    char* password)
```

The SaConnect function accepts the following parameters:

Table 7.14. SaConnect Parameters

Parameters	Usage Type	Description
servername	in, use	Server name. An empty servername connects to the linked server.
username	in, use	User name
password	in, use	Password

7.15.2 Return Value

Table 7.15. SaConnect Return Value

Return Usage Type	Description
give	Connect pointer, or if connection failed, NULL.

7.16 SaCursorAscending

SaCursorAscending specifies ascending order criteria for a column.

To sort by more than one column, you must call this function once for each column.

If there is no key (primary key, or index) on the column, then the rows are sorted locally (on the client) rather than on the server side.

7.16.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorAscending(
   SaCursorT* scur,
   char* colname)
```

The SaCursorAscending function accepts the following parameters:

Table 7.16. SaCursorAscending Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name

7.16.2 Return Value

SA_RC_SUCC or error code

7.17 SaCursorAtleast

`SaCursorAtleast` specifies the Atleast criterion for a column. Atleast criterion means that the column value must be greater than or equal to the Atleast value.

The Atleast value is taken from the user variable currently bound to the column.

7.17.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorAtleast(
    SaCursorT* scur,
    char* colname)
```

The `SaCursorAtleast` function accepts the following parameters:

Table 7.17. SaCursorAtleast Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name

7.17.2 Return Value

SA_RC_SUCC or error code

7.18 SaCursorAtmost

`SaCursorAtmost` specifies the Atmost criterion for a column. Atmost criterion means that the column value must be less than or equal to the Atmost value.

The Atmost value is taken from the user variable currently bound to the column.

7.18.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorAtmost(
    SaCursorT* scur,
    char* colname)
```

The `SaCursorAtmost` function accepts the following parameters:

Table 7.18. SaCursorAtmost Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name

7.18.2 Return Value

SA_RC_SUCC or error code

7.19 SaCursorBegin

`SaCursorBegin` positions the cursor to the beginning of the set. The subsequent call to the `SaCursorNext` function returns the first row.

7.19.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorBegin(
    SaCursorT* scur)
```

The `SaCursorBegin` function accepts the following parameters:

Table 7.19. SaCursorBegin Parameters

Parameters	Usage Type	Description
scur	use	Pointer to a cursor object

7.19.2 Return Value

SA_RC_SUCC or error code

7.20 SaCursorClearConstr

`SaCursorClearConstr` clears all search constraints from a cursor.

7.20.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorClearConstr(
    SaCursorT* scur)
```

The `SaCursorClearConstr` function accepts the following parameters:

Table 7.20. SaCursorClearConstr Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object

7.20.2 Return Value

SA_RC_SUCC or error code

7.21 SaCursorColData

`SaCursorColData` binds a user variable to a database column. The bound variable may be used either as an "input" parameter or an "output" parameter. An "input" parameter passes data values from the client to the server for operations such as inserts and updates, and for search constraints. An "output" parameter holds values read by the server during searches. For example, to INSERT data, the user first binds the variables, then stores values into the bound variables before the actual INSERT; those values are then copied into the database when the INSERT is performed. Similarly, during a fetch operation, when the next row is retrieved, the values in the columns of that row are copied into bound variables so that the client program can see them.

A variable may be used multiple times after a single binding. For example, if you wanted to insert multiple rows, you might create a loop in which you store appropriate values in the bound variable and then invoke the INSERT operation. The "bind" operation would only need to be done once before the loop; it would not need to be executed inside the loop for each INSERT operation. Similarly, after binding the variable(s) once, you could retrieve many rows (one at a time) using the `SaCursorNext` function. Each time that you retrieved a row, its value(s) would be copied into the bound variable(s). Note that the address of the data buffer does not change; only the value stored there changes each time what you call `SaCursorNext`.

If the column has been set as a search constraint (rather like using a WHERE clause in a SELECT statement), then the value for this constraint is set to the value pointed to by the user data variable whose address is passed as dataptr. For example, if the function `SaCursorEquals` has been called for the column, then the server retrieves only the rows whose value exactly matches the current value of the bound variable. Note that the search constraints are set up for the search operations (`SaCursorSearch`, followed by calls to `SaCursorNext`) but may actually be used to set the cursor to the correct position for other operations (such as `SaCursorUpdate` or `SaCursorDelete`). Typically, updates are combined with searches to update only some of the rows. This means that the values for columns which have search constraints are used to define the affected rows (in effect the "WHERE" clause in SQL) and other bound variables are used to define the new values for the rest of the columns. Note that the same bound variable can be used in both the search constraint and in the update/insert operation (just as the same column may be used in both the WHERE clause and the "UPDATE ... SET col = value" clause of an SQL UPDATE statement). If the same bound variable is used in both the search constraint and to convey data back and forth between the client and the server, the search constraint does not change each time that the data in the bound variable is updated; the server uses the value that was in the bound variable at the time that the search constraint was created (e.g. when functions like `SaCursortAtmost()` were called).

In search operations, the user variable is updated to contain the value of the current row. Also, if search criteria are involved, this function is used to pass the values for them. In insert and update operations the new value for the column is taken from the user variable.

When the bound variable is used as an "in" parameter (for example, in INSERT or UPDATE operations), the user is responsible for the allocation and freeing of the buffer. When a bound variable is used as an "out" parameter, the SA layer allocates and frees the buffers. When the variable is used as an "out" parameter, the value stored to the user variable is a pointer to a buffer that contains a local copy of the column data. After each row is retrieved, that row's value will be copied to this buffer. The pointer to this buffer is valid until the next `SaCursorOpen` or `SaCursorFree` call, after which the pointer should not be referenced.

7.21.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColData(
    SaCursorT* scur,
    char* colname,
```

```
    char** dataptr,
    unsigned* lenptr)
```

The SaCursorColData function accepts the following parameters:

Table 7.21. SaCursorColData Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name
dataptr	in, hold	Pointer to the user variable
lenptr	in, hold	Pointer to variable used to hold length of data

7.21.2 Return Value

SA_RC_SUCC or error code.

7.22 SaCursorColDate

SaCursorColDate binds a user variable of type SaDateT to a database column. In search operations, the user variable is updated to contain the value of the current row. Also, if search criteria are involved, this function is used to pass the values for them. In insert and update operations the new value for the column is taken from the user variable.

7.22.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColDate(
SaCursorT* scur,
char* colname,
SaDateT* dateptr)
```

The SaCursorColDate function accepts the following parameters:

Table 7.22. SaCursorColDate Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object

Parameters	Usage Type	Description
colname	in, use	Column name
dateptr	in, hold	Pointer to the user variable

7.22.2 Return Value

SA_RC_SUCC or error code.

7.22.3 See Also

See Section 7.21, “SaCursorColData” for a more detailed discussion of binding variables.

7.23 SaCursorColDateFormat

`SaCursorColDateFormat` binds date format string to a database column. In search operations, the user variable is updated to contain the value of the current row. Also, if search criteria are involved, this function is used to pass the values for them. Depending on the column data type, the format string should be date, time, or timestamp format.

7.23.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColDateFormat(
    SaCursorT* scur,
    char* colname,
    char* dtformat)
```

The `SaCursorColDateFormat` function accepts the following parameters:

Table 7.23. SaCursorColDateFormat Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name
dtformat	in, hold	Date/time/timestamp format string

7.23.2 Return Value

SA_RC_SUCC or error code.

7.23.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of binding variables. For explanation of possible date/time/timestamp formats, see Section 7.58, “SaDateSetAsciiz”.

7.24 SaCursorColDfloat

`SaCursorColDfloat` binds a user variable of type SaDfloatT to a database column. In search operations, the user variable is updated to contain the value of the current row. Also, if search criteria are involved, this function is used to pass the values for them. In insert and update operations the new value for the column is taken from the user variable.

SaDFloatT corresponds to the SQL data type DECIMAL (not FLOAT).

7.24.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColDfloat(
    SaCursorT* scur,
    char* colname,
    SaDfloatT* dfloatptr)
```

The `SaCursorColDfloat` function accepts the following parameters:

Table 7.24. SaCursorColDfloat Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name
dtfloatptr	in, hold	Pointer to the user variable

7.24.2 Return Value

SA_RC_SUCC or error code.

7.24.3 See Also

Section 7.25, “SaCursorColDouble”.

Section 7.28, “SaCursorColFloat”.

See Section 7.21, “SaCursorColData” for a more detailed discussion of binding variables.

7.25 SaCursorColDouble

`SaCursorColDouble` binds a user variable of type double to a database column. In search operations, the user variable is updated to contain the value of the current row. Also, if search criteria are involved, this function is used to pass the values for them. In insert and update operations the new value for the column is taken from the user variable.

Remember that C-language data type "double" is equivalent to SQL data type "FLOAT".

7.25.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColDouble(
    SaCursorT* scur,
    char* colname,
    double* doubleptr)
```

The `SaCursorColDouble` function accepts the following parameters:

Table 7.25. SaCursorColDouble Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name
doubleptr	in, hold	Pointer to the user variable

7.25.2 Return Value

SA_RC_SUCC or error code.

7.25.3 See Also

Section 7.28, “SaCursorColFloat”.

Section 7.24, “SaCursorColDfloat”.

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of binding variables.

7.26 SaCursorColDynData

`SaCursorColDynData` binds a user variable of type SaDynDataT to a database column. In search operations, the user variable is updated to contain the value of the current row. Also, if search criteria are involved, this function is used to pass the values for them. In insert and update operations, the new value for the column is taken from the user variable.

In search operations, the column data is stored to the SaDynDataT variable using function `SaDynDataMove`, which overwrites the old data. The user is responsible for releasing the SaDynDataT variable after the search ends using function SaDynDataFree.

Dynamic data objects (SaDynDataT) are an abstraction that simplifies the handling of variable length data. Although dynamic data can be used with all types of data, it is best fit for variable length data (VARBINARY, LONG VARBINARY, VARCHAR, LONG VARCHAR, etc.).

The memory management of the data object is hidden inside the object. Dynamic data objects have two externally-visible attributes: the data and the length. Typically, the functions `SaDynDataMove` and `SaDynDataAppend` are used to set and modify the data value inside the dynamic data object. More memory will be automatically allocated when necessary and all the associated memory will be automatically deallocated when the dynamic data object is disposed of using `SaDynDataFree`. The user can access the data or the length using the respective functions `SaDynDataGetData` and `SaDynDataGetLen`.

The use of `SaDynDataMove` and `SaDynDataAppend` may not be feasible when the data already exists completely in a memory buffer. In addition to increasing the memory usage by keeping two copies of the same data, the overhead of the memory copy may be significant if the buffers are large. Therefore, it may be wise to directly assign the data pointer by using `SaDynDataMoveRef` (rather than copying by using `SaDynDataMove`). In this case, the user may modify or deallocate the memory buffer only after the dynamic data object itself has been freed.

7.26.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColDynData(
    SaCursorT* scur,
    char* colname,
    SaDynDataT* dd)
```

The `SaCursorColDynData` function accepts the following parameters:

Table 7.26. SaCursorColDynData Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name
dd	in, hold	Pointer to the user variable

7.26.2 Return Value

SA_RC_SUCC or error code.

7.26.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of binding variables.

7.27 SaCursorColDynStr

`SaCursorColDynStr` binds a user variable of type SaDynStrT to a database column. In search operations, the user variable is updated to contain the value of the current row. Also, if search criteria are involved, this function is used to pass the values for them. In insert and update operations, the new value for the column is taken from the user variable.

In search operations, the column data is stored to the SaDynStrT variable using function `SaDynStrMove`, which overwrites the old data. The user is responsible for releasing the SaDynStrT variable after the search ends using function `SaDynStrFree`.

The user may bind an SaDynStrT variable to any type of column (not just character columns) and the data will be converted back and forth between the column type and the Dynamic String type.

Dynamic String objects (SaDynStrT) are an abstraction that simplifies the handling of variable length strings. Typically, the functions `SaDynStrMove` and `SaDynStrAppend` are used to set and modify the data value inside the dynamic string object. More memory will be automatically allocated when necessary and all the associated memory will be automatically deallocated when the dynamic data object is disposed of using SaDynStrFree.

7.27.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColDynStr(
    SaCursorT* scur,
```

```
    char* colname,
    SaDynStrT* ds)
```

The SaCursorColDynStr function accepts the following parameters:

Table 7.27. SaCursorColDynStr Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name
ds	in, hold	Pointer to the user variable

7.27.2 Return Value

SA_RC_SUCC or error code.

7.27.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of binding variables.

7.28 SaCursorColFloat

SaCursorColFloat binds a user variable of type float to a database column.

After the variable has been bound, it can be used to hold a value that will be written to or read from a column, or that will be used to constrain a search operation (e.g. as part of the equivalent of a WHERE clause in SQL). In search operations, the user variable is updated to contain the value read from the current row that has been retrieved. Also, if search criteria are involved, this function can be used to pass the values for them. In update and insert operations, the new value is taken from the bound user variable and then written to the column in the database.

Remember that C-language "float" corresponds to SQL "SMALLFLOAT", not SQL "FLOAT".

7.28.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColFloat(
    SaCursorT* scur,
```

```
    char* colname,
    float* floatptr)
```

The `SaCursorColFloat` function accepts the following parameters:

Table 7.28. SaCursorColFloat Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name
floatptr	in, hold	Pointer to the user variable

7.28.2 Return Value

SA_RC_SUCC or error code.

7.28.3 See Also

Section 7.25, “SaCursorColDouble”.

Section 7.24, “SaCursorColDfloat”.

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of binding variables.

7.29 SaCursorColInt

`SaCursorColInt` binds a user variable of type int to a database column.

After the variable has been bound, it can be used to hold a value that will be written to or read from a column, or that will be used to constrain a search operation (e.g. as part of the equivalent of a WHERE clause in SQL). In search operations, the user variable is updated to contain the value read from the current row that has been retrieved. Also, if search criteria are involved, this function can be used to pass the values for them. In update and insert operations, the new value is taken from the bound user variable and then written to the column in the database.

Note that the C-language "int" data type is platform-dependent, while the SQL data types (TINYINT, SMALLINT, INT, and BIGINT) are platform-independent. You must be careful to map the appropriate C-language data type and value to the corresponding SQL data type.

7.29.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColInt(
SaCursorT* scur,
char* colname,
int* intptr)
```

The `SaCursorColInt` function accepts the following parameters:

Table 7.29. SaCursorColInt Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name
intptr	in, hold	Pointer to the user variable

7.29.2 Return Value

SA_RC_SUCC or error code.

7.29.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of binding variables.

7.30 SaCursorColLong

`SaCursorColLong` binds a user variable to a database column.

After the variable has been bound, it can be used to hold a value that will be written to or read from a column, or that will be used to constrain a search operation (e.g. as part of the equivalent of a WHERE clause in SQL). In search operations, the user variable is updated to contain the value read from the current row that has been retrieved. Also, if search criteria are involved, this function can be used to pass the values for them. In update and insert operations, the new value is taken from the bound user variable and then written to the column in the database.

Note that the C-language "long" data type is platform-dependent, while the SQL data types (TINYINT, SMALLINT, INT, and BIGINT) are platform-independent. You must be careful to map the appropriate C-language data type and value to the corresponding SQL data type.

7.30.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColLong(
    SaCursorT* scur,
    char* colname,
    long* longptr)
```

The `SaCursorColLong` function accepts the following parameters:

Table 7.30. SaCursorColLong Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name
longptr	in, hold	Pointer to the user variable

7.30.2 Return Value

SA_RC_SUCC or error code.

7.30.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of binding variables.

7.31 SaCursorColNullFlag

`SaCursorColNullFlag` binds a NULL value flag to a column. If the column value is NULL, then * p_isnullflag has a value 1, otherwise the value is 0. The * p_isnullflag value is updated automatically during fetch operations. In search operations, the user variable is updated to contain the value of the current row. Also, if search criteria are involved, this function is used to pass the values for them. During insert and update, a NULL value is inserted to the database if *p _isnullflag is not zero.

7.31.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColNullFlag(
SaCursorT* scur,
```

```
char* colname,
int* p_isnullflag)
```

The SaCursorColNullFlag function accepts the following parameters:

Table 7.31. SaCursorColNullFlag Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name
p_isnullflag	in, hold	Pointer to an integer variable into where the NULL status is stored during fetch operations, and from where the NULL status is taken during insert and update operations.

7.31.2 Return Value

SA_RC_SUCC or error code.

7.31.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of binding variables.

7.32 SaCursorColStr

SaCursorColStr binds a user variable to a database column. In search operations, the user variable is updated to contain the value of the current row. Also, if search criteria are involved, this function is used to pass the values for them. In insert and update operations the new value for the column is taken from the user variable.

In search operations, the value stored to the user variable is a pointer to a local copy of the column data. The data pointer is valid until the next SaCursorOpen or SaCursorFree call, after which the pointer should not be referenced.

7.32.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColStr(
SaCursorT* scur,
```

```
char* colname,
char** strptr)
```

The SaCursorColStr function accepts the following parameters:

Table 7.32. SaCursorColStr Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name
strptr	in, hold	Pointer to the user variable.

7.32.2 Return Value

SA_RC_SUCC or error code.

7.32.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of binding variables.

7.33 SaCursorColTime

SaCursorColTime binds a user variable of type SaDateT to a database column. In search operations, the user variable is updated to contain the value of the current row. Also, if search criteria are involved, this function is used to pass the values for them. In insert and update operations the new value for the column is taken from the user variable.

7.33.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColTime(
    SaCursorT* scur,
    char* colname,
    SaDateT* timeptr)
```

Note that the data type of timeptr is indeed SaDateT; there is no separate SaTimeT for time data.

The SaCursorColTime function accepts the following parameters:

Table 7.33. SaCursorColTime Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name
timeptr	in, hold	Pointer to the user variable.

7.33.2 Return Value

SA_RC_SUCC or error code.

7.33.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of binding variables.

7.34 SaCursorColTimestamp

`SaCursorColTimestamp` binds a user variable of type SaDateT to a database column. In search operations, the user variable is updated to contain the value of the current row. Also, if search criteria are involved, this function is used to pass the values for them. In insert and update operations the new value for the column is taken from the user variable.

7.34.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorColTimestamp(
    SaCursorT* scur,
    char* colname,
    SaDateT* timestampptr)
```

Note that the data type of timeptr is indeed SaDateT; there is no separate SaTimestampT for timestamp data.

The `SaCursorColTimestamp` function accepts the following parameters:

Table 7.34. SaCursorColTimestamp Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name

Parameters	Usage Type	Description
timestampptr	in, hold	Pointer to the user variable.

7.34.2 Return Value

SA_RC_SUCC or error code.

7.34.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of binding variables.

7.35 SaCursorCreate

`SaCursorCreate` creates a cursor to a table specified by table name. The operation fails if the table does not exist.

7.35.1 Synopsis

```
SaCursorT* SA_EXPORT_H SaCursorCreate(
    SaConnectT* scon,
    char* tablename)
```

The `SaCursorCreate` function accepts the following parameters:

Table 7.35. SaCursorCreate Parameters

Parameters	Usage Type	Description
scon	in, hold	Pointer to a connection object
tablename	in, use	Table name

7.35.2 Return value

The parameter scon has the Usage Type "hold" because the created cursor object keeps referencing the scon object even after the function call has returned.

Table 7.36. Return Value

Return Usage Type	Description
give	Pointer to the cursor object, or NULL if table does not exist.

7.36 SaCursorDelete

`SaCursorDelete` deletes the current row in a cursor from the database. The cursor must be positioned to a row.

7.36.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorDelete(SaCursorT* scur)
```

The `SaCursorDelete` function accepts the following parameters:

Table 7.37. SaCursorDelete Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object

7.36.2 Return Value

SA_RC_SUCC or error code

7.37 SaCursorDescending

`SaCursorDescending` specifies descending sorting criterion for a column.

To sort by more than one column, you must call this function once for each column.

If there is no key (primary key, or index) on the column, then the rows are sorted locally (on the client) rather than on the server side.

7.37.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorDescending(
```

```
    SaCursorT* scur,
    char* colname)
```

The `SaCursorDescending` function accepts the following parameters:

Table 7.38. SaCursorDescending Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name

7.37.2 Return Value

SA_RC_SUCC or error code

7.38 SaCursorEnd

`SaCursorEnd` positions the cursor to the end of the set. A subsequent call to `SaCursorPrev` will position the cursor to the last row in the set.

7.38.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorEnd(
    SaCursorT* scur)
```

The `SaCursorEnd` function accepts the following parameters:

Table 7.39. SaCursorEnd Parameters

Parameters	Usage Type	Description
scur	use	Pointer to a cursor object

7.38.2 Return Value

SA_RC_SUCC or error code

7.39 SaCursorEqual

`SaCursorEqual` specifies an equal search criterion for a column.

7.39.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorEqual(
    SaCursorT* scur,
    char* colname)
```

The `SaCursorEqual` function accepts the following parameters:

Table 7.40. SaCursorEqual Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name

7.39.2 Return Value

SA_RC_SUCC or error code

7.40 SaCursorErrorInfo

`SaCursorErrorInfo` returns error information from the last operation in the cursor.

7.40.1 Synopsis

```
bool SA_EXPORT_H SaCursorErrorInfo(
SaCursorT* scur,
char** errstr,
int* errcode)
```

The `SaCursorErrorInfo` function accepts the following parameters:

Table 7.41. SaCursorErrorInfo Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
errstr	out, ref	If non-NULL, pointer to a local copy of an error string is stored into * errstr.
errcode	out	If non-NULL, error code is stored into * errcode.

7.40.2 Return Value

TRUE If there are errors, errstr and errcode are updated.

FALSE If there are no errors, errstr and errcode are not updated.

7.41 SaCursorFree

`SaCursorFree` releases a cursor. After this call the cursor pointer is invalid.

7.41.1 Synopsis

```
void SA_EXPORT_H SaCursorFree(SaCursorT* scur)
```

The `SaCursorFree` function accepts the following parameters:

Table 7.42. SaCursorFree Parameters

Parameters	Usage Type	Description
scur	in, take	Pointer to a cursor object

7.41.2 Return Value

None.

7.42 SaCursorInsert

`SaCursorInsert` inserts a new row into the database. Column values for the new row are taken from the user variables bound to columns. The cursor must be opened before new rows can be inserted.

7.42.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorInsert(SaCursorT* scur)
```

The `SaCursorInsert` function accepts the following parameters:

Table 7.43. SaCursorInsert Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object

7.42.2 Return Value

SA_RC_SUCC or error code

7.43 SaCursorLike

`SaCursorLike` specifies a like criterion for a column. The value cannot contain any wild card characters like '_' or '%' in SQL. If such characters exist in the column value, they are quoted with escape characters by the system. Thus, the like value is effectively the same as the SQL like with no wild card characters ending with a '%' character. For example, if you specify that the engine should search for "MARK" in the column, then the engine will find all values that start with "MARK", such as "MARK", "MARK SMITH", and "MARKETING".

The like value is taken from the user variable bound to the column.

7.43.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorLike(
    SaCursorT* scur,
```

```
    char* colname,
    int likelen)
```

The SaCursorLike function accepts the following parameters:

Table 7.44. SaCursorLike Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name
likelen	in	Length of like part (excluding the string terminator)

7.43.2 Return Value

SA_RC_SUCC or error code

7.44 SaCursorNext

SaCursorNext fetches the next row from the database. All user variables bound to columns are updated.

7.44.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorNext(SaCursorT* scur)
```

The SaCursorNext function accepts the following parameters:

Table 7.45. SaCursorNext Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object

7.44.2 Return Value

SA_RC_SUCC Next row found

SA_RC_END End of search

7.45 SaCursorOpen

`SaCursorOpen` opens a cursor. All `SaCursorColXXX` operations must be done before the cursor is opened. When cursor is opened, possible existing search is terminated. Also all search criteria specified for the cursor are cleared.

After the cursor is opened, user can insert new rows to the cursor or specify search criteria. Cursor must be opened before a search can be started.

7.45.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorOpen(SaCursorT* scur)
```

The `SaCursorOpen` function accepts the following parameters:

Table 7.46. SaCursorOpen Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object

7.45.2 Return Value

SA_RC_SUCC or error code

7.46 SaCursorOrderbyVector

`SaCursorOrderbyVector` is used to specify the order of columns used in a search. The initial values are used as a vector of values to specify the starting position for the search in the key. The initial value is used only for the starting point selection in the key; after that, the initial values are not checked against the column values. If several criteria are given, they are solved in the given order. A proper key must exist for the ordering.

The initial value is taken from the user variable bound to the column.

7.46.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorOrderbyVector(
```

```
    SaCursorT* scur,
    char* colname)
```

The `SaCursorOrderbyVector` function accepts the following parameters:

Table 7.47. SaCursorOrderbyVector Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
colname	in, use	Column name

7.46.2 Return Value

SA_RC_SUCC or error code

Example 7.1. SaCursorOrderbyVector Example

```
/* These variables will be bound to the columns named "I" and "J" */
int i, j;
/* Bind variables to columns in this cursor. */
SaCursorColStr(scur, "I", 'i);
SaCursorColStr(scur, "J", 'j);
/* Set the values that we want to use in the search. */
i = 2;
j = 1;
/* Specify the order of the columns. */
SaCursorOrderByVector(scur, "I");
SaCursorOrderByVector(scur, "J");
/* Search the cursor for matching values. */
SaCursorSearch(scur);
```

The preceding would be the equivalent of the following SQL WHERE clause:

```
...WHERE (i,j) >= (2,1)
```

7.47 SaCursorPrev

`SaCursorPrev` fetches the previous row from the database. All user variables currently bound to columns are updated.

7.47.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorPrev(SaCursorT* scur)
```

The `SaCursorPrev` function accepts the following parameters:

Table 7.48. SaCursorPrev Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object

7.47.2 Return Value

SA_RC_SUCC Previous row found

SA_RC_END Beginning of search (we are already at the first row, so there is no previous row). Note that SA_RC_END can apply to either end (start or finish) of the cursor.

7.48 SaCursorReSearch

`SaCursorReSearch` starts a new search using old search criteria.

7.48.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorReSearch(SaCursorT* scur)

The SaCursorReSearch function accepts the following
parameters:
```

Table 7.49. SaCursorReSearch Parameters

Parameters	Usage Type	Description
scur	use	Pointer to a cursor object

7.48.2 Return Value

SA_RC_SUCC, SA_RC_END, or error code. See Section 7.7, “Handling Database Errors” for a list of error codes.

7.49 SaCursorSearch

`SaCursorSearch` starts a search in a cursor. After the search is started, the user can fetch rows from the database.

Every search is executed as a separate transaction and it does not see any changes made by the current user or any other user after the search is started.

7.49.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorSearch(SaCursorT* scur)
```

The `SaCursorSearch` function accepts the following parameters:

Table 7.50. SaCursorSearch Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object

7.49.2 Return Value

SA_RC_SUCC SA_RC_END or error code

7.50 SaCursorSearchByRowid

`SaCursorSearchByRowid` starts a new search where the row specified by rowid belongs to the search set. This searches only according to rowid, so it returns one row or zero rows. Previous search constraints are not removed, and they become effective in the next `SaCursorReSearch` call.

To get the rowid for a particular record, simply read the value of the rowid column. (Every table has a rowid column; you do not need to explicitly create a rowid column with in a CREATE TABLE or ALTER TABLE statement.)

7.50.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorSearchByRowid(
    SaCursorT* scur,
```

```
    void* rowid,
    int rowidlen)
```

The `SaCursorSearchByRowid` function accepts the following parameters:

Table 7.51. SaCursorSearchByRowid Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
rowid	in, use	Pointer to a data area containing rowid. The rowid should be in the form of a string (char *) despite the fact that it is declared as "void *".
rowidlen	in	Length of data (string) pointed to by the rowid parameter

7.50.2 Return Value

SA_RC_SUCC

SA_RC_END

or error code

7.51 SaCursorSearchReset

This function "resets" a search cursor. The old search constraints are used, but their values are re-read from the user buffers (i.e. the parameters). This allows you to increase performance in situations where you want to repeat a search using a query that is identical except for the specific values used.

For example, suppose that a particular user or connection always searches a particular table based on the ID column in that table, but uses a different ID value in each search. Instead of creating a "new" query to search for the next ID, you can reset the existing query and use a new value.

As an example, suppose that your existing code looks similar to the following:

```
...
/* Bind variable(s) to column(s). */
SaCursorColInt(scur, "MY_COL_NAME", &search_parameter1);

/* Repeat a query using different values each time. */
while (there_are_more_values_to_look_for)  {
    /* Set the parameter to the value that you want to search for. */
```

```
    search_parameter1 = some_value;
    /* Specify the search criterion. */
    rc = SaCursorEqual(scur, "MY_COL_NAME");
    /* Create new query that uses that search criterion and param value*/
    rc = SaCursorSearch(scur);
    /* Get the row (or rows) that match the search criteria. */
    rc = SaCursorNext(scur);
    /* Process the retrieved data... */
    foo();
    ...
    /* Get rid of the old query before the next loop iteration. */
    rc = SaCursorClearConstr(scur);
    }
...
```

You can get significantly better performance in most cases by changing your code to look similar to the following:

```
...
/* Bind variable(s) to column(s). */
SaCursorColInt(scur, "MY_COL_NAME", &search_parameter1);

/* Create a new query. */
rc = SaCursorEqual(scur, "MY_COL_NAME");
rc = SaCursorSearch(scur);
/* Set the parameter to the value that you want to search for. */
search_parameter1 = some_value;

/* Repeat a query using different values each time. */
while (there_are_more_values_to_look_for)  {
    /* Get the row (or rows) that match the search criteria. */
    rc = SaCursorNext(scur);
    /* Process the retrieved data... */
    foo();
    ...
    /* Set the param to the next value that you want to search for. */
    search_parameter1 = some_value;
    /* Reset the existing query to use the latest value in the param. */
    rc = SaCursorSearchReset(scur);
```

```
    }
...
```

As you can see, when you use `SaCursorSearchReset()`, you no longer have to re-specify the constraint condition ("Equal", in the example above) and call `SaCursorSearch()` each time.

Note

Make sure that you update the values of the search parameters in the buffers BEFORE you call this function; the new values are read during this function call.

`SaCursorSearchReset` resets the cursor to the beginning of the new result set. For example, if you reset a search with no constraints at all, it will rewind the cursor to the beginning of the table.

LIMITATIONS

1. Currently, `SaCursorSearchReset()` can not be used if the search:

   - has a local sort, i.e. not all sorting criteria could be solved by the index used for the search
   - is done by rowid with `SaCursorSearchByRowid`

   In these cases, `SaCursorSearchReset` returns SA_ERR_NORESETSEARCH.

2. There is a strict limitation when using "like" constraints: each "like" value that you use must be the same length. The reason for this is that `SaCursorLike()` takes the length of the "like" constraint as an argument, but there's no way to change this length when `SaCursorSearchReset()` is called. For example, the function will work correctly if you use the following sequence of "like" values, because they are all the same length:

   ```
   "SMITH"
   ```

   ```
   "JONES"
   ```

   However, the function will not work correctly if you use the following sequence of "like" values:

   ```
   "SMITH"
   ```

   ```
   "JOHNSON"
   ```

3. Using `SaCursorSearchReset` is usually impractical if you set multiple constraints using the same column binding. For example, suppose that you want to search for values of "col" in the range between 1 and 10 (inclusive). Your code would look like:

```
SaCursorColInt(scur, "col", &i);
i = 1;
SaCursorAtleast(scur, "col");
i = 10;
SaCursorAtmost(scur, "col");
```

   If you reset a search like this, the new value for the column is read from the variable i only once. Therefore, the server reads one value and uses it as both the upper and lower bound. For example, suppose that you use the following code:

```
i = 5;
SaCursorSearchReset(scur);
```

   This code makes the search 5 <= i <= 5, which is almost certainly not what you want.

7.51.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorSearchReset(
    SaCursorT* scur
)
```

The `SaCursorSearchReset` function accepts the following parameters:

Table 7.52. SaCursorSearchReset Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object

7.51.2 Return Value

SA_RC_SUCC

or error code

7.52 SaCursorSetLockMode

`SaCursorSetLockMode` sets the cursor search mode. This setting affects the possible locking modes in the server. If a search is already active, the setting will affect only the next search done in the same cursor. By default the search mode is SA_LOCK_SHARE.

7.52.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorSetLockMode(
    SaCursorT* scur,
    sa_lockmode_t lockmode)
```

The `SaCursorSetLockMode` function accepts the following parameters:

Table 7.53. SaCursorSetLockMode Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
lockmode	in	Search mode that can be one of the following: SA_LOCK_SHARE SA_LOCK_FORUPDATE SA_LOCK_EXCLUSIVE

The meanings of the various lockmodes are:

SA_LOCK_SHARE: default optimistic concurrency control.

SA_LOCK_FORUPDATE: locks the row for update; others can only read, not write.

SA_LOCK_EXCLUSIVE: locks the row exclusively; others cannot read or write this record.

Note that this function applies to any table; the table does not need to have a particular lock mode for this function to apply.

7.52.2 Return Value

SA_RC_SUCC

SA_ERR_ILLENUMVAL

7.53 SaCursorSetPosition

`SaCursorSetPosition` positions the cursor to a row specified by a key value. The key value is taken from user bound column variables which have a constraint specification.

7.53.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorSetPosition(
    SaCursorT* scur)
```

The `SaCursorSetPosition` function accepts the following parameters:

Table 7.54. SaCursorSetPosition Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object

7.53.2 Return Value

SA_RC_SUCC or error code

7.54 SaCursorSetRowsPerMessage

`SaCursorSetRowsPerMessage` sets the number of rows to be sent in one network message from the server to the client. Note that the setting has no effect after the search has been started by function `SaCursorSearch`.

7.54.1 Synopsis

```
SaRetT SA_EXPORT_H
    SaCursorSetRowsPerMessage(
    SaCursorT* scur,
    int rows_per_message)
```

The `SaCursorSetRowsPerMessage` function accepts the following parameters:

Table 7.55. SaCursorSetRowsPerMessage Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object
rows_per_message	in	Number of rows to send in one network message

7.54.2 Return Value

SA_RC_SUCC Success

SA_ERR_FAILED Error, rows_per_message < 1

7.55 SaCursorUpdate

`SaCursorUpdate` updates the current row in a cursor in the database. The cursor must be positioned to a row. Column values for the new row are taken from the user variables bound to columns.

7.55.1 Synopsis

```
SaRetT SA_EXPORT_H SaCursorUpdate(SaCursorT* scur)
```

The `SaCursorUpdate` function accepts the following parameters:

Table 7.56. SaCursorUpdate Parameters

Parameters	Usage Type	Description
scur	in, use	Pointer to a cursor object

7.55.2 Return Value

SA_RC_SUCC or error code

7.56 SaDateCreate

`SaDateCreate` creates a new date object. The date stored in the date object is undefined.

7.56.1 Synopsis

```
SaDateT* SA_EXPORT_H SaDateCreate(void)
```

The `SaDateCreate` function accepts no parameters.

7.56.2 Return Value

Table 7.57. SaDateCreate Return Values

Return Usage Type	Description
give	A new date object

7.57 SaDateFree

`SaDateFree` releases a date object. After this call the date object is invalid and cannot be used.

7.57.1 Synopsis

```
void SA_EXPORT_H SaDateFree(SaDateT* date)
```

The `SaDateFree` function accepts the following parameters:

Table 7.58. SaDateFree Parameters

Parameters	Usage Type	Description
date	in, take	Date object

7.57.2 Return Value

None.

7.58 SaDateSetAsciiz

`SaDateSetAsciiz` sets ASCII zero string date to a date object.

The following special characters are recognized in the format string:

```
YYYY        year including century
YY          year with default century 1900
MM          month
M           month
DD          day of month
D           day of month
HH          hours
H           hours
NN          minutes
N           minutes
SS          seconds
S           seconds
FFF         fractions of a second, 1/1000 seconds
```

All fields are optional. The fields are scanned from the format string, and when a match is found, the field is replaced with the proper value. All other characters in the format are treated literally.

Double letters (for example, "MM", "DD", etc.) indicate that the values should be expressed with two digits (values 1-9 will be preceded with the 0 character, for example, 01). Single letters indicate that the value should be expressed with one digit if possible. For example, if you define the date format as "YY-M-D" then the date January 2, 1999 will look like "99-1-2". If you define the date format as "YY-MM-DD", then the date will look like "99-01-02"

Below are examples of the usage of date formats:

```
SaDateSetAsciiz(date, "YY-MM-DD", "94-09-13");
```

```
SaDateSetAsciiz(date, "MM/DD/YY HH.NN", "09/13/94 19.20");
```

The default date format is YYYY-MM-DD HH:NN:SS, where time fields are optional.

7.58.1 Synopsis

```
SaRetT SA_EXPORT_H SaDateSetAsciiz(
    SaDateT* date,
    char* format,
    char* asciiz)
```

The `SaDateSetAsciiz` function accepts the following parameters:

Table 7.59. SaDateSetAsciiz Parameters

Parameters	Usage Type	Description
date	in, out	Date object
format	in, use	Format of date in asciiz (zero-terminated ASCII) buffer, or NULL if default format is used
asciiz	in, use	Buffer containing the data in asciiz (zero-terminated ASCII) string format

7.58.2 Return Value

SA_RC_SUCC

SA_ERR_FAILED

7.59 SaDateSetTimet

`SaDateSetTimet` copies the input value from the variable named "timet" to the variable named "date". The value is automatically converted from the format time_t (the format returned by C-library function `time()`) to the format SaDateT.

7.59.1 Synopsis

```
SaRetT SA_EXPORT_H SaDateSetTimet(
SaDateT* date,
long timet)
```

The `SaDateSetTimet` function accepts the following parameters:

Table 7.60. SaDateSetTimet Parameters

Parameters	Usage Type	Description
date	use	Date object
timet	in	New date value in time_t format

7.59.2 Return Value

SA_RC_SUCC

SA_ERR_FAILED

7.60 SaDateToAsciiz

`SaDateToAsciiz` stores the date in an ASCII zero-terminated string format. For an explanation of different date formats, see function `SaDateSetAsciiz`.

7.60.1 Synopsis

```
SaRetT SA_EXPORT_H SaDateToAsciiz(
SaDateT* date,
char* format,
char* asciiz)
```

The `SaDateToAsciiz` function accepts the following parameters:

Table 7.61. SaDateToAsciiz parameters

Parameters	Usage Type	Description
date	in, use	Date object
format	in, use	Format of date in asciiz (zero-terminated ASCII) buffer, or NULL if default format is used
asciiz	out	Buffer where date is stored. Note that the caller must allocate a sufficiently large buffer before calling this function, and is also responsible for deallocating the buffer when done with it.

7.60.2 Return Value

SA_RC_SUCC

SA_ERR_FAILED

7.61 SaDateToTimet

`SaDateToTimet` stores the date in a time_t format. The time_t date is the same value as returned by C-library function `time()`.

7.61.1 Synopsis

```
SaRetT SA_EXPORT_H SaDateToTimet(
SaDateT* date,
long* p_timet)
```

The `SaDateToTimet` function accepts the following parameters:

Table 7.62. SaDateToTimet Parameters

Parameters	Usage Type	Description
date	in, use	Date object
timet	out	Pointer to a long variable into where the date is stored in time_t format.

7.61.2 Return Value

SA_RC_SUCC

SA_ERR_FAILED

7.62 SaDefineChSet

`SaDefineChSet` defines the client character set.

7.62.1 Synopsis

```
SaRetT SA_EXPORT_H SaDefineChSet(
SaConnectT* scon,
SaChSetT chset)
```

The `SaDefineChSet` function accepts the following parameters:

Table 7.63. SaDefineChSet Parameters

Parameters	Usage Type	Description
scon	in out	Pointer to a connection object

Parameters	Usage Type	Description
chset	in	Enumerated charset specification. The valid character sets are listed in the `sa.h` file and include SA_CHSET_DEFAULT, SA_CHSET_ANSI, etc.

Note that the usage type of scon includes "out" because the scon parameter is modified by this function call.

7.62.2 Return Value

SA_RC_SUCC when OK or SA_ERR_CHSETUNSUPP when specified character set is not supported.

7.63 SaDfloatCmp

`SaDfloatCmp` compares two dfloat values.

7.63.1 Synopsis

```
int SA_EXPORT_H SaDfloatCmp(
SaDfloatT* p_dfl1,
SaDfloatT* p_dfl2)
```

The `SaDfloatCmp` function accepts the following parameters:

Table 7.64. SaDfloatCmp Parameters

Parameters	Usage Type	Description
p_dfl1	in, use	Pointer to dfloat variable
p_dfl2	in, use	Pointer to dfloat variable

7.63.2 Return Value

```
<   -1 if p_dfl1 < p_dfl2
=   0  if p_dfl1 = p_dfl2
>   1 if p_dfl1 > p_dfl2
```

This parallels the `strcmp()` function in C, which returns a negative number if the first parameter is less than the second, zero if the two are equal, and a positive number (greater than zero) if the first parameter is greater than the second.

7.64 SaDfloatDiff

`SaDfloatDiff` calculates the difference of two dfloat values (that is, p_dfl1 - p_dfl2). The result is stored into * p_result_dfl.

7.64.1 Synopsis

```
SaRetT SA_EXPORT_H SaDfloatDiff(
    SaDfloatT* p_result_dfl,
    SaDfloatT* p_dfl1,
    SaDfloatT* p_dfl2)
```

The `SaDfloatDiff` function accepts the following parameters:

Table 7.65. SaDfloatDiff Parameters

Parameters	Usage Type	Description
p_result_dfl	out	Pointer to dfloat variable where the result is stored.
p_dfl1	in, use	Pointer to dfloat variable
p_dfl2	in, use	Pointer to dfloat variable

7.64.2 Return Value

SA_RC_SUCC

SA_ERR_FAILED

7.65 SaDfloatOverflow

`SaDfloatOverflow` checks if the dfloat contains an overflow value.

7.65.1 Synopsis

```
int SA_EXPORT_H SaDfloatOverflow(
    SaDfloatT* p_dfl)
```

The `SaDfloatOverflow` function accepts the following parameters:

Table 7.66. SaDfloatOverflow Parameters

Parameters	Usage Type	Description
p_dfl	in, use	Pointer to dfloat variable

7.65.2 Return Value

1: dfloat value is an overflow value

0: dfloat value is not an overflow value

7.66 SaDfloatProd

`SaDfloatProd` calculates the product of two dfloat values. The result is stored into *p_result_dfl.

7.66.1 Synopsis

```
SaRetT SA_EXPORT_H SaDfloatProd(
SaDfloatT* p_result_dfl,
SaDfloatT* p_dfl1,
SaDfloatT* p_dfl2)
```

The `SaDfloatProd` function accepts the following parameters:

Table 7.67. SaDfloatProd Parameters

Parameters	Usage Type	Description
p_result_dfl	out	Pointer to dfloat variable where the result is stored.
p_dfl1	in	Pointer to dfloat variable.

Parameters	Usage Type	Description
p_dfl2	in	Pointer to dfloat variable.

7.66.2 Return Value

SA_RC_SUCC

SA_ERR_FAILED

7.67 SaDfloatQuot

`SaDfloatQuot` calculates the quotient of two dfloat values (that is, p_dfl1 / p_dfl2). The result is stored into * p_result_dfl.

7.67.1 Synopsis

```
SaRetT SA_EXPORT_H SaDfloatQuot(
    SaDfloatT* p_result_dfl,
    SaDfloatT* p_dfl1,
    SaDfloatT* p_dfl2)
```

The `SaDfloatQuot` function accepts the following parameters:

Table 7.68. SaDfloatQuot Parameters

Parameters	Usage Type	Description
p_result_dfl	out	Pointer to dfloat variable where the result is stored
p_dfl1	in	Pointer to dfloat variable.
p_dfl2	in	Pointer to dfloat variable.

7.67.2 Return Value

SA_RC_SUCC

SA_ERR_FAILED

7.68 SaDfloatSetAsciiz

`SaDfloatSetAsciiz` sets the value of the dfloat from a zero-terminated ASCII string.

7.68.1 Synopsis

```
SaRetT SA_EXPORT_H SaDfloatSetAsciiz(
    SaDfloatT* p_dfl,
    char* asciiz)
```

The `SaDfloatSetAsciiz` function accepts the following parameters:

Table 7.69. SaDfloatSetAsciiz Parameters

Parameters	Usage Type	Description
p_dfl1	out	Pointer to dfloat variable where the result is stored.
asciiz	in	Buffer where the dfloat value is read as a zero-terminated ASCII string.

7.68.2 Return Value

SA_RC_SUCC

SA_ERR_FAILED

7.69 SaDfloatSum

`SaDfloatSum` calculates the sum of two dfloat values. The result is stored into * p_result_dfl.

7.69.1 Synopsis

```
SaRetT SA_EXPORT_H SaDfloatSum(
    SaDfloatT* p_result_dfl,
    SaDfloatT* p_dfl1,
    SaDfloatT* p_dfl2)
```

The `SaDfloatSum` function accepts the following parameters:

Table 7.70. SaDfloatSum Parameters

Parameters	Usage Type	Description
p_result_dfl	out	Pointer to dfloat variable where the result is stored
p_dfl1	in	Pointer to dfloat variable.
p_dfl2	in	Pointer to dfloat variable.

7.69.2 Return Value

SA_RC_SUCC or error code

7.70 SaDfloatToAsciiz

`SaDfloatToAsciiz` stores the dfloat value as an asciiz (zero-terminated ASCII) string.

7.70.1 Synopsis

```
SaRetT SA_EXPORT_H SaDfloatToAsciiz(
    SaDfloatT* p_dfl,
    char* asciiz)
```

The `SaDfloatToAsciiz` function accepts the following parameters:

Table 7.71. SaDfloatToAsciiz Parameters

Parameters	Usage Type	Description
p_dfl	in	Pointer to dfloat variable.
asciiz	out	Buffer where the dfloat is stored in asciiz (zero-terminated ASCII) string format. The memory for this must already be allocated by the caller.

7.70.2 Return Value

SA_RC_SUCC

SA_ERR_FAILED

7.71 SaDfloatUnderflow

`SaDfloatUnderflow` checks if the dfloat contains an underflow value.

7.71.1 Synopsis

```
int SA_EXPORT_H SaDfloatUnderflow(
    SaDfloatT* p_dfl)
```

The `SaDfloatUnderflow` function accepts the following parameters:

Table 7.72. SaDfloatUnderflow Parameters

Parameters	Usage Type	Description
p_dfl	in, use	Pointer to dfloat variable.

7.71.2 Return Value

1: dfloat value is an underflow value

0: dfloat value is not an underflow value

7.72 SaDisconnect

`SaDisconnect` disconnects the user from the IBM solidDB server.

7.72.1 Synopsis

```
void SA_EXPORT_H SaDisconnect(SaConnectT* scon)
```

The `SaDisconnect` function accepts the following parameters:

Table 7.73. SaDisconnect Parameters

Parameters	Usage Type	Description
scon	in, take	Pointer to a connection object.

7.72.2 Return Value

None.

7.73 SaDynDataAppend

`SaDynDataAppend` appends data to the dynamic data object.

7.73.1 Synopsis

```
void SA_EXPORT_H SaDynDataAppend(
    SaDynDataT* dd,
    char* data,
    unsigned len)
```

The `SaDynDataAppend` function accepts the following parameters:

Table 7.74. SaDynDataAppend Parameters

Parameters	Usage Type	Description
dd	use	Dynamic data object.
data	in out, use	Data that is appended to the dd.
len	in	Length of the data to be appended.

7.73.2 Return Value

None.

7.73.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of "Dynamic Data" (SaDynDataT).

7.74 SaDynDataChLen

`SaDynDataChLen` changes the data area length of dynamic data object. It allocates/deallocates memory as necessary. If new length is smaller than current length, the data area is truncated. If new length is greater than current length, the new data area content is initialized with space characters.

7.74.1 Synopsis

```
void SA_EXPORT_H SaDynDataChLen(
    SaDynDataT* dd,
    unsigned len)
```

The SaDynDataChLen function accepts the following parameters:

Table 7.75. SaDynDataChLen Parameters

Parameters	Usage Type	Description
dd	in out, use	Dynamic data object.
len	in	New data area length of dynamic data object.

7.74.2 Return Value

None

7.74.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of "Dynamic Data" (SaDynDataT).

7.75 SaDynDataClear

SaDynDataClear deallocates the memory allocations from an SaDynDataT object. Note that this deallocates the data; it does not deallocate the SaDynDataT object itself. The result of SaDynDataClear is to leave an "empty" dynamic data object returned by SaDynDataCreate. The SaDynDataT object itself must be deallocated separately using the SaDynDataFree function.

7.75.1 Synopsis

```
void SA_EXPORT_H SaDynDataClear(
    SaDynDataT* dd)
```

The SaDynDataClear function accepts the following parameters:

Table 7.76. SaDynDataClear Parameters

Parameters	Usage Type	Description
dd	in out, use	Dynamic data object.

7.75.2 Return Value

None

7.75.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of "Dynamic Data" (SaDynDataT).

7.76 SaDynDataCreate

`SaDynDataCreate` creates a new dynamic data object. A dynamic data object is an object that can hold variable amounts of any type of data. This object can be manipulated using other `SaDynDataXXX` functions.

7.76.1 Synopsis

```
SaDynDataT* SA_EXPORT_H SaDynDataCreate(void)
```

`SaDynDataCreate` accepts no parameters.

7.76.2 Return Value

Table 7.77. SaDynDataCreate Return Value

Return Usage Type	Description
give	A new empty dynamic data object. Returns NULL in case of an error.

7.76.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of "Dynamic Data" (SaDynDataT).

7.77 SaDynDataFree

`SaDynDataFree` releases a dynamic data object. After this call, the dynamic data object pointer is invalid and cannot be used.

7.77.1 Synopsis

```
void SA_EXPORT_H SaDynDataFree(
    SaDynDataT* dd)
```

The `SaDynDataFree` function accepts the following parameters:

Table 7.78. SaDynDataFree Parameters

Parameters	Usage Type	Description
dd	in, take	Dynamic data object.

7.77.2 Return Value

None

7.77.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of "Dynamic Data" (SaDynDataT).

7.78 SaDynDataGetData

`SaDynDataGetData` returns the pointer to the data area of the dynamic data object.

7.78.1 Synopsis

```
char* SA_EXPORT_H SaDynDataGetData(
    SaDynDataT* dd)
```

The `SaDynDataGetData` function accepts the following parameters:

Table 7.79. SaDynDataGetData Parameters

Parameters	Usage Type	Description
dd	in, use	Dynamic data object.

7.78.2 Return Value

A reference to the local data area of dynamic data object.

7.78.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of "Dynamic Data" (SaDynDataT).

7.79 SaDynDataGetLen

`SaDynDataGetLen` returns the length of the data area of the dynamic data object.

7.79.1 Synopsis

```
unsigned SA_EXPORT_H SaDynDataGetLen(
    SaDynDataT* dd)
```

The `SaDynDataGetData` function accepts the following parameters:

Table 7.80. SaDynDataGetData Parameters

Parameters	Usage Type	Description
dd	in, use	Dynamic data object.

7.79.2 Return Value

Data area length. The function returns 0 if there is an error, or if the actual length of the data area is 0.

7.79.3 See Also

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of "Dynamic Data" (SaDynDataT).

7.80 SaDynDataMove

`SaDynDataMove` copies data from the parameter named "data" to a dynamic data object (named dd). This function overwrites possible existing data.

The parameter dd must point to a Dynamic Data Object previously created with the `SaDynDataCreate` function.

Note that this function copies the data. To copy just the reference rather than the data, see Section 7.81, “SaDynDataMoveRef”.

Typically, the functions `SaDynDataMove` and `SaDynDataAppend` are used to set and modify the data value inside the dynamic data object. More memory will be automatically allocated when necessary and all the associated memory will be automatically deallocated when the dynamic data object is disposed of using SaDynDataFree. The user can access the data or the length using the respective functions `SaDynDataGetData` and `SaDynDataGetLen`.

The use of `SaDynDataMove` and `SaDynDataAppend` may not be feasible when the data already exists completely in a memory buffer. In addition to increasing the memory usage by keeping two copies of the same data, the overhead of the memory copy may be significant if the buffers are large. Therefore, it may be wise to directly assign the data pointer by using `SaDynDataMoveRef` (rather than copying by using `SaDynDataMove`). In this case, the user may modify or deallocate the memory buffer only after the dynamic data object itself has been freed.

7.80.1 Synopsis

```
void SA_EXPORT_H SaDynDataMove(
SaDynDataT* dd,
char* data,
unsigned len)
```

The `SaDynDataMove` function accepts the following parameters:

Table 7.81. SaDynDataMove Parameters

Parameters	Usage Type	Description
dd	in out, use	Dynamic data object.
data	in, use	New data

Parameters	Usage Type	Description
len	in	Length of data (if the data is a string, this length should include the string terminator)

7.80.2 Return Value

None

7.80.3 See Also

Section 7.81, “SaDynDataMoveRef”.

Section 7.26, “SaCursorColDynData”.

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of "Dynamic Data" (SaDynDataT).

7.81 SaDynDataMoveRef

`SaDynDataMoveRef` moves a data reference to a dynamic dataobject. In other words, it copies the pointer (address) from the parameter named "data" to the appropriate field of the parameter named "dd". The caller must guarantee that the input data is alive as long as the dynamic data object refers to that data.

Note that this function copies only the reference, not the data. To copy the data rather than just the reference, see Section 7.80, “SaDynDataMove”.

Typically, the functions `SaDynDataMove` and `SaDynDataAppend` are used to set and modify the data value inside the dynamic data object. More memory will be automatically allocated when necessary and all the associated memory will be automatically deallocated when the dynamic data object is disposed of using `SaDynDataFree`. The user can access the data or the length using the respective functions `SaDynDataGetData` and `SaDynDataGetLen`.

The use of `SaDynDataMove` and `SaDynDataAppend` may not be feasible when the data already exists completely in a memory buffer. In addition to increasing the memory usage by keeping two copies of the same data, the overhead of the memory copy may be significant if the buffers are large. Therefore, it may be wise to directly assign the data pointer by using `SaDynDataMoveRef` (rather than copying by using SaDynDataMove). In this case, the user may modify or deallocate the memory buffer only after the dynamic data object itself has been freed.

7.81.1 Synopsis

```
void SA_EXPORT_H SaDynDataMoveRef(
    SaDynDataT* dd,
    char* data,
    unsigned len)
```

The SaDynDataMoveRef function accepts the following parameters:

Table 7.82. SaDynDataMoveRef Parameters

Parameters	Usage Type	Description
dd	in out, use	Dynamic data object
data	in, hold	Data
len	in	Length of data (if the data is a string, this length should include the string terminator)

7.81.2 Return Value

None

7.81.3 See Also

Section 7.80, “SaDynDataMove”.

Section 7.26, “SaCursorColDynData”.

See Section 7.26, “SaCursorColDynData” for a more detailed discussion of "Dynamic Data" (SaDynDataT).

7.82 SaDynStrAppend

SaDynStrAppend appends another string at the end of a dynamic string.

7.82.1 Synopsis

```
void SA_EXPORT_H SaDynStrAppend(
```

```
    SaDynStrT* p_ds,
    char* str)
```

The SaDynStrAppend function accepts the following parameters:

Table 7.83. SaDynStrAppend Parameters

Parameters	Usage Type	Description
p_ds	out	Dynamic string
str	in, use	String that is appended at p_ds

7.82.2 Return Value

None

7.83 SaDynStrCreate

SaDynStrCreate creates (initializes) a new dynamic string object.

7.83.1 Synopsis

```
SaDynStrT SA_EXPORT_H SaDynStrCreate(void)
```

7.83.2 Parameters

None

7.83.3 Return Value

Table 7.84. SaDynStrCreate Return Value

Return Usage Type	Description
give	Dynamic string object initialized with empty data. Returns NULL if we ran out of memory.

7.84 SaDynStrFree

`SaDynStrFree` frees the SaDynStrT variable. In search operations, the column data is stored to the SaDynStrT variable using function `SaDynStrMove`, which overwrites the old data. The user is responsible for releasing the SaDynStrT variable after the search ends using function `SaDynStrFree`.

7.84.1 Synopsis

```
void SA_EXPORT_H SaDynStrFree(
    SaDynStrT* p_ds)
```

The `SaDynStrFree` function accepts the following parameters:

Table 7.85. SaDynStrFree Parameters

Parameters	Usage Type	Description
p_ds	in, take	Dynamic string.

Because the function deallocates the memory, the pointer p_ds is no longer valid after the function call and thus the usage type is "take".

7.84.2 Return Value

None

7.85 SaDynStrMove

`SaDynStrMove` copies the value of the string (the second parameter) to the SaDynStrT (the first parameter). Note that this copies the string, not the pointer.

The SaDynStrT must be initialized with `SaDynStrCreate` before SaDynStrT is set with `SaDynStrMove`.

Caution

Do not ever copy a SaDynStrT to another SaDynStrT (for example with memcpy). This would result in two SaDynStrT pointers pointing at the same allocated area.

7.85.1 Synopsis

```
void SA_EXPORT_H SaDynStrMove(
    SaDynStrT* p_ds,
    char* str)
```

The `SaDynStrMove` function accepts the following parameters:

Table 7.86. SaDynStrMove Parameters

Parameters	Usage Type	Description
p_ds	out	Pointer to a dynamic string variable.
str	in, use	New value of a dynamic string.

7.85.2 Return Value

None

7.86 SaErrorInfo

`SaErrorInfo` returns error information from the last operation in a server connection. Cursor errors cannot be checked with this function; instead function `SaCursorErrorInfo` must be used.

7.86.1 Synopsis

```
bool SA_EXPORT_H SaErrorInfo(
SaConnectT* scon,
char** errstr,
int* errcode)
```

The `SaErrorInfo` function accepts the following parameters:

Table 7.87. SaErrorInfo Parameters

Parameters	Usage Type	Description
scon	use	Pointer to a connection object.

Parameters	Usage Type	Description
errstr	out, ref	If there was an error, and if this parameter is non-NULL, then a pointer to a local copy of an error string is stored into *errstr.
errcode	out	If there was an error, and if this parameter is non-NULL, then an error code is stored into *errcode.

7.86.2 Return Value

TRUE There was an error, so errstr and errcode were updated.

FALSE There were no errors, so errstr and errcode not were updated.

7.87 SaGlobalInit

`SaGloballnit` performs some global initialization in the SA system. This function must be called before any other SA function except `SaConnect`. (If the `SaConnect` function is called before any other SA function, then you do not need to call `SaGlobalInit` because `SaConnect` will call it for you.)

7.87.1 Synopsis

```
void SA_EXPORT_H SaGlobalInit(void)
```

7.87.2 Parameters

None

7.87.3 Return Value

None

7.88 SaSetDateFormat

`SaSetDateFormat` defines default date format. For explanation of possible date formats, see documentation of function in Section 7.60, “SaDateToAsciiz”.

7.88.1 Synopsis

```
SaRetT SA_EXPORT_H SaSetDateFormat(
SaConnectT* scon,
char* dateformat)
```

The `SaErrorInfo` function accepts the following parameters:

Table 7.88. SaErrorInfo Parameters

Parameters	Usage Type	Description
scon	in, out, use	Pointer to a connection object.
dateformat	in, use	Default data format for connection.

Note that the usage type includes "out" because the scon parameter is modified by this function call.

7.88.2 Return Value

SA_RC_SUCC if success.

SA_ERR_COMERROR if the connection to the server is broken.

7.88.3 See Also

For explanation of possible date/time/timestamp formats, see Section 7.60, “SaDateToAsciiz”.

7.89 SaSetSortBufSize

`SaSetSortBufSize` sets the amount of memory that a connection uses for local sorts (sorts that are done on the client side by the SA library).

7.89.1 Synopsis

```
SaRetT SA_EXPORT_H SaSetSortBufSize(
    SaConnectT* scon,
    unsigned long size)
```

The `SaSetSortBufSize` function accepts the following parameters:

Table 7.89. SaSetSortBufSize Parameters

Parameters	Usage Type	Description
scon	in, out, use	Pointer to a connection object.
size	in	Memory buffer size in bytes.

Note that the usage type includes "out" because the scon parameter is modified by this function call.

7.89.2 Return Value

SA_RC_SUCC when OK or SA_ERR_FAILED when specified memory size was too small (< 10KB)

7.90 SaSetSortMaxFiles

`SaSetSortMaxFiles` sets the maximum number of files that the connection uses for local sorts (sorts that are done on the client side by the SA library).

7.90.1 Synopsis

```
SaRetT SA_EXPORT_H SaSetSortMaxFiles(
SaConnectT* scon,
unsigned int nfiles)
```

The `SaSetSortMaxFiles` function accepts the following parameters:

Table 7.90. SaSetSortMaxFiles Parameters

Parameters	Usage Type	Description
scon	in, out, use	Pointer to a connection object.
nfiles	in	Maximum number of files

Note that the usage type includes "out" because the scon parameter is modified by this function call.

7.90.2 Return Value

SA_RC_SUCC when OK or SA_ERR_FAILED when specified number of files is too small (< 3).

7.91 SaSetTimeFormat

`SaSetTimeFormat` defines the default time format. For explanation of possible formats, see the time portion documentation of `SaDateSetAsciiz` in Section 7.60, “SaDateToAsciiz”.

7.91.1 Synopsis

```
SaRetT SA_EXPORT_H SaSetTimeFormat(
    SaConnectT* scon,
    char* timeformat)
```

The `SaSetTimeFormat` function accepts the following parameters:

Table 7.91. SaSetTimeFormat Parameters

Parameters	Usage Type	Description
scon	in, out, use	Pointer to a connection object.
timeformat	in	Default time format for connection.

Note that the usage type of scon includes "out" because the scon parameter is modified by this function call.

7.91.2 Return Value

SA_RC_SUCC

SA_ERR_COMERROR if the connection to the server is broken.

7.91.3 See Also

For explanation of possible date/time/timestamp formats, see Section 7.58, “SaDateSetAsciiz”.

7.92 SaSetTimestampFormat

`SaSetTimestampFormat` defines the default timestamp format. For explanation of possible date/time/timestamp formats, see Section 7.58, “SaDateSetAsciiz”.

7.92.1 Synopsis

```
SaRetT SA_EXPORT_H SaSetTimestampFormat(
    SaConnectT* scon,
    char* timestampformat)
```

The `SaSetTimestampFormat` function accepts the following parameters:

Table 7.92. SaSetTimestampFormat Parameters

Parameters	Usage Type	Description
scon	in, out, use	Pointer to a connection object.
timestampformat	in	Default timestamp format for connection.

7.92.2 Return Value

SA_RC_SUCC

7.92.3 See Also

For explanation of possible date/time/timestamp formats, see Section 7.58, “SaDateSetAsciiz”.

7.93 SaSQLExecDirect

`SaSQLExecDirect` allows you to execute simple SQL statements such as CREATE TABLE, DROP TABLE, INSERT, and DELETE. You cannot do SELECTs because there is no way to fetch the data.

7.93.1 Synopsis

```
SaRetT SA_EXPORT_H SaSQLExecDirect(SaConnectT* scon, char *sqlstr)
```

The `SaSQLExecDirect` function accepts the following parameters:

Table 7.93. SaSQLExecDirect Parameters

Parameters	Usage Type	Description
scon	in, use	Pointer to a connection object.
sqlstr	in, use	Pointer to a string containing the SQL statement to execute.

7.93.2 Return Value

SA_RC_SUCC

The possible error codes are:

```
15001: SAP_ERR_SYNTAXERROR_SD. Syntax error: <error>, <line>.
15002: SAP_ERR_ILLCOLNAME_S. Illegal column name <name>.
15003: SAP_ERR_TOOMANYPARAMS. Too many parameters for string constraints.
15004: SAP_ERR_TOOFEWPARAMS. Too few parameters for string constraints.
```

7.94 SaTransBegin

`SaTransBegin` starts a new transaction. After this call, all select, insert, update and delete operations are executed in the same transaction, and the changes are not visible in the database until `SaTransCommit` is called. (Without the `SaTransBegin` call, the server is in autocommit mode by default and therefore each select, insert, update, and delete operation is executed in a separate transaction. No explicit commit (`SaTransCommit`) is required when in autocommit mode.)

The transaction is run in a mode where write operations are validated for lost updates and unique errors.

7.94.1 Synopsis

```
void SA_EXPORT_H SaTransBegin(SaConnectT* scon)
```

The `SaTransBegin` function accepts the following parameters:

Table 7.94. SaTransBegin Parameters

Parameters	Usage Type	Description
scon	in, use	Pointer to a connection object.

7.94.2 Return Value

None

7.95 SaTransCommit

`SaTransCommit` commits the current transaction started by `SaTransBegin`. After this call all changes are made persistent in the database. After the current transaction is completed, the database server returns to autocommit mode until the next call to `SaTransBegin`.

7.95.1 Synopsis

```
SaRetT SA_EXPORT_H SaTransCommit(SaConnectT* scon)
```

The `SaTransCommit` function accepts the following parameters:

Table 7.95. SaTransCommit Parameters

Parameters	Usage Type	Description
scon	in, use	Pointer to a connection object

7.95.2 Return Value

SA_RC_SUCC or error code

7.96 SaTransRollback

`SaTransRollback` rolls back the current transaction started by `SaTransBegin`. No changes are made to the database. After the current transaction is completed, the database server returns to autocommit mode until the next call to `SaTransBegin`.

7.96.1 Synopsis

```
SaRetT SA_EXPORT_H SaTransRollback(SaConnectT* scon)
```

The `SaTransRollback` function accepts the following parameters:

Table 7.96. SaTransRollback Parameters

Parameters	Usage Type	Description
scon	in, use	Pointer to a connection object

7.96.2 Return Value

SA_RC_SUCC or error code

7.97 SaUserId

`SaUserID` returns current user id of a connection.

7.97.1 Synopsis

```
int SA_EXPORT_H SaUserId(SaConnectT* scon)
```

The `SaUserId` function accepts the following parameters:

Table 7.97. SaUserId Parameters

Parameters	Usage Type	Description
scon	in, use	Pointer to a connection object

7.97.2 Return Value

User id in the server.

Appendix A. IBM solidDB Supported ODBC Functions

Table A.1. IBM solidDB Supported ODBC Functions

Function Names/Version Introduced*	Purpose	Availability when using ODBC	Conformance**
Connecting to a Data Source			
`SQLAllocEnv` (1.0)	N/A	Deprecated (replaced by `SQLAllocHandle`)	N/A
`SQLAllocConnect` (1.0)	N/A	Deprecated (replaced by `SQLAllocHandle`)	N/A
`SQLAllocHandle` (3.0)	Returns the list of supported data source attributes. Returns the list of installed drivers and their attributes.	Supported Supported	ISO 92 ODBC
`SQLConnect` (1.0)	Establishes connections to a driver and a data source. The connection handle references storage of all information about the connection to the data source, including status, transaction state, and error information.	Supported	ISO 92
`SQLDriverConnect` (1.0)	This function is an alternative to `SQLConnect`. It supports data sources that require more connection information than the three arguments in `SQLConnect`, including dialog boxes to prompt the user for all connection information, and data sources that are not defined in the system information.	Supported (including Unicode version of this function).	ODBC
* Version introduced is the version when the function was initially added to the ODBC API.			

Function Names/Version Introduced*	Purpose	Availability when using ODBC	Conformance**
** Conformance level can be ISO 92 (also appears in X/Open version 1 because X/Open is a pure superset of ISO 92), X/Open (also appears in ODBC 3.x because ODBC 3.x is a pure superset of X/Open version 1), ODBC (appears in neither ISO 92 or X/Open) or N/A (Deprecated in ODBC 3.x).			
`SQLBrowseConnect` (1.0)	Returns successive levels of attributes and attribute values. When all levels have been enumerated, a connection to the data source is completed and a complete connection string is returned. A return of SQL_SUCCESS_WITH_INFO indicates that all connection information has been specified and the application is now connected to the data source.	Not supported	ISO 92
`SQLGetInfo` (1.0)	Returns general information about the driver and data source associated with a connection.	Supported	ISO 92
`SQLGetFunctions` (1.0)	Returns information about whether a driver supports a specific ODBC function.	Supported; this function is implemented in the ODBC Driver Manager. It can also be implemented in drivers. If a driver implements `SQLGetFunctions`, the Driver manager calls the function in the driver. Otherwise, it executes the function itself. In IBM solidDB's case, the function is implemented in the driver so that the application linked to the driver can also call this function from the application.	ISO 92
`SQLGetTypeInfo` (1.0)	Returns information about data types supported by the data source. The driver returns the information in the form of an SQL result set. The data types are inten-	Supported	ISO 92

Function Names/Version Introduced*	Purpose	Availability when using ODBC	Conformance**
	ded for use in Data Definition Language (DDL) statements.		
Obtaining Information about a Driver and Data Source			
`SQLDataSources` (1.0)	Returns information about a data source.	Supported; this function is implemented in the ODBC Driver Manager. For non-Microsoft Windows platforms which do not have the Microsoft ODBC Driver manager, this function is not supported.	ISO 92
`SQLDrivers` (2.0)	Lists driver descriptions and driver attribute keywords.	Supported; this function is implemented in the ODBC Driver Manager. For Microsoft Windows, the Driver Manager is required if applications that connect to IBM solidDB use OLE DB or ADO APIs or if database tools that require the Driver Manager, such as Microsoft Access, FoxPro, or Crystal Reports are to be used. For platforms other than Microsoft Windows, the Driver Managers are provided by vendors such as iODBC, Merant, and UnixODBC, etc.	ODBC
`SQLGetConnectAttr` (3.0)	Returns the value of a connection attribute.	Supported	ISO 92

Function Names/Version Introduced*	Purpose	Availability when using ODBC	Conformance**
SQLSetConnectAttr (3.0)	Sets a connection attribute.	Supported	ISO 92
SQLGetEnvAttr (3.0) SQLSetEnvAttr (3.0)	Returns the value of an environment attribute. Sets an environment attribute.	Supported Supported	ISO 92 ISO 92
SQLGetStmtAttr (3.0) SQLSetStmtAttr (3.0)	Returns the value of a statement attribute. Sets a statement attribute.	Supported (replaced by SQLGetStmtAttr) Supported	ISO 92 ISO 92
SQLSetConnectOption (1.0) SQLGetConnectOption (1.0)	N/A	Deprecated (replaced by SQLSetConnectAttr) Deprecated (replaced by SQLGetConnectAttr)	N/A N/A
SQLGetStmtOption (1.0) SQLSetStmtOption (1.0)	N/A N/A	Deprecated (replaced by SQLGetStmtAttr) Deprecated (replaced by SQLSetStmtAttr)	N/A N/A
Setting and Retrieving Descriptor Fields			
SQLGetDescField (3.0) SQLSetDescField (3.0)	Returns the current setting or value of a single descriptor field. Sets the value of a single field of a descriptor record.	Supported Supported	ISO 92 ISO 92
SQLGetDescRec (3.0) SQLSetDescRec (3.0)	Returns the current settings or values of multiple fields of a descriptor record. The fields returned describe the name, data type, and storage column or parameter data.	Supported Supported	ISO 92 ISO 92

Function Names/Version Introduced*	Purpose	Availability when using ODBC	Conformance**
	Sets multiple descriptor fields that affect the data type and buffer bound to a column or parameter data.		
SQLCopyDesc (3.0)	Copies descriptor information from one descriptor handle to another.	Supported	ISO 92
Preparing SQL Requests			
SQLAllocStmt (1.0)	N/A	Deprecated (replaced by SQLAllocHandle)	N/A
SQLPrepare (1.0)	Prepares an SQL statement for later execution.	Supported	ISO 92
SQLBindParameter (2.0)	Assigns storage for a parameter in an SQL statement.	Supported Note: This function replaces SQLBindParam which did not exist in ODBC 2.x, although it is in the X/Open and ISO standards.	ODBC
SQLGetCursorName (1.0) SQLSetCursorName (1.0)	Returns the cursor name associated with a statement handle. Specifies a cursor name with an active statement. If an application does not call SQLSetCursorName, the driver generates cursor names as needed for SQL statement processing.	Supported Supported	ISO 92 ISO 92
SQLParamOptions (1.0)	N/A	Deprecated (replaced by SQLSetStmtAttr)	N/A
SQLSetParam (1.0)	N/A	Deprecated (replaced by SQLBindParameter)	N/A
SQLSetScrollOptions (1.0)	Sets options that control cursor behavior.	Deprecated (replaced by SQLGetInfo and SQLSetStmtAttr)	ODBC
Submitting Requests			

Function Names/Version Introduced*	Purpose	Availability when using ODBC	Conformance**
SQLExecute (1.0)	Executes a prepared statement using the current values of the parameter marker variables if any parameter markers exist in the statement.	Supported	ISO 92
SQLExecDirect (1.0)	Executes a preparable statement using the current values of the parameter marker variables if any parameters exist in the statement. SQLExecDirect is the fastest way to submit an SQL statement for one-time execution.	Supported	ISO 92
SQLNativeSQL (1.0)	Returns the SQL string as modified by the driver. SQLNativeSQL does not execute the SQL statement.	Not implemented; IBM solidDB does not support this functionality.	N/A
SQLDescribeParam (1.0)	Returns the text of an SQL statement as translated by the driver. This information is also available in the fields of the IPD.	Supported	ODBC
SQLNumParams (1.0)	Returns the number of parameters in an SQL statement.	Supported	ISO 92
SQLParamData (1.0)	Used in conjunction with SQLPutData to supply parameter data at execution time. (Useful for long data values.)	Supported	ISO 92
SQLPutData (1.0)	Allows an application to send data for a parameter or column to the driver at statement execution time. This function can be used to send character or binary data values in parts to a column with a character, binary, or data source-specific data type (for example, parameters of the SQL_LONGVARBINARY or SQL_LONGVARCHAR types).	Supported	ISO 92
Retrieving Results and Information about Results			
SQLRowCount (1.0)	Returns the number of rows affected by an UPDATE, INSERT, or DELETE statement.	Supported	ISO 92

Function Names/Version Introduced*	Purpose	Availability when using ODBC	Conformance**
SQLNumResultCols (1.0)	Returns the number of columns in a result set.	Supported	ISO 92
SQLDescribeCol (1.0)	Returns the result descriptor (column name, type, column size, decimal digits, and nullability) for one column in the result set. This information is also available in the fields of the IRD. NOTE: The driver now returns the number of characters instead of the number of bytes for the following attributes: SQL_DESC_LABEL, SQL_DESC_NAME, SQL_DESC_SCHEMA_ NAME, SQL_DESC_CATALOG_ NAME, SQL_DESC_BASE_COLUMN_NAME, and SQLDESC_BASE_TABLE_NAME This conforms more closely to the ODBC standard and works correctly using ADO, VB, OLE-DB, and ODBC calls. Note, however, that this causes failure of the Microsoft Visual DataBase Project. After updating/inserting the record, the record is not saved and the following error is displayed: "the table does not exist.	Supported.	ISO 92
SQLColAttributes (1.0)	N/A	Deprecated (replaced by SQLColAttribute)	N/A
SQLColAttribute (3.0)	Describes attributes of a column in the result set. NOTE: The driver now returns the number of characters instead of the number of bytes for the following attributes: SQL_DESC_LABEL, SQL_DESC_NAME, SQL_DESC_SCHEMA_ NAME,	Supported.	ISO 92

Function Names/Version Introduced*	Purpose	Availability when using ODBC	Conformance**
	SQL_DESC_CATALOG_NAME, SQL_DESC_BASE_COLUMN_NAME, and SQLDESC_BASE_TABLE_NAME This conforms more closely to the ODBC standard and works correctly using ADO, VB, OLE-DB, and ODBC calls. Note, however, that this causes failure of the Microsoft Visual DataBase Project. After updating/inserting the record, the record is not saved and the following error is displayed: "the table does not exist."		
`SQLBindCol` (1.0)	Assigns storage for a result column and specifies the data type.	Supported	ISO 92
`SQLFetch` (1.0)	Returns multiple result rows, fetching the next rowset of data from the result set and returning data for all bound columns.	Supported	ISO 92
`SQLExtended-Fetch` (2.0)	N/A	Replaced by `SQLFetch-Scroll`	N/A
`SQLFetchScroll` (3.0)	Returns scrollable result rows, fetching the specified rowset of data from the result set and returning data for all bound columns. Block cursor support enables an application to fetch more than one row with a single fetch into the application buffer. When working with an ODBC 2.x driver, the Driver Manager maps this function to `SQLExtendedFetch`.	Supported Note: Since the IBM solidDB ODBC Driver currently has no support for bookmarks, it is not possible to support the SQL_FETCH_BOOK-MARK option in `SQLFetchScroll`.	ISO 92
`SQLGetData` (1.0)	Returns part or all of one column of one row of a result set. It can be called multiple times to retrieve variable length data in parts, making it useful for long data values.	Supported	ISO 92

Function Names/Version Introduced*	Purpose	Availability when using ODBC	Conformance**
SQLSetPos (1.0)	Positions a cursor within a fetched block of data and allows an application to refresh data in the rowset or to update or delete data in the result set.	Supported, along with all the options, that is, SQL_POSITION, SQL_DELETE, and SQL_UPDATE	ODBC
SQLBulkOperations (3.0)	Performs bulk insertions and bulk bookmark operations, including update, delete, and fetch by bookmark.	IBM solidDB supports this, but only when using the SQL_ADD option.	ODBC
SQLMoreResults (1.0)	Determines whether there are more results available on a statement containing SELECT, UPDATE, INSERT, or DELETE statement and, if so, initializes processing for those results.	Not supported IBM solidDB does not support multiple results.	ODBC
SQLGetDiagField (3.0)	Returns additional diagnostic information (a single field of the diagnostic data structure associated with a specified handle). This information includes error, warning, and status information.	Supported	ISO 92
SQLGetDiagRec (3.0)	Returns additional diagnostic information (multiple fields of the diagnostic data structure). Unlike SQLGetDiagField, which returns one diagnostic field per call, SQLGetDiagRec returns several commonly used fields of a diagnostic record, including the SQLSTATE, the native error code, and the diagnostic message text.	Supported	ISO 92
SQLError (1.0)	N/A	Deprecated (replaced by SQLGetDiagRec)	N/A
Obtaining Information about the Data Source's System Tables			
SQLColumnPrivileges (1.0)	Returns a list of columns and associated privileges for the specified table. The driver returns the information as a result	Supported	ODBC

Function Names/Version Introduced*	Purpose	Availability when using ODBC	Conformance**
	set on the specified `StatementHandle`. This function is supported via an appropriate SQL execution.		
`SQLColumns` (1.0)	Returns a list of columns and associated privileges for the specified table. The driver returns the information as a result set on the specified StatementHandle. This function is supported via an appropriate SQL execution.	Supported	X/Open
`SQLForeignKeys` (1.0)	Returns two type of lists: • Foreign keys in the specified table (columns in the specified table that refer to primary keys in other tables). • Foreign keys in other tables that refer to the primary key in the specified table. The driver returns each list as a result set on the specified statement.	Supported	ODBC
`SQLPrimaryKeys` (1.0)	Returns the list of column names that make up the primary key for a table. The driver returns the information as a result set. This function does not support returning primary keys from multiple tables in a single call.	Supported	ODBC
`SQLProcedureColumns` (1.0)	Returns the list of input and output parameters, as well as the columns that make up the result set for the specified procedures. The driver returns the information as a result set on the specified statement.	Supported.	ODBC
`SQLProcedures` (1.0)	Returns the list of procedure names stored in a specific data source. Procedure is a generic term used to describe an executable object, or a named entity that	Supported	ODBC

Function Names/Version Introduced*	Purpose	Availability when using ODBC	Conformance**
	can be invoked using input and output parameters.		
`SQLSpecialColumns` (1.0)	Returns the following information about columns within a specified table: • The optimal set of columns that uniquely identifies a row in the table. • Columns that are automatically updated when any value in the row is updated by a transaction.	Supported	X/Open
`SQLStatistics` (1.0)	Returns statistics about a single table and the list of indexes associated with the table. The driver returns the information as a result set.	Supported	ISO 92
`SQLTablePrivileges` (1.0)	Returns a list of tables and the privileges associated with each table. The driver returns the information as a result set on the specified statement.	Supported	ODBC
`SQLTables` (1.0)	Returns the list of table, catalog, or schema names, and table types, stored in a specific data source.	Supported	X/Open
Terminating a statement			
`SQLFreeStmt` (1.0)	Ends statement processing, discards pending results, and optionally, frees all resources associated with the statement handle.	Supported Note: The `SQLFreeStmt` with an option of SQL_DROP is replaced by `SQLFreeHandle`.	ISO 92
`SQLCloseCursor` (3.0)	Closes a cursor that has been opened on a statement, and discards pending results.	Supported	ISO 92
`SQLCancel` (1.0)	Cancels the processing on an SQL statement.	Supported	ISO 92

Function Names/Version Introduced*	Purpose	Availability when using ODBC	Conformance**
SQLEndTran (3.0)	Requests a transaction commit or rollback on all statements associated with a connection. SQLEndTran can also request that a commit or rollback operation be performed for all connections associated with an environment.	Supported	ISO 92
SQLTransact (1.0)	N/A	Deprecated (replaced by SQLEndTran)	N/A
Terminating a Connection			
SQLDisconnect (1.0)	Closes the connection associated with a specific connection handle.	Supported	ISO 92
SQLFreeConnect (1.0)	N/A	Deprecated (replaced by SQLFreeHandle)	N/A
SQLFreeEnv (1.0)	N/A	Deprecated (replaced by SQLFreeHandle)	N/A
SQLFreeHandle (3.0)	Frees resources associated with a specific environment, connection, statement, or descriptor handle	Supported	ISO 92

Appendix B. IBM solidDB ODBC Driver 3.5.1 Attributes Support

Table B.1. IBM solidDB ODBC Driver 3.5.1 Attributes Support: 001 Environment Level

Attribute	Value (Option)	Driver Manager	Driver Alone	Comments
SQL_ATTR_CONNECTION_POOLING	SQL_CP_OFF SQL_CP_ONE_PER_DRIVER SQL_CP_ONE_PER_HENV	All values are supported	All values are not applicable to the driver	All values are not applicable to ODBC drivers, handled by Driver Manager, so this attribute will be supported if the application links to ODBC DM and can't be simulated by the driver itself.
SQL_ATTR_CP_MATCH	SQL_CP_STRICT_MATCH SQL_CP_RELAXED_MATCH	All values supported	All values are not applicable to the driver	All values are not applicable to ODBC drivers, handled by Driver Manager, so this attribute will be supported if the application links to ODBC DM and can't be simulated by the driver itself.
SQL_ATTR_ODBC_VERSION	SQL_OV_ODBC3 SQL_OV_ODBC2	Supported Not Supported	Supported Not Supported	Allows user to set and get the version to 2, but the behavior is a per 3.0 and above.
SQL_ATTR_OUTPUT_NTS	SQL_TRUE SQL_FALSE	Supported Not Supported	Supported Not Supported	

Table B.2. IBM solidDB ODBC Driver 3.5.1 Attributes Support: 002 Connection Level

Attribute	Value (Option)	Driver Manager	Driver Alone	Comments
SQL_ATTR_ODBC_CURSORS	SQL_CUR_IF_NEEDED SQL_FETCH_PRIOR SQL_CUR_USE_ODBC SQL_CUR_USE_DRIVER	All values not supported	All values not supported	
SQL_ATTR_ACCESS_MODE	SQL_MODE_READ_ONLY SQL_MODE_READ_WRITE	All values not supported	All values not supported	
SQL_ATTR_ASYNC_ENABLE	SQL_ASYNC_ENABLE_OFF SQL_ASYNC_ENABLE_ON	All values not supported	All values not supported	
SQL_ATTR_AUTO_IPD	SQL_TRUE SQL_FALSE	All values not supported	All values not supported	
SQL_ATTR_AUTOCOMMIT	SQL_ATTR_AUTOCOMMIT_OFF SQL_ATTR_AUTOCOMMIT_ON	All values are supported	All values are supported	
SQL_ATTR_CONNECTION_TIMEOUT	Timeout value in sec	Supported	Supported	
SQL_ATTR_CURRENT_CATALOG	CatalogName	Supported	Supported	
SQL_ATTR_LOGIN_TIMEOUT	Timeout value in sec	Supported	Supported	
SQL_ATTR_METADATA_ID	SQL_TRUE SQL_FALSE	All values not supported	All values not supported	
SQL_ATTR_PACKET_SIZE	Packet size in bytes	the desired size	Not supported	
SQL_ATTR_QUIET_MODE	Set to NULL	can set and get	Not supported	

Attribute	Value (Option)	Driver Manager	Driver Alone	Comments
SQL_ATTR_TRACE	SQL_TRACE_OFF SQL_TRACE_ON	All values supported	All values not supported	All values handled by DM, not by driver
SQL_ATTR_TRACEFILE	Pointer to trace file name	Supported	Not supported	Handled by DM, not by driver
SQL_ATTR_TRNSLATE_LIB	Pointer Name of lib	Supported	Not supported	Handled by DM, not by driver
SQL_ATTR_TXN_ISOLATION	SQL_TXN_SERIALIZABLE SQL_TXN_READ_UNCOMMITTED SQL_TXN_READ_COMMITTED SQL_TXN_REPEATABLE_READ	All values are supported, except SQL_TXN_READ_UNCOMMITTED	All values are supported, except SQL_TXN_READ_UNCOMMITTED	A IBM solidDB server does not support READ_UNCOMMITTED feature.

Table B.3. IBM solidDB ODBC Driver 3.5.1 Attributes Support: 03 Statement Level

Attribute	Value (Option)	Driver Manager	Driver Alone	Comments
SQL_ATTR_CONCURRENCY	SQL_CONCUR_READ_ONLY SQL_CONCUR_LOCK SQL_CONCUR_ROWVER SQL_CONCUR_VALUES	All values supported	All values supported	For the value SQL_CONCUR_READ_ONLY, set and get are supported. For all other values, set is supported and get returns READ_ONLY.
SQL_ATTR_CURSOR_TYPE	SQL_CURSOR_FORWARD_ONLY	Supported	Supported	

Attribute	Value (Option)	Driver Manager	Driver Alone	Comments
	SQL_CURSOR_KEY-SET_DRIVEN SQL_CURSOR_DYNAM-IC SQL_CURSOR_STATIC	Forced to dynam-ic Forced to dynam-ic Forced to dynam-ic	Forced to dynam-ic Forced to dynam-ic Forced to dynam-ic	
SQL_AT-TR_MAX_LENGTH	Length in bytes	Not supported	Not supported	Whatever the length, sets only to default (0).
SQL_ATTR_MAX_ROWS	Maximum number of rows	Not supported	Not supported	Whatever the length, sets only to default (0).
SQL_ATTR_RE-TRIEVE_DATA	SQL_RD_OFF SQL_RD_ON	Not supported Supported	Not supported Supported	Sets to SQL_RD_ON only
SQL_ATTR_USE_BOOK-MARKS	SQL_UB_OFF SQL_UB_ON	All values not supported	All values not supported	
SQL_ATTR_ROW_AR-RAY_SIZE	An SQLUSMALLINT* value that points to an array of SQLUSMALLINT val-ues containing row status values after a call to `SQLFetch` or `SQLFetchScroll`.	Supported	Supported	The array has as many elements as there are rows in the rowset.
SQL_AT-TR_ROWS_FETCHED_PTR	An SQLUINTEGER* value that points to a buffer in which to return the number of rows fetched after a call to `SQLFetch` or `SQLFetchScroll`.	Supported	Supported	
SQL_AT-TR_ROW_STATUS_PTR	An SQLUINTEGER value that specifies the number of rows returned by each call to `SQLFetch` or `SQLFetchScroll`.	Supported	Supported	

Attribute	Value (Option)	Driver Manager	Driver Alone	Comments
SQL_ROWSET_SIZE	Number of rows to return	Supported	Supported	Allows the ODBC application to set its value to greater than 1.
SQL_ASYNC_ENABLE	SQL_ASYNC_ENABLE_ON SQL_ASYNC_ENABLE_OFF	All values not supported	All values not supported	
SQL_BIND_TYPE	SQL_BIND_BY_COLUMN	Not supported	Not supported	
SQL_ATTR_KEYSET_SIZE	Size	Not supported	Not supported	Whatever the size, sets only to default (0).
SQL_ATTR_NOSCAN	SQL_NOSCAN_OFF SQL_NOSCAN_ON	Not supported Not supported	Not supported Not supported	Sets to SQL_NOSCAN_OFF only
SQL_ATTR_SIMULATE_CURSOR	SQL_SC_NON_UNIQUE SQL_SC_TRY_UNIQUE SQL_SC_UNIQUE	All values not supported	All values not supported	All values are not relevant to IBM solidDB Driver
SQL_ATTR_APP_PARAM_DESC	SQL_NULL_HDESC	Not supported	Not supported	
SQL_ATTR_APP_ROW_DESC	SQL_NULL_HDESC	Not supported	Not supported	
SQL_ATTR_CURSOR_SCROLLABLE	SQL_SCROLLABLE SQL_NONSCROLLABLE	Not supported Not supported	Not supported Not supported	Sets to SQL_NONSCROLLABLE only
SQL_ATTR_CURSOR_SENSITIVITY	SQL_UNSPECIFIED SQL_INSENSITIVE SQL_SENSITIVE	Not supported Not supported Not supported	Not supported Not supported Not supported	Sets to SQL_UNSPECIFIED only Sets to SQL_ UNSPECIFIED only
SQL_ATTR_ROW_NUMBER	Number of current row	Supported	Supported	User can get the number of rows; cannot set because of read-only property

Attribute	Value (Option)	Driver Manager	Driver Alone	Comments
SQL_ATTR_ENABLE_AUTO_IPD	SQL_TRUE SQL_FALSE	Both values not supported	Both values not supported	
SQL_ATTR_METADATA_ID	SQL_TRUE SQL_FALSE	Both values not supported	Both values not supported	
SQL_ATTR_PARAM_BIND_OFFSET_PTR	SQL_DESC_DATA_PTR SQL_DESC_INDICATOR_PTR SQL_DESC_OCTET_LENGTH_PTR SQL_DESC_BIND_OFFSET_PTR	All values are supported	All values are supported	
SQL_ATTR_PARAM_OPERATION_PTR	Pointer to array containing list of parameters to be ignored	Supported	Supported	
SQL_ATTR_PARAMS_PROCESSED_PTR	Unsigned integer pointer to return the number of sets of parameters that have been processed by the SQL statement executed through `SQLExecute` or `SQLExecDirect`.	Supported	Supported	

Table B.4. IBM solidDB ODBC Driver 3.5.1 Attributes Support: 04 Column Attributes

Attribute	Value (Option)	Driver Manager	Driver Alone	Comments
SQL_DESC_BASE_COLUMN_NAME		Supported	Supported	
SQL_DESC_BASE_TABLE_NAME		Supported	Supported	
SQL_DESC_DISPLAY_SIZE		Supported	Supported	
SQL_DESC_NAME				
SQL_DESC_NULLABLE		Supported	Supported	
SQL_DESC_OCTET_LENGTH		Supported	Supported	

Attribute	Value (Option)	Driver Manager	Driver Alone	Comments
SQL_DESC_PRECISION		Supported	Supported	
SQL_DESC_SCALE		Supported	Supported	
SQL_DESC_UPDATABLE		Supported	Supported	
SQL_DESC_FIXED_PREC_SCALE		Supported	Supported	
SQL_DESC_TABLE_NAME		Supported	Supported	
SQL_DESC_TYPE		Supported	Supported	
SQL_DESC_UNNAMED		Supported	Supported	
SQL_DESC_SCHEMA_NAME		Supported	Supported	
SQL_DESC_LOCAL_TYPE_NAME		Supported	Supported	
SQL_DESC_LABEL		Supported	Supported	
SQL_DESC_TYPE_NAME		Supported	Supported	
SQL_DESC_AUTO_UNIQUE_VALUE		Supported	Supported	
SQL_DESC_CONCISE_TYPE		Supported	Supported	
SQL_DESC_LITERAL_PREFIX		Supported	Supported	
SQL_DESC_UNSIGNED		Supported	Supported	
SQL_DESC_LITERAL_PREFIX		Supported	Supported	
SQL_DESC_UNSIGNED		Supported	Supported	
SQL_DESC_LITERAL_SUFFIX		Supported	Supported	
SQL_DESC_CATALOG_NAME		Supported	Supported	
SQL_DESC_COUNT		Supported	Supported	
SQL_DESC_SEARCHABLE		Supported	Supported	
SQL_DESC_LENGTH		Supported	Supported	
SQL_DESC_CASE_SENSITIVE		Supported	Supported	
SQL_DESC_NUM_PREX_RADIX		Supported	Supported	

Appendix C. Error Codes

This appendix contains an Error Codes Table that provides possible SQLSTATE values that a driver returns for the `SQLGetDiagRec` function. Note that `SQLGetDiagRec` and `SQLGetDiagField` return SQLSTATE values that conform to the X/Open Data Management: Structured Query Language (SQL), Version 2 (3/95).

C.1 Error Codes Table Convention

SQLSTATE values are strings that contain five characters; the first two is a string class value, followed by a three-character subclass value. For example 01000 has 01 as its class value and 000 as its subclass value. Note that a subclass value of 000 means there is no subclass for that SQLSTATE. Class and subclass values are defined in SQL-92.

Table C.1. Error Code Class Values

Class value	Meaning
01	Indicates a warning and includes a return code of SQL_SUCCESS_WITH_INFO.
01, 07, 08, 21, 22, 25, 28, 34, 3C, 3D, 3F, 40, 42, 44, HY	Indicates an error that includes a return value of SQL_ERROR.
IM	Indicates warning and errors that are derived from ODBC.

Note

Typically, when a function successfully executes, it returns a value of SQL_SUCCESS; in some cases, however, the function may also return the SQLSTATE 00000, which also indicates successful execution.

Table C.2. SQLSTATE Codes

SQLSTATE	Error	Can be returned from

01000	General warning	All ODBC functions except:
		`SQLGetDiagField`
		`SQLGetDiagRec`

01001	Cursor operation conflict	`SQLExecDirect`

SQLSTATE	Error	Can be returned from
		SQLExecute SQLParamData SQLSetPos
01002	Disconnect error	SQLDisconnect
01003	NULL value eliminated in set function	SQLExecDirect SQLExecute SQLParamData
01004	String data, right truncated	SQLColAttribute SQLDataSources SQLDescribeCol SQLDriverConnect SQLDrivers SQLExecDirect SQLExecute SQLExtendedFetch SQLFetch SQLFetchScroll SQLGetConnectAttr SQLGetCursorName SQLGetData SQLGetDescField SQLGetDescRec SQLGetEnvAttr

SQLSTATE	Error	Can be returned from
		SQLGetInfo SQLGetStmtAttr SQLParamData SQLPutData SQLSetCursorName
01006	Privilege not revoked	SQLExecDirect SQLExecute SQLParamData
01007	Privilege not granted	SQLExecDirect SQLExecute SQLParamData
01S00	Invalid connection string attribute	SQLDriverConnect SQLSetPos
01S01	Error in row	SQLExtendedFetch
01S02	Option value changed	SQLConnect SQLDriverConnect SQLExecDirect SQLExecute SQLParamData SQLPrepare SQLSetConnectAttr SQLSetDescField SQLSetEnvAttr

SQLSTATE	Error	Can be returned from
		SQLSetStmtAttr
01S06	Attempt to fetch before the result set returned the first rowset	SQLExtendedFetch SQLFetchScroll
01S07	Fractional truncation	SQLExecDirect SQLExecute SQLExtendedFetch SQLFetch SQLFetchScroll SQLGetData SQLParamData SQLSetPos
01S08	Error saving File DSN	SQCriverConnect
01S09	Invalid keyword	SQLDriverConnect
07001	Wrong number of parameters	SQLExecDirect SQLExecute
07002	COUNT field incorrect	SQLExecDirect SQLExecute SQLParamData
07005	Prepared statement not a cursor_specification	SQLColAttribute SQLDescribeCol
07006	Restricted data type attribute violation	SQLBindCol SQLBindParameter SQLExecDirect SQLExecute

SQLSTATE	Error	Can be returned from
		SQLExtendedFetch SQLFetch SQLFetchScroll SQLGetData SQLParamData SQLPutData
07009	Invalid descriptor index	SQLBindCol SQLBindParameter SQLColAttribute SQLDescribeCol SQLDesribeParam SQLFetch SQLFetchScroll SQLGetData SQLGetDescField SQLParamData SQLSetDescField SQLSetDescRec SetSetPos
07S01	Invalid use of default parameter	SQLExecDirect SQLExecute SQLParamData

SQLSTATE	Error	Can be returned from
		SQLPutData
08001	Client unable to establish connection	SQLConnect SQLDriverConnect
08002	Connection name in use	SQLConnect SQLDriverConnect SQLSetConnectAttr
08003	Connection does not exist	SQLAllocHandle SQLDisconnect SQLEndTran SQLGetConnectAttr SQLGetInfo SQLSetConnectAttr
08004	Server rejected the connection	SQLConnect SQLDriverConnect
08007	Connection failure during transaction	SQLEndTran
08S01	Communication link failure	SQLColumnPrivileges SQLColumns SQLConnect SQLCopyDesc SQLDescribeCol SQLDescribeParam SQLDriverConnect SQLExecDirect

SQLSTATE	Error	Can be returned from
		SQLExecute
		SQLExtendedFetch
		SQLFetch
		SQLFetchScroll
		SQLForeignKeys
		SQLGetConnectAttr
		SQLGetData
		SQLGetDescField
		SQLGetDescRec
		SQLGetFunctions
		SQLGetInfo
		SQLGetTypeInfo
		SQLMoreResults
		SQLNumParams
		SQLNumResultCols
		SQLParamData
		SQLPrepare
		SQLPrimaryKeys
		SQLProcedureColumns
		SQLProcedures
		SQLPutData
		SQLSetConnectAttr

SQLSTATE	Error	Can be returned from
		SQLSetDescField SQLSetDescRec SQLSetEnvAttr SQLSetStmtAttr SQLSpecialColumns SQLStatistics SQLTablePrivileges SQLTables
21S01	Insert value list does not match column list	SQLExecDirect SQLPrepare
21S02	Degree of derived table does not match column list	SQLExecDirect SQLExecute SQLParamData SQLPrepare SQLSetPos
22001	String data, right truncated	SQLExecDirect SQLExecute SQLFetch SQLFetchScroll SQLParamData SQLPutData SQLSetDescField SQLSetPos

SQLSTATE	Error	Can be returned from
22002	Indicator variable required but not supplied	SQLExecDirect SQLExecute SQLExtendedFetch SQLFetch SQLFetchScroll SQLGetData SQLParamData
22003	Numeric value out of range	SQLExecDirect SQLExecute SQLExtendedFetch SQLFetch SQLFetchScroll SQLGetData SQLGetInfo SQLParamData SQLPutData SQLSetPos
22007	Invalid datetime format	SQLExecDirect SQLExecute SQLExtendedFetch SQLFetch SQLFetchScroll

SQLSTATE	Error	Can be returned from
		SQLGetData SQLParamData SQLPutData SQLSetPos
22008	Datetime field overflow	SQLExecDirect SQLExecute SQLParamData SQLPutData
22012	Division by zero	SQLExecDirect SQLExecute SQLExtendedFetch SQLFetch SQLFetchScroll SQLGetData SQLParamData SQLPutData
22015	Interval field overflow	SQLExecDirect SQLExecute SQLExtendedFetch SQLFetch SQLFetchScroll SQLGetData SQLParamData

SQLSTATE	Error	Can be returned from
		`SQLPutData` `SQLSetPos`

22018	Invalid character value for cast specification	`SQLExecDirect`
		`SQLExecute`
		`SQLExtendedFetch`
		`SQLFetch`
		`SQLFetchScroll`
		`SQLGetData`
		`SQLParamData`
		`SQLPutData`
		`SQLSetPos`

22019	Invalid escape character	`SQLExecDirect`
		`SQLExecute`
		`SQLPrepare`

22025	Invalid escape sequence	`SQLExecDirect`
		`SQLExecute`
		`SQLPrepare`

22026	String data, length mismatch	`SQLParamData`

23000	Integrity constraint violation	`SQLExecDirect`
		`SQLExecute`
		`SQLParamData`
		`SQLSetPos`

24000	Invalid cursor state	`SQLCloseCursor`

SQLSTATE	Error	Can be returned from
		SQLColumnPrivileges SQLColumns SQLExecDirect SQLExecute SQLExtendedFetch SQLFetch SQLFetchScroll SQLForeignKeys SQLGetData SQLGetStmtAttr SQLGetTypeInfo SQLPrepare SQLPrimaryKeys SQLProcedureColumns SQLProcedures SQLConnectAttr SQLSetCursorName SQLSetPos SQLSpecialColumns SQLStatistics SQLTablePrivileges SQLTables

SQLSTATE	Error	Can be returned from
25000	Invalid transaction state	`SQLDisconnect`
25S01	Transaction state	`SQLEndTran`
25S02	Transaction is still active	`SQLEndTran`
25S03	Transaction is rolled back	`SQLEndTran`
28000	Invalid authorization specification	`SQLConnect` `SQLDriverConnect`

34000	Invalid cursor name	`SQLExecDirect`
		`SQLPrepare`
		`SQLSetCursorName`

3C000	Duplicate cursor name	`SQLSetCursorName`

3D000	Invalid catalog name	`SQLExecDirect`
		`SQLPrepare`
		`SQLSetConnectAttr`

3F000	Invalid schema name	`SQLExecDirect` `SQLPrepare`

40001	Serialization failure	`SQLColumnPrivileges`
		`SQLColumns`
		`SQLEndTran`
		`SQLExecDirect`
		`SQLExecute`
		`SQLFetch`
		`SQLFetchScroll`
		`SQLForeignKeys`
		`SQLGetTypeInfo`

SQLSTATE	Error	Can be returned from
		SQLMoreResults SQLParamData SQLPrimaryKeys SQLProcedureColumns SQLProcedures SQLSetPos SQLSpecialColumns SQLStatistics SQLTablePrivileges SQLTables
40002	Integrity constraint violation	SQLEndTran
40003	Statement completion unknown	SQLColumnPrivileges SQLColumns SQLExecDirect SQLExecute SQLFetch SQLFetchScroll SQLGetTypeInfo SQLForeignKeys SQLMoreResults SQLPrimaryKeys SQLProcedureColumns

SQLSTATE	Error	Can be returned from
		SQLProcedures SQLParamData SQLSetPos SQLSpecialColumns SQLStatistics SQLTables
42000	Syntax error or access violation	SQLExecDirect SQLExecute SQLParamData SQLPrepare SQLSetPos
42S01	Base table or view already exists	SQLExecDirect SQLPrepare
42S02	Base table or view not found	SQLExecDirect SQLPrepare
42S11	Index already exists	SQLExecDirect SQLPrepare
42S12	Index not found	SQLExecDirect SQLPrepare
42S21	Column already exists	SQLExecDirect SQLPrepare
42S22	Column not found	SQLExecDirect SQLPrepare

SQLSTATE	Error	Can be returned from

44000	WITH CHECK OPTION violation	`SQLExecDirect`
		`SQLExecute`
		`SQLParamData`

HY000	General Error	All ODBC functions except:
		`SQLGetDiagField`
		`SQLGetDiagRec`

HY001	Memory allocation error	All ODBC function except:
		`SQLGetDiagField`
		`SQLGetDiagRec`

HY003	Invalid application buffer type	`SQLBindCol`
		`SQLBindParameter`
		`SQLGetData`

HY004	Invalid SQL data type	`SQLBindParameter` `SQLGetTypeInfo`

HY007	Associated statement is not prepared	`SQLCopyDesc`
		`SQLGetDescField`
		`SQLGetDescRec`

HY008	Operation canceled	All ODBC functions that can be processed asynchronously:
		`SQLColAttribute`
		`SQLColumnPrivileges`
		`SQLColumns`
		`SQLDescribeCol`
		`SQLDescribeParam`

SQLSTATE	Error	Can be returned from
		SQLExecDirect
		SQLExecute
		SQLExtendedFetch
		SQLFetch
		SQLFetchScroll
		SQLForeignKeys
		SQLGetData
		SQLGetTypeInfo
		SQLMoreResults
		SQLNumParams
		SQLNumResultCols
		SQLParamData
		SQLPrepare
		SQLPrimaryKeys
		SQLProcedureColumns
		SQLProcedures
		SQLPutData
		SQLSetPos
		SQLSpecialColumns
		SQLStatistics
		SQLTablePrivileges
		SQLTables

SQLSTATE	Error	Can be returned from
HY009	Invalid use of null pointer	SQLAllocHandle SQLBindParameter SQLColumnPrivileges SQLColumns SQLExecDirect SQLForeignKeys SQLGetCursorName SQLGetData SQLGetFunctions SQLPrepare SQLPrimaryKeys SQLProcedureColumns SQLProcedures SQLPutData SQLSetConnectAttr SQLSetCursorName SQLSetEnvAttr SQLSetStmtAttr SQLSpecialColumns SQLStatistics SQLTablePrivileges SQLTables

SQLSTATE	Error	Can be returned from
HY010	Function sequence error	SQLAllocHandle SQLBindCol SQLBindParameter SQLCloseCursor SQLColAttribute SQLColumnPrivileges SQLColumns SQLCopyDesc SQLDescribeCol SQLDescribeParam SQLDisconnect SQLEndTran SQLExecDirect SQLExecute SQLExtendedFetch SQLFetch SQLFetchScroll SQLForeignKeys SQLFreeHandle SQLFreeStmt SQLGetConnectAttr SQLGetCursorName

SQLSTATE	Error	Can be returned from
		SQLGetData
		SQLGetDescField
		SQLGetDescRec
		SQLGetFunctions
		SQLGetStmtAttr
		SQLGetTypeInfo
		SQLMoreResults
		SQLNumParams
		SQLNumResultCols
		SQLParamData
		SQLPrepare
		SQLPrimaryKeys
		SQLProcedureColumns
		SQLProcedures
		SQLPutData
		SQLRowCount
		SQLSetConnectAttr
		SQLSetCursorName
		SQLSetDescField
		SQLSetEnvAttr
		SQLSetDescRec
		SQLSetPos

SQLSTATE	Error	Can be returned from

		`SQLSetStmtAttr`
		`SQLSpecialColumns`
		`SQLStatistics`
		`SQLTablePrivileges`
		`SQLTables`

HY011	Attribute cannot be set now	`SQLParamData`
		`SQLSetConnectAttr`
		`SQLSetPos`
		`SQLSetStmtAttr`

HY012	Invalid transaction operation code	`SQLEndTran`

HY013	Memory Management err	All ODBC functions except:
		`SQLGetDiagField`
		`SQLGetDiagRec`

HY014	Limit on the number of handles exceeded	`SQLAllocHandle`
HY015	No cursor name available	`SQLGetCursorName`

HY016	Cannot modify an implementation row descriptor	`SQLCopyDesc`
		`SQLSetDescField`
		`SQLSetDescRec`

HY017	Invalid use of an automatically allocated descriptor handle	`SQLFreeHandle` `SQLSetStmtAttr`
HY018	Server declined cancel request	`SQLCancel`
HY019	Non-character and non-binary data sent in pieces	`SQLPutData`

SQLSTATE	Error	Can be returned from
HY020	Attempt to concatenate a null value	SQLPutData
HY021	Inconsistent descriptor information	SQLBindParameter SQLCopyDesc SQLGetDescField SQLSetDescField SQLSetDescRec
HY024	Invalid attribute value	SQLSetConnectAttr SQLSetEnvAttr SQLSetStmtAttr
HY090	Invalid string or buffer length	SQLBindCol SQLBindParameter SQLBrowseConnect SQLColAttribute SQLColumnPrivileges SQLColumns SQLConnect SQLDataSources SQLDescribeCol SQLDriverConnect SQLDrivers SQLExecDirect SQLExecute

SQLSTATE	Error	Can be returned from
		SQLFetch
		SQLFetchScroll
		SQLForeignKeys
		SQLGetConnectAttr
		SQLGetCursorName
		SQLGetData
		SQLGetDescField
		SQLGetInfo
		SQLGetStmtAttr
		SQLParamData
		SQLPrepare
		SQLPrimaryKeys
		SQLProcedureColumns
		SQLProcedures
		SQLPutData
		SQLSetConnectAttr
		SQLSetCursorName
		SQLSetDescField
		SQLSetDescRec
		SQLSetEnvAttr
		SQLSetStmtAttr
		SQLSetPos

SQLSTATE	Error	Can be returned from
		SQLSpecialColumns SQLTablePrivileges SQLStatistics SQLTables
HY091	Invalid descriptor field identifier	SQLColAttribute SQLGetDescField SQLSetDescField
HY092	Invalid attribute/option identifier	SQLAllocHandle SQLCopyDesc SQLDriverConnect SQLEndTran SQLFreeStmt SQLGetConnectAttr SQLGetEnvAttr SQLGetStmtAttr SQLParamData SQLSetConnectAttr SQLSetDescField SQLSetEnvAttr SQLSetPos SQLSetStmtAttr
HY095	Function type out of range	SQLGetFunctions
HY096	Invalid information type	SQLGetInfo

SQLSTATE	Error	Can be returned from
HY097	Column type out of range	SQLSpecial Columns
HY098	Scope type out of range	SQLSpecial Columns
HY099	Nullable type out of range	SQLSpecial Columns
HY100	Uniqueness option type out of range	SQLStatistics
HY101	Accuracy option type out of range	SQLStatistics
HY103	Invalid retrieval code	SQLDataSources SQLDrivers
HY104	Invalid precision or scale value	SQLBindParameter
HY105	Invalid parameter type	SQLBindParameter SQLExecDirect SQLExecute SQLParamData SQLSetDescField
HY106	Fetch type out of range	SQLExtendedFetch SQLFetchScroll
HY107	Row value out of range	SQLExtendedFetch SQLFetch SQLFetchScroll SQLSetPos
HY109	Invalid cursor position	SQLExecDirect SQLExecute SQLGetData SQLGetStmtAttr

SQLSTATE	Error	Can be returned from
		SQLParamData SQLSetPos
HY110	Invalid driver completion	SQLDriverConnect
HY111	Invalid bookmark value	SQLExtendedFetch SQLFetchScroll
HYC00	Optional feature not implemented	SQLBindCol SQLBindParameter SQLColAttribute SQLColumnPrivileges SQLColumns SQLDriverConnect SQLEndTran SQLConnect SQLExecDirect SQLExecute SQLExtendedFetch SQLFetch SQLFetchScroll SQLForeignKeys SQLGetConnectAttr SQLGetData SQLGetEnvAttr SQLSetPos

SQLSTATE	Error	Can be returned from
		SQLGetInfo SQLGetStmtAttr SQLGetTypeInfo SQLParamData SQLPrepare SQLPrimaryKeys SQLProcedureColumns SQLProcedures SQLSetConnectAttr SQLSetEnvAttr SQLSetStmtAttr SQLSpecialColumns SQLStatistics SQLTablePrivileges SQLTables
HYT00	Timeout expired	SQLBrowseConnect SQLColumnPrivileges SQLColumns SQLConnect SQLDriverConnect SQLExecDirect SQLExecute

SQLSTATE	Error	Can be returned from
		SQLExtendedFetch SQLForeignKeys SQLGetTypeInfo SQLParamData SQLPrepare SQLPrimaryKeys SQLProcedureColumns SQLProcedures SQLSetPos SQLSpecialColumns SQLStatistics SQLTablePrivileges SQLTables
HYT01	Connection timeout expired	All ODBC functions except: SQLDrivers SQLDataSources SQLGetEnvAttr SQLSetEnvAttr
IM001	Driver does not support this function	All ODBC functions except: SQLAllocHandle SQLDataSources SQLDrivers

SQLSTATE	Error	Can be returned from
		SQLFreeHandle SQLGetFunctions
IM002	Data source name not found and no default driver specified	SQLConnect SQLDriverConnect
IM003	Specified driver could not be loaded.	SQLConnect
IM004	Driver's SQLAllocHandle on SQL_HANDLE_ENV failed	SQLDriverConnec SQLConnect SQLDriverConnect
IM005	Driver's SQLAllocHandle on SQL_HANDLE_DBC failed	SQLConnect SQLDriverConnect
IM006	Driver's SQLSetConnectAttr Failed	SQLConnect SQLDriverConnect
IM007	No data source or driver specified; dialog prohibited	SQLDriverConnect
IM008	Dialog failed	SQLDriverConnect
IM009	Unable to load translation DLL	SQLConnect SQLDriverConnect SQLSetConnectAttr
IM010	Data source name too long	SQLConnect SQLDriverConnect
IM011	Driver name too long	SQLDriverConnect
IM012	DRIVER keyword syntax error	SQLDriverConnect
IM013	Trace file error	All ODBC functions
IM014	Invalid name of File DSN	SQLDriverConnect

SQLSTATE	Error	Can be returned from
IM015	Corrupt file data source	`SQLDriverConnect`

Appendix D. SQL Minimum Grammar

An ODBC driver must support a subset of SQL-92 Entry level syntax. This appendix describes this SQL minimum syntax that an ODBC driver must support. An application that uses this syntax will be supported by any ODBC-compliant driver.

Applications can call `SQLGetInfo` with the SQL_SQL_CONFORMANCE to determine if additional features of SQL-92, not covered in this appendix, are supported.

Note

If the driver supports only read-only data sources, the SQL syntax that applies to changing data may not apply to the driver. Applications need to call `SQLGetInfo` with the SQL_DATA_SOURCE_READ_ONLY information type to determine if a data source is read-only.

D.1 SQL Statements

```
create-table-statement ::=
        CREATE TABLE base_table_name
        (column_identifier data_type [, column_identifier data_type]...)
```

Important

As the *data_type* in a *create_table_statement*, applications require a data type from the TYPE_NAME column of the result set returned by `SQLGetTypeInfo`.

```
delete_statement_searched ::=
        DELETE FROM table_name [WHERE search_condition]
drop_table_statement ::=
        DROP TABLE base_table_name
select_statement ::=
        SELECT [ALL | DISTINCT] select_list
        FROM table_reference_list
        [WHERE search_condition]
        [order_by_clause]
statement ::= create_table_statement |
        delete_statement_searched |
        drop_table_statement |
```

```
        insert_stetement |
        select_statement |
        update_statement_searched
Update_statement_searched ::=
   UPDATE table_name
   SET column_identifier = {expression |
         NULL}
   [, column_identifier = {expression |
         NULL}]...
   [WHERE search_condition]
```

D.2 SQL Statement Elements

```
base_table_identifier ::= user_defined_name
base_table_name ::= base_table_identifier
boolean_factor ::= [NOT] boolean_primary
boolean_primary ::= predicate | ( search_condition )
boolean_term ::= boolean_factor [AND boolean_term]
character_string_literal :: = "{character}..."
(character is any character in the character set
of the driver/data source. To include a single
literal quote character (') in a character_string_literal,
use two literal quote characters [""].)
column_identifier ::= user_defined_name
column_name ::= [table_name.]column_identifier
comparison_operator ::= < | > | <= | >= | = | <>
comparison_predicate ::= expression comparison_operator expression
data_type ::= character_string_type
(character_string_type is any data type for which the
""DATA_TYPE"" column in the result set returned by SQLGetTypeInfo
is either SQL_CHAR or SQLVARCHAR.)
digit ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
dynamic_parameter ::= ?
expression ::= term | expression {+|-} term
factor ::= [+|-]primary
insert_value ::= dynamic_parameter | literal | NULL | USER
letter ::= lower_case_letter | upper_case_letter
literal ::= character_string_literal
lower_case_letter ::= a | b | c | d | e | f | g |
  h | i | j | k | l | m | n | o | p | q | r | s |
```

```
  t | u | v | w | x | y | z
order_by_clause ::= ORDER BY sort_specification [, sort_specification]...
primary ::= column_name | dynamic_parameter | literal | ( expression )
search_condition ::= boolean_term [OR search_condition]
select_list ::= * | select_sublist [, select_sublist]...
(select_list cannot contain parameters.)
select_sublist ::= expression
sort_specification ::= {unsigned_integer | column_name } [ASC | DESC]
table_identifier ::= user_defined_name
table_name ::= table_identifier
table_reference ::= table_name
table_reference ::= table_name [,table_reference]...
term ::= factor | term {*|/} factor
unsigned_integer ::= {digit}
upper_case_letter ::=  A | B | C | D | E | F | G |
   H | I | J | K | L | M | N | O | P | Q | R | S |
   T | U | V | W | X | Y | Z
user_defined_name ::= letter[ digit | letter| _ ]...
```

D.2.1 Control Statements (Logical Condition)

The following table provides a brief summary of control statements that are available in IBM solidDB database procedures. For a more in-depth description of these control statements, see the discussion of Stored Procedures in IBM solidDB SQL Guide.

Table D.1. Control Statements

Control statement	Description
`set variable = expression`	Assigns a value to a variable. The value can be either a literal value (e.g., 10 or 'text') or another variable. Parameters are considered as normal variables.
`variable := expression`	Alternate syntax for assigning values to variables.
`boolean_expr`	A boolean expression which evaluates to "true" or "false". The expression can include comparison operators, such as =, >, <, etc.) and logical operators and, or, and not.

Control statement	Description
statement_list	A valid procedure statement that executes as a result of a boolean expression.

while
    boolean_expr
loop
    statement_list
end loop
	This loops while the expression is true. For examples of valid parentheses use in WHILE loops, see the discussion of Stored Procedures in IBM solidDB SQL Guide.

leave	Leaves the innermost while loop and continues executing the procedure from the next statement after the keyword end loop.

if
    boolean_expr
then
    statement_list1
else
    statement_list2
end if
	Executes *statement_list1* if boolean_expr is true; otherwise, executes *statement_list2*. For examples of valid parentheses use in IF statements, see the discussion of Stored Procedures in IBM solidDB SQL Guide.

if
    boolean_expr1
then
    statement_list1
elseif
    boolean_expr2
then
    statement_list2
end if
	If *boolean_expr1* is true, executes *statement_list1*. If *boolean_expr2* is true, executes *statement_list2*. The statement can optionally contain multiple elseif statements and also an else statement. For examples of valid parentheses use in IF statement, see the discussion of Stored Procedures in IBM solidDB SQL Guide.

Control statement	Description
`return`	Returns the current values of output parameters and exits the procedure. If a procedure has a *`return row`* statement, *`return`* behaves like *`return norow`*.
`return sqlerror of` *`cursor_name`*	Returns the sqlerror associated with the cursor and exits the procedure.
`return row`	Returns the current values of output parameters and continues execution of the procedure. Return row does not exit the procedure and return control to the caller.
`return norow`	Returns the end of the set and exits the procedure.

D.3 Data Type Support

At minimum, ODBC drivers must support either SQL_CHAR or SQL_VARCHAR. Other data types support is determined by the driver's or data source's SQL-92 conformance level. To determine the SQL-92 conformance level for a driver or data source, applications need to call `SQLGetTypeInfo`.

D.4 Parameter Data Types

Even though each parameter specified with `SQLBindParameter` is defined using an SQL data type, the parameters in an SQL statement have no intrinsic data type. Therefore, parameter markers can be included in an SQL statement only if their data types can be inferred from another operand in the statement. For example, in an arithmetic expression such as ? + COLUMN1, the data type of the parameter can be inferred from the data type of the named column represented by COLUMN1. An application cannot use a parameter marker if the data type cannot be determined.

The following table describes how a data type is determined for several types of parameters according to SQL-92 standards. For comprehensive information on inferring the parameter type, see the SQL-92 specification.

Table D.2. Determinig Data Ttype for Several Types of Parameters

Location of Parameter	Assumed Data Type
One operand of a binary arithmetic or comparison operator	Same as the other operand
The first operand in a BETWEEN clause	Same as the second operand
The second or third operand in a BETWEEN clause	Same as the first operand
An expression used with IN	Same as the first value or the result column of the subquery
A value used with IN	Same as the expression or the first value if there is a parameter marker in the expression
A pattern value used with LIKE	VARCHAR
An update value used with UPDATE	Same as the update column

D.4.1 Parameter Markers

According to the SQL-92 specification, an application cannot place parameter markers in the following locations:

- In a SELECT list.
- As both *`expressions`* in a *`comparison-predicate`*.
- As both operands of a binary operator.
- As both the first and second operands of a BETWEEN operation.
- As both the first and third operands of a BETWEEN operation.
- As both the expression and the first value of an IN operation.
- As the operand of a unary + or - operation.
- As the argument of a *`set-function-reference`*.

For a comprehensive list and more details, see the SQL-92 specification.

D.5 Literals in ODBC

The ODBC literal syntax in this section is provided to aid driver writers who are converting a character string type to a numeric or interval type, or from a numeric or interval type to a character string type.

D.5.1 Interval Literal Syntax

The following syntax is used for interval literals in ODBC.

```
interval_literal ::= INTERVAL [+|_] interval_string interval_qualifier
interval_string ::= quote { year_month_literal
     | day_time_literal } quote
year_month_literal ::= years_value | [years_value] months_value
day_time_literal ::= day_time_interval | time_interval
day_time_interval ::= days_value [hours_value
     [:minutes_value[:seconds_value]]]
time_interval ::= hours_value [:minutes_value [:seconds_value ] ]
     | minutes_value [:seconds_value ]
     | seconds_value
years_value ::= datetime_value
months_value ::= datetime_value
days_value ::= datetime_value
hours_value ::= datetime_value
minutes_value ::= datetime_value
seconds_value ::= seconds_integer_value [.[seconds_fraction] ]
seconds_integer_value ::= unsigned_integer
seconds_fraction ::= unsigned_integer
datetime_value ::= unsigned_integer
interval_qualifier ::= start_field TO end_field
     | single_datetime_field
start_field ::= non_second_datetime_field
     [(interval_leading_field_precision )]
end_field ::= non_second_datetime_field
     | SECOND[(interval_fractional_seconds_precision)]
single_datetime_field ::= non_second_datetime_field
     [(interval_leading_field_precision)]
     | SECOND[(interval_leading_field_precision
     [, (interval_fractional_seconds_precision)]
datetime_field ::= non_second_datetime_field | SECOND
non_second_datetime_field ::= YEAR | MONTH | DAY | HOUR | MINUTE
```

```
interval_fractional_seconds_precision ::= unsigned_integer
interval_leading_field_precision ::= unsigned_integer
quote ::= '
unsigned_integer ::= digit...
```

D.5.2 Numeric Literal Syntax

The following syntax is used for numeric literals in ODBC:

```
numeric_literal ::= signed_numeric_literal | unsigned_numeric_literal
signed_numeric_literal ::= [sign] unsigned_numeric_literal
unsigned_numeric_literal ::= exact_numeric_literal
     | approximate_numeric_literal
exact_numeric_literal ::= unsigned_integer [period[unsigned_integer]]
     | period unsigned_integer
sign ::= plus_sign | minus_sign
approximate_numeric_literal ::= mantissa E exponent
mantissa ::= exact_numeric_literal
exponent ::= signed_integer
signed_integer ::= [sign] unsigned_integer
unsigned_integer ::= digit...
plus_sign ::= +
minus_sign ::= _
digit ::= 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0
period ::= .
```

D.6 List of Reserved Keywords

The following words are reserved for use in ODBC function calls. These words do not constrain the minimum SQL grammar; however, to ensure compatibility with drivers that support the core SQL grammar, applications should avoid using any of these keywords. The #define value SQL_ODBC_KEYWORDS contains a comma-separated list of these keywords.

For a complete list of reserved keywords in several SQL standards and IBM solidDB ODBC API, see the appendix, "Reserved Words" in *IBM solidDB Administration Guide*.

Table D.3. List of Reserved Keywords

Keyword	Keyword	Keyword	Keyword
ABSOLUTE	ACTION	ADA	ADD

Keyword	**Keyword**	**Keyword**	**Keyword**
ALL	ALLOCATE	ALTER	AND
ANY	ARE	AS	ASC
ASSERTION	AT	AUTHORIZATION	AVG
BEGIN	BETWEEN	BIT	BIT_LENGTH
BOTH	BY	CASCADE	CASCADED
CASE	CAST	CATALOG	CHAR
CHAR_LENGTH	CHARACTER	CHARACTER_LENGTH	CHECK
CLOSE	COALESCE	COLLATE	COLLATION
COLUMN	COMMIT	CONNECT	CONNECTION
CONSTRAINT	CONSTRAINTS	CONTINUE	CONVERT
CORRESPONDING	COUNT	CREATE	CROSS
CURRENT	CURRENT_DATE	CURRENT_TIME	C U R - RENT_TIMESTAMP
CURRENT_USER	CURSOR	DATE	DAY
DEALLOCATE	DEC	DECIMAL	DECLARE
DEFAULT	DEFERRABLE	DEFERRED	DELETE
DESC	DESCRIBE	DESCRIPTOR	DIAGNOSTICS
DISCONNECT	DISTINCT	DOMAIN	DOUBLE
DROP	ELSE	END	END-EXEC
ESCAPE	EXCEPT	EXCEPTION	EXEC
EXECUTE	EXISTS	EXTERNAL	EXTRACT
FALSE	FETCH	FIRST	FLOAT
FOR	FOREIGN	FORTRAN	FOUND
FROM	FULL	GET	GLOBAL
GO	GOTO	GRANT	GROUP
HAVING	HOUR	IDENTITY	IMMEDIATE
IN	INCLUDE	INDEX	INDICATOR
INITIALLY	INNER	INPUT	INSENSITIVE
INSERT	INT	INTEGER	INTERSECT
INTERVAL	INTO	IS	ISOLATION

Keyword	Keyword	Keyword	Keyword
JOIN	KEY	LANGUAGE	LAST
LEADING	LEFT	LEVEL	LIKE
LOCAl	LOWER	MATCH	MAX
MIN	MINUTE	MODULE	MONTH
NAMES	NATIONAL	NATURAL	NCHAR
NEXT	NO	NONE	NOT
NULL	NULLIF	NUMERIC	OCTET_LENGTH
OF	ON	ONLY	OPEN
OPTION	OR	ORDER	OUTER
OUTPUT	OVERLAPS	PASCAL	POSITION
PRECISION	PREPARE	PRESERVE	PRIMARY
PRIOR	PRIVILEGES	PROCEDURE	PUBLIC
READ	REAL	REFERENCES	RELATIVE
RESTRICT	REVOKE	RIGHT	ROLLBACK
ROWS	SCHEMA	SCROLL	SECOND
SECOND	SECTION	SELECT	SESSION
SESSION_USER	SET	SIZE	SMALLINT
SOME	SPACE	SQL	SQLCA
SQLCODE	SQLERROR	SQLSTATE	SQLWARNING
SUBSTRING	SUM	SYSTEM_USER	TABLE
TEMPORARY	THEN	TIME	TIMESTAMP
TIMEZONE_HOUR	TIMEZONE_MINUTE	TO	TRAILING
TRANSACTION	TRANSLATE	TRANSLATION	TRIM
TRUE	UNION	UNIQUE	UNKNOWN
UPDATE	UPPER	USAGE	USER
USING	VALUE	VALUES	VARCHAR
VARYING	VIEW	WHEN	WHENEVER
WHERE	WITH	WORK	WRITE
YEAR	ZONE		

Appendix E. Data Types

ODBC defines the following sets of data types:

- SQL data types, which indicate the data type of data stored at the data source (e.g. the IBM solidDB server).
- C data types, which indicate the data type of data stored in application buffers.

Each SQL data type corresponds to an ODBC C data type. Before returning data from the data source, the driver converts it to the specified C data type. Before sending data to the data source, the driver converts it from the specified C data type.

This appendix contains the following topics:

- ODBC SQL data types
- ODBC C data types
- Numeric literals
- Data type identifiers including pseudo-type identifiers and Descriptors
- Decimal digits and transfer octet length of SQL data types
- Converting data from SQL to C data types
- Converting data from C to SQL data types

For information about driver-specific SQL data types, see the driver's documentation.

E.1 SQL Data Types

In accordance with the SQL-92 standard, each DBMS defines its own set of SQL data types. For each SQL data type in the SQL-92 standard, a #define value, known as a type identifier, is passed as an argument in ODBC functions or returned in the metadata of a result set. Drivers map data source-specific SQL data types to ODBC SQL data type identifiers and driver-specific SQL data type identifiers. The SQL_DESC_CONCISE_TYPE field of an implementation descriptor is where the SQL data type is stored.

IBM solidDB's ODBC driver does not support the following SQL_92 data types:

- BIT

- BIT_VARYING
- TIME_WITH_TIMEZONE
- TIMESTAMP_WITH_TIMEZONE
- NATIONAL_CHARACTER

E.2 C Data Types

ODBC defines the C data types and their corresponding ODBC type identifiers. Applications either call

- `SQLBindCol` or `SQLGetData` to pass an applicable C type identifier in the *`TargetType`* argument. In this way, applications specify the C data type of the buffer that receives result set data.
- `SQLBindParameter` to pass the appropriate C type identifier in the *`ValueType`* argument. In this way, applications specify the C data type of the buffer containing a statement parameter.

The SQL_DESC_CONCISE_TYPE field of an application descriptor is where the C data type is stored.

Note

Driver-specific C data types do not exist.

E.3 Data Type Identifiers

Data type identifiers are stored in the SQL_DESC_CONCISE_TYPE field of a descriptor. Data type identifiers in applications describe their buffers to the driver. They also retrieve metadata about the result set from the driver so applications know what type of C buffers to use for data storage. Applications use data type identifiers to perform these tasks by calling these functions:

- To describe the C data type of application buffers, applications call `SQLBindParameter`, `SQLBindCol`, and `SQLGetData`.
- To describe the SQL data type of dynamic parameters, applications call `SQLBindParameter`.
- To retrieve the SQL data types of result set columns, applications call `SQLColAttribute` and `SQLDescribeCol`.
- To retrieve the SQL data types of parameters, applications call `SQLDescribeParameter`.

- To retrieve the SQL data types of various schema information, applications call `SQLColumns`, `SQLProcedureColumns`, and `SQLSpecialColumns`.
- To retrieve a list of supported data types, applications call `SQLGetTypeInfo`.

In addition, the `SQLSetDescField` and `SQLSetDescRec` descriptor functions are also used to perform the above tasks. For details, see the `SQLSetDescField` and `SQLSetDescRec` functions.

E.4 SQL Data Types

A given driver and data source do not necessarily support all of the SQL data types defined in the ODBC grammar. Furthermore, they may support additional, driver-specific SQL data types. A driver's support is determined by the level of SQL-92 conformance. To determine which data types a driver supports, an application calls `SQLGetTypeInfo`. See Section E.4.1, “SQLGetTypeInfo Result Set Example”. For information about driver-specific SQL data types, see the driver's documentation.

A driver also returns the SQL data types when it describes the data types of columns and parameters using the following functions:

- `SQLColAttribute`
- `SQLColumns`
- `SQLDescribeCol`
- `SQLDescribeParam`
- `SQLProcedureColumns`
- `SQLSpecialColumns`

Note

For details on fields that store SQL data type values and characteristics, see Section E.8, “Data Type Identifiers and Descriptors”.

The following table is not a comprehensive list of SQL data types, but offers commonly used names, ranges, and limits. A data source may only support some of the data types that are listed in the table and depending on your driver, the characteristics of the data types can differ form this table's description. The table includes the description of the associated data type from SQL-92 (if applicable)

Table E.1. Common SQL Data Type Names, Ranges, and Limits

SQL Type Identifier [1]	Typical SQL Data Type [2]	Typical Type Description
SQL_CHAR	CHAR(n)	Character string of fixed string length *n*.
SQL_VARCHAR	VARCHAR(n)	Variable-length character string with a maximum string length *n*.
SQL_LONGVARCHAR	LONG VARCHAR	Variable length character data. Maximum length is data source-dependent. [3]
SQL_WCHAR	WCHAR(n)	Unicode character string of fixed string length *n*.
SQL_WVARCHAR	VARWCHAR(n)	Unicode variable-length character string with a maximum string length *n*.
SQL_WLONGVARCHAR	LONGWVARCHAR	Unicode variable-length character data. Maximum length is data source-dependent.
SQL_DECIMAL	DECIMAL(p, s)	Signed, exact, numeric value with a precision *p* and scale *s*. (The maximum precision is driver-defined.) (1 <= *p* <= 16; *s* <= *p*). [4]
SQL_NUMERIC	NUMERIC(p,s)	Signed, exact, numeric value with a precision *p* and scale *s*. (1 <= *p* <= 16; *s* <= *p*). [4]
SQL_SMALLINT	SMALLINT	Exact numeric value with precision 5 and scale 0. (signed: -32,768 <=n <= 32,767, unsigned: 0 <= n <= 65,535) IBM solidDB supports only signed, not unsigned, SMALLINT. [5]
SQL_INTEGER	INTEGER	Exact numeric value with precision 10 and scale 0. (signed: -2^{31} <= n <= 2^{31} -1, unsigned: 0 <= n <= 2^{32} -1) IBM solidDB supports only signed, not unsigned, INTEGER. [5]
SQL_REAL	REAL	Signed, approximate, numeric value with a binary precision 24 (zero or absolute value 10^{-38} to 1038).
SQL_FLOAT	FLOAT(p)	Signed, approximate, numeric value with a binary precision of at least *p*. (The maximum precision is driver defined.) [6]

SQL Type Identifier [1]	Typical SQL Data Type [2]	Typical Type Description
SQL_DOUBLE	DOUBLE PRECISION	Signed, approximate, numeric value with a binary precision 53 (zero or absolute value 10-308 to 10 308).
SQL_BIT	BIT	Single bit binary data. NOTE: IBM solidDB does not support BIT/SQL_BIT. [7]
SQL_TINYINT	TINYINT	Exact numeric value with precision 3 and scale 0 (signed:-128 <= *n* <= 127 unsigned: 0 <= *n* <= 255) IBM solidDB supports only signed, not unsigned, TINYINT. [5].
SQL_BIGINT	BIGINT	Exact numeric value with precision 19 (if signed) or 20 (if unsigned) and scale 0 (signed: -2^{63} <= *n* <= 2^{63} - 1, unsigned: 0 <= *n* <= 2^{64} - 1) IBM solidDB supports only signed, not unsigned, BIGINT. [3], [5].
SQL_BINARY	BINARY(n)	Binary data of fixed length *n*. [3]
SQL_VARBINARY	VARBINARY(n)	Variable length binary data of maximum length *n*. The maximum is set by the user. [3]
SQL_LONGVARBINARY	LONG VARBINARY	Variable length binary data. Maximum length is data source-dependent. [3]
SQL_TYPE_DATE [8]	DATE	Year, month, and day fields, conforming to the rules of the Gregorian calendar. (See Section E.11, “Constraints of the Gregorian Calendar”.)
SQL_TYPE_TIME [8]	TIME(p)	Hour, minute, and second fields. Valid values for hours are 00 to 23. Valid values for minutes are 00 to 59. Valid values for seconds are 00 to 61 (60 and 61 are to handle "leap seconds" (see http://tycho.usno.navy.mil/leapsec.html). Precision *p* indicates the precision of the seconds field.
SQL_TYPE_TIMESTAMP [8]	TIMESTAMP(p)	Year, month, day, hour, minute, and send fields, with valid values as defined for the DATE and Time data types.

Explanations of Footnote Numbering in the Table Above

[1] This is the value returned in the DATA_TYPE column by a call to `SQLGetTypeInfo`.

[2] This is the value returned in the NAME and CREATE PARAMS column by a call to `SQLGetTypeInfo`. The NAME column returns the designation - for example, CHAR - while the CREATE PARAMS column returns a comma-separated list of creation parameters such as precision, scale, and length.

[3] This data type has no corresponding data type in SQL-92.

[4] SQL_DECIMAL and SQL_NUMERIC data types differ only in their precision. The precision of a DECIMAL(p,s) is an implementation-defined decimal precision that is no less than p, while the precision of a NUMERIC(p,s) is exactly equal to p.

[5] An application uses `SQLGetTypeInfo` or `SQLColAttribute` to determine if a particular data type or a particular column in a result set is unsigned.

[6] Depending on the implementation, the precision of SQL_FLOAT can be either 24 or 53: if it is 24, the SQL_FLOAT data type is the same as SQL_REAL; if it is 53, the SQL_FLOAT data type is the same as SQL_DOUBLE.

[7] The SQL_BIT data type has different characteristics than the BIT type in SQL-92.

[8] This data type has no corresponding data type in SQL-92.

E.4.1 SQLGetTypeInfo Result Set Example

Applications call `SQLGetTypeInfo` result set for a list of supported data types and their characteristics for a given data source. The example below shows the data types that `SQLGetTypeInfo` returns for a data source; all data types under "DATA_TYPE" are supported in this data source.

The example below is divided into 3 sections so that it fits the width of a page. In fact, it is all one example.

Table E.2. Data Types SQLGetTypeInfo Returns (1)

TYPE_ NAME	DATA_TYPE	COLUMN_ SIZE	LITERAL_ PREFIX	LITERAL_ SUFFIX	CREATE_ PARAMS	NULLABLE
"char"	SQL_CHAR	255	""	""	"length"	SQL_TRUE
"text"	SQL_LONG VARCHAR	2147483647	""	""	<Null>	SQL_TRUE
"decimal"	SQL_DECIMAL	18 [a]	<Null>	<Null>	"precision, scale"	SQL_TRUE
"real"	SQL_REAL	7	<Null>	<Null>	<Null>	SQL_TRUE
"datetime"	SQL_TYPE_ TIMESTAMP	29 [b]	""	""	<Null>	SQL_TRUE

Table E.3. Data Types SQLGetTypeInfo Returns (2)

(continued)	CASE_ SENSITIVE	SEARCHABLE	UNSIGNED_ ATTRIBUTE	FIXED_ PREC_ SCALE	AUTO_ UNIQUE_ VALUE	LOCAL_ TYPE_ NAME
SQL_CHAR	SQL_FALSE	SQL_SEARCH-ABLE	<Null>	SQL_FALSE	<Null>	"char"
SQL_LONG VARCHAR	SQL_FALSE	SQL_PRED_CHAR	<Null>	SQL_FALSE	<Null>	"text"
SQL_DECIMAL	SQL_FALSE	SQL_PRED_BA-SIC	SQL_FALSE	SQL_FALSE	SQL_FALSE	"decimal"
SQL_REAL	SQL_FALSE	SQL_PRED_BA-SIC	SQL_FALSE	SQL_FALSE	SQL_FALSE	"real"
SQL_TYPE_ TIMESTAMP	SQL_FALSE	SQL_SEARCH-ABLE	<Null>	SQL_FALSE	<Null>	"datetime"

Table E.4. Data Types SQLGetTypeInfo Returns (3)

(continued)	MINIMUM_ SCALE	MAXIMUM_ SCALE	SQL_DATA_ TYPE	SQL_DATE-TIME_SUB	NUM_PREC_ RADIX	INTERVAL_ PRECISION
SQL_CHAR	<Null>	<Null>	SQL_CHAR	<Null>	<Null>	<Null>
SQL_LONG VARCHAR	<Null>	<Null>	SQL_LONG VARCHAR	<Null>	<Null>	<Null>
SQL_DECIMAL	0	16	SQL_DECIM-AL	<Null>	10	<Null>
SQL_REAL	<Null>	<Null>	SQL_REAL	<Null>	10	<Null>
SQL_TYPE_ TIMESTAMP	3	3	SQL_DATE-TIME	SQL_CODE_ TIMESTAMP	<Null>	12

Explanations of Footnote Numbering in the Table Above

[a] 16 digits, 1 decimal point, and an optional sign character for negative numbers

[b] 29 characters to display yyyy-mm-dd hh:MM:ss.nnnnnnnnn

E.5 C Data Types

The ODBC Driver supports all C data types in keeping with the need for character SQL type conversion to and from all C types.

The C data type is specified in the following functions:

- `SQLBindCol` and `SQLGetData` functions with the *`TargetType`* argument.
- `SQLBindParameter` with the *`ValueType`* argument.
- `SQLSetDescField` to set the SQL_DESC_CONCISE_TYPE field of an ARD1 or APD2
- `SQLSetDescRec` with the Type argument, SubType argument (if needed), and the DescriptorHandle argument set to the handle of an ARD [1] or APD. [2]

The table below contains three columns.

1. The first column contains the C Type Identifiers. These C Type Identifiers are passed to functions like `SQLBindCol` to indicate the type of the variable that will be bound to the column. In the following example, SQL_C_DECIMAL is a C Type Identifier:

```
// Bind MySharedVariable to column 1 of the result set. (Column 1 is a
// DECIMAL column.) The C Type Identifier SQL_C_DECIMAL shows that the
// variable MySharedVariable is of a type equivalent to DECIMAL.
SQLBindCol(..., 1, SQL_C_DECIMAL, &MySharedVariable, ...);
```

[1] ARD: Application Row Descriptors

These descriptors contain information about application variables that are bound to columns returned by an SQL statement. The information includes the addresses, lengths, and C data types of the bound variables.

[2] APD: Application Parameter Descriptors

These descriptors contain information about application variables that are bound to the parameter markers ("?") used in an SQL statement, e.g.

```
SELECT * FROM table1 WHERE id = ?
```

The information in the descriptors includes the addresses, lengths, and C data types of the bound variables.

2. The second columns shows the ODBC C Data Type that is associated with each C Type Identifier. This ODBC C data type is a "typedef" that you use to define variables in your ODBC program. This helps insulate your program from platform-specific requirements. For example, suppose that you have a column of type SQL FLOAT and you want to bind a variable to that column. You can declare your variable to be of type SQLFLOAT, as shown in the example below.

```
SQLFLOAT MySharedVariable; // Can be bound to a column of type SQL FLOAT.
```

3. The third column contains an example of a C type definition that corresponds to the ODBC C Data Type "typdef". The examples in this column show the most frequently used definitions on 32-bit platforms. The data types specified in this column are NOT platform-independent; they are simply examples.

```
// A portable way to declare a variable that will be bound to a column of
// type SQL FLOAT.
SQLFLOAT MySharedSQLFLOATVariable = 0.0;
// A non-portable way to declare a variable that will be bound to a column
// of type SQL INTEGER. This declaration works properly on most 32-bit
// platforms, but may fail on 64-bit platforms.
long int MySharedSQLINTEGERVariable = 0;
// Bind MySharedSQLFLOATVariable to column 1 of the result set.
SQLBindCol(..., 1, SQL_C_DOUBLE, &MySharedSQLFLOATVariable, ...);
// Bind MySharedSQLINTEGERVariable to column 2 of the result set.
SQLBindCol(..., 2, SQL_C_SLONG, &MySharedSQLINTEGERVariable, ...);
```

As you can see, the C Type Identifier and the ODBC C Type do not always have similar names. The C Type Identifier has a name based on the C language data type (e.g. "float"), while the ODBC C Typedef has a name that is based on the SQL data type. Since C-language "float" corresponds to SQL "REAL", the table lists "SQL_C_FLOAT" as the C Type Identifier that corresponds to the ODBC C Typedef "SQLREAL".

Table E.5. C vs ODBC Naming Correspondencies

C Type identifier	ODBC C Typedef	C Type
SQL_C_CHAR	SQLCHAR	unsigned char
SQL_C_STINYINT	SCHAR	char
SQL_C_UTINYINT [i]	UCHAR	unsigned char

C Type identifier	ODBC C Typedef	C Type
SQL_C_SSHORT [h]	SQLSMALLINT	short int
SQL_C_USHORT [h] [i]	SQLUSMALLINT	unsigned short int
SQL_C_SLONG [h]	SQLINTEGER	long int
SQL_C_ULONG [h] [i]	SQLUINTEGER	unsigned long int
SQL_C_SBIGINT	SQLBIGINT	_int64 [g]
SQL_C_UBIGINT [i]	SQLUBIGINT	unsigned _int64 [g] Unsigned data types such as this are not supported by IBM solidDB.
SQL_C_FLOAT	SQLREAL	float
SQL_C_DOUBLE	SQLDOUBLE SQLFLOAT	double
SQL_C_NUMERIC	SQLNUMERIC	unsigned char [f]
SQL_C_DECIMAL	SQLDECIMAL	unsigned char [f]
SQL_C_BINARY	SQLCHAR *	unsigned char *

SQL_C_TYPE_DATE [c]	SQL_DATE_STRUCT	`struct tagDATE_STRUCT{`
		`  SQLSMALLINT year;`
		`  SQLUSMALLINT month;`
		`  SQLUSMALLINT day;`
		`} DATE_STRUCT; [a]`

SQL_C_TYPE_TIME [c]	SQL_TIME_STRUCT	`struct tagTIME_STRUCT {`
		`  SQLUSMALLINT hour;`
		`  SQLUSMALLINT minute;[d]`
		`  SQLUSMALLINT second;[e]`
		`}`

SQL_C_TYPE_TIMESTAMP [c]	SQL_TIMESTAMP_STRUCT	`struct tagTIMESTAMP_STRUCT {`
		`  SQLSMALLINT year; [a]`
		`  SQLUSMALLINT month; [b]`
		`  SQLUSMALLINT day; [c]`
		`  SQLUSMALLINT hour;`

C Type identifier	ODBC C Typedef	C Type
		SQLUSMALLINT minute; [d] SQLUSMALLINT second;[e] SQLUINTEGER fraction; }

Explanations of Footnote Numbering in the Table Above

[a] The values of the year, month, day, hour, minute, and second fields in the datetime C data types must conform to the constraints of the Gregorian calendar. (See Section E.11, “Constraints of the Gregorian Calendar”.)

[b] The value of the fraction field is the number of nanoseconds (billionths of a second) and ranges from 0 through 999,999,999 (1 less than 1 billion). For example, the value of the fraction field for a half-second is 500,000,000, for a thousandth of a second (one millisecond) is 1,000,000, for a millionth of a second (one microsecond) is 1,000, and for a billionth of a second (one nanosecond) is 1.

[c] In ODBC 2.x, the C date, time, and timestamp data types are SQL_C_DATE, SQL_C_TIME, and SQL_C_TIMESTAMP.

[d] A number is stored in the val field of the SQL_NUMERIC_STRUCT structure as a scaled integer, in little endian mode (the leftmost byte being the least-significant byte). For example, the number 10.001 base 10, with a scale of 4, is scaled to an integer of 100010. Because this is 186AA in hexadecimal format, the value in SQL_NUMERIC_STRUCT would be "AA 86 01 00 00 ... 00", with the number of bytes defined by the SQL_MAX_NUMERIC_LEN #define.

[e] The precision and scale fields of the SQL_C_NUMERIC data type are never used for input from an application, only for output from the driver to the application. When the driver writes a numeric value into the SQL_NUMERIC_STRUCT, it will use its own driver-specific default as the value for the precision field, and it will use the value in the SQL_DESC_SCALE field of the application descriptor (which defaults to 0) for the scale field. An application can provide its own values for precision and scale by setting the SQL_DESC_PRECISION and SQL_DESC_SCALE fields of the application descriptor.

[f] The DECIMAL and NUMERIC data types take up more than one byte/character, of course. The data types will actually be declared as arrays based on the precision required for the column. For example, a column of type SQL DECIMAL(10,4) might be declared as SQL_DECIMAL[13] to take into account the 10 digits, the sign character, the decimal point character, and the string terminator.

[g] _int64 might not be supplied by some compilers.

[h] _SQL_C_SHORT, SQL_C_LONG, and SQL_C_TINYINT have been replaced in ODBC by signed and unsigned types: SQL_C_SSHORT and SQL_C_USHORT, SQL_C_SLONG and SQL_C_ULONG, and SQL_C_STINYINT and SQL_C_UTINYINT. An ODBC 3.x driver that should work with ODBC 2.x applications should support SQL_C_SHORT, SQL_C_LONG, and SQL_C_TINYINT, because when they are called, the Driver Manager passes them through to the driver.

[i] IBM solidDB does not support unsigned SQL data types. You may bind an unsigned C data type to a signed SQL column, but you should not do this unless the values stored in the SQL column and the C variable are within the valid range for both data types. For example, since signed TINYINT columns hold values from -128 to +127, while unsigned SQL_C_UTINYINT variables hold values from 0 to 255, you may only store values between 0 and +127 in the column and bound variable if you want the values to be interpreted properly.

E.5.1 64-Bit Integer Structures

On Microsoft C compilers, the C data type identifiers SQL_C_SBIGINT and SQL_C_UBIGINT are defined as _int64. When a non-Microsoft C compiler is used, the C type may differ. If the compiler in use is supporting 64-bit integers natively, then define the driver or application ODBCINT64 as the native 64-bit integer type. If the compiler in use does not support 64-bit integers natively, define the following structures to ensure access to these C types:

```
typedef struct{
SQLUINTEGER dwLowWord;
SQLUINTEGER dwHighWord;
} SQLUBIGINT

typedef struct {
SQLUINTEGER dwLowWord;
SQLINTEGER sdwHighWord;
} SQLBIGINT
```

Because a 64-bit integer is aligned to the 8-byte boundary, be sure to align these structures to an 8-byte boundary.

Note

Solid supports signed BIGINT, but not unsigned BIGINT.

E.5.2 Default C Data Types

In applications that specify SQL_C_DEFAULT in `SQLBindCol`, `SQLGetData`, or `SQLBindParameter`, the driver assumes that the C data type of the output or input buffer corresponds to the SQL data type of the column or parameter to which the buffer is bound.

Important

To avoid compatibility problems when using different platforms, we strongly recommend that you avoid using SQL_C_DEFAULT. Instead, specify the C type of the buffer in use.

Drivers cannot always determine the correct default C type for these reasons:

- The DBMS may have promoted an SQL data type of a column or a parameter; in this case, the driver is unable to determine the original SQL data type and consequently, cannot determine the corresponding default C data type.
- The DBMS determined whether the data type of a column or parameter is signed or unsigned; in this case, the driver is unable to determine this for a particular SQL data type and consequently, cannot determine this for the corresponding default C data type.

See Section E.12, “Converting Data from SQL to C Data Types”.

E.5.3 SQL_C_TCHAR

The SQL_C_TCHAR type identifier is used for unicode purposes. Use this identifier in applications that transfer character data and are compiled to use both ASCII and Unicode character sets. Note that the SQL_C_TCHAR is not a type identifier in the conventional sense; instead, it is a macro contained in the header file for Unicode conversion. SQL_C_CHAR or SQL_C_WCHAR replaces SQL_C_TCHAR depending on the setting of the UNICODE #define.

E.6 Numeric Literals

To store numeric data values in character strings, you use numeric literals. Numeric literal syntax specifies what is stored in the target during the following conversions:

- SQL data to an SQL_C_CHAR string
- C data to an SQL_CHAR or SQL_VARCHAR string

The syntax also validates what is stored in the source during the following conversions:

- numeric stored as an SQL_C_CHAR string to numeric SQL data
- numeric stored as an SQL_CHAR string to numeric C data

See the numeric literal syntax described in Appendix D, "SQL Minimum Grammar", for details.

E.6.1 Conversion Rules

The rules in this section apply to conversions involving numeric literals. Following are terms used in this section:

Table E.6. Conversions Involving Numeric Literals

Term	Meaning
Store assignment	Refers to sending data into a table column in a database when calling `SQLExecute` and `SQLExecDirect`. During store assignment, "target" refers to a database column and "source" refers to data in application buffers.
Retrieval assignment	Refers to retrieving data from the database into application buffers when calling `SQLFetch`, `SQLGetData`, and `SQLFetchScroll`. During retrieval assignment, "target" refers to the application buffers and "source" refers to the database column.
CS	Value in the character source.
NT	Value in the numeric target.
NS	Value in the numeric source.
CT	Value in the character target.
Precision of an exact numeric literal	Number of digits that the literal contains.
Scale of an exact numeric literal	Number of digits to the right of the expressed or implied decimal point.
Precision of an approximate numeric literal	Precision of the literal's mantissa.

E.6.1.1 Rules for Character Source to Numeric Target

Following are the rules for converting from a character source (CS) to a numeric target (NT):

1. Replace CS with the value obtained by removing any leading or trailing spaces in CS. If CS is not a valid numeric-literal, SQLSTATE 22018 (Invalid character value for cast specification) is returned.

2. Replace CS with the value obtained by removing leading zeroes before the decimal point, trailing zeroes after the decimal point, or both.

3. Convert CS to NT. If the conversion results in a loss of significant digits, SQLSTATE 22003 (Numeric value out of range) is returned. If the conversion results in the loss of nonsignificant digits, SQLSTATE 01S07 (Fractional truncation) is returned.

E.6.1.2 Rules for Numeric Source to Character Target

Following are the rules for converting from a numeric source (NS) to a character target (CT):

1. Let LT be the length in characters of CT.

   For retrieval assignment, LT is equal to the length of the buffer in characters minus the number of bytes in the null-termination character for this character set.

2. Take one of the following actions depending on the type of NS.

   - If NS is an exact numeric type, then let YP equal the shortest character string that conforms to the definition of exact-numeric-literal such that the scale of YP is the same as the scale of NS, and the interpreted value of YP is the absolute value of NS.

   - If NS is an approximate numeric type, then let YP be a character string as follows:

   Case:

   a. If NS is equal to 0, then YP is the string "0".

   b. Let YSN be the shortest character string that conforms to the definition of exact-numeric-literal and whose interpreted value is the absolute value of NS. If the length of YSN is less than the (precision + 1) of the data type of NS, then let YP equal YSN.

   c. Otherwise, YP is the shortest character string that conforms to the definition of approximate-numeric-literal whose interpreted value is the absolute value of NS and whose mantissa consists of a single digit that is not '0', followed by a period and an unsigned-integer.

3. If NS is less than 0, then let Y be the result of:

   ```
   '-' || YP
   ```

   where '||' is the string concatenation operator.

Otherwise, let Y equal YP.

4. Let LY be the length in characters of Y.

5. Take one of the following action depending on the value of LY.

   - If LY equals LT, then CT is set to Y.
   - If LY is less than LT, then CT is set to Y extended on the right by appropriate number of spaces.
   - Otherwise (LY > LT), copy the first LT characters of Y into CT.

     Case:

     - If this is a store assignment, return the error SQLSTATE 22001 (String data, right-truncated).
     - If this is retrieval assignment, return the warning SQLSTATE 01004 (String data, right-truncated). When the copy results in the loss of fractional digits (other than trailing zeros), depending on the driver definition, one of the following actions occurs:

     a. The driver truncates the string in Y to an appropriate scale (which can be zero also) and writes the result into CT.

     b. The driver rounds the string in Y to an appropriate scale (which can be zero also) and writes the result into CT.

     c. The driver neither truncates nor rounds, but just copies the first LT characters of Y into CT.

E.7 Overriding Default Precision and Scale for Numeric Data Types

The following table provides the override default precision and scale values for numeric data type.

Table E.7. Override Default Precision and Scale Values for Numeric Data Type

Function calls to	Setting	Override
`SQLBindCol` or `SQLSetDescField`	SQL_DESC_TYPE field in an ARD is set to SQL_C_NUMERIC	SQL_DESC_SCALE field in the ARD is set to 0 and the SQL_DESC_PRECISION field is set to a driver-defined default precision. [a]

Function calls to	Setting	Override
`SQLBindParameter` or `SQLSetDescField`	SQL_DESC_SCALE field in an APD is set to SQL_C_NUMERIC	SQL_DESC_SCALE field in the ARD is set to 0 and the SQL_DESC_PRECISION field is set to a driver-defined default precision. This is true for input, input/output, or output parameters. [a]
`SQLGetData`	Data is returned into an SQL_C_NUMERIC structure	Default SQL_DESC_SCALE and SQL_DESC_PRECISION fields are used. [b]

Explanations of Footnote Numbering in the Table Above

[a] If the defaults are not acceptable for an application, the application can call the `SQLSetDescField` or `SQLSetDescRec` to set the SQL_DESC_SCALE or SQL_DESC_PRECISION field.

[b] If the defaults are not acceptable, the application must call `SQLSetDescRec` or `SQLSetDescField` to set the fields and then call `SQLGetData` with a *`TargetType`* of SQL_ARD_TYPE to use the values in the descriptor fields.

E.8 Data Type Identifiers and Descriptors

Unlike the "concise" SQL and C data types, where each identifier refers to a single data type, descriptors do not in all cases use a single value to identify data types. In some cases, descriptors use a verbose data type and a type subcode. For most data types, the verbose data type identifier matches the concise type identifier.

The exception, however, is the datetime and interval data types. For these data types:

- SQL_DESC_TYPE contains the verbose type (SQL_DATETIME)
- SQL_DESC_CONCISE_TYPE contains a concise type

For details on setting fields and a setting's effect on other fields, see the `SQLSetDescField` function description on the Microsoft ODBC website.

When the SQL_DESC_TYPE or SQL_DESC_CONCISE_TYPE field is set for some data types, the following fields are set to default values appropriate for the data type:

- SQL_DESC_DATETIME_INTERVAL_PRECISION
- SQL_DESC_LENGTH
- SQL_DESC_PRECISION
- SQL_DESC_SCALE

For more information, see the SQL_DESC_TYPE field under `SQLSetDescField` function description on the Microsoft ODBC Website.

Note

If the default values set are not appropriate, you can explicitly set the descriptor field in the application by calling `SQLSetDescField`.

The following table lists for each SQL and C type identifier, the concise type identifier, verbose identifier, and type subcode for each datetime.

For datetime data types, the SQL_DESC_TYPE have the same manifest constants for both SQL data types (in implementation descriptors) and for C data types (in application descriptors):

Table E.8. Concise Type Identifier, Verbose Identifier, and Type Subcode for Each Datetime

Concise SQL Type	Concise C Type	Verbose Type	DATETIME_INTERVAL_CODE (aka "type subcode")
SQL_TYPE_DATE	SQL_C_TYPE_DATE	SQL_DATETIME	SQL_CODE_DATE
SQL_TYPE_TIME	SQL_C_TYPE_TIME	SQL_DATETIME	SQL_CODE_TIME
SQL_TYPE_TIMESTAMP	SQL_C_TYPE_TIMESTAMP	SQL_DATETIME	SQL_CODE_TIMESTAMP

E.8.1 Pseudo-Type Identifiers

ODBC defines a number of pseudo-type identifiers, which depending on the situation, resolve to existing data types. Note that these identifiers do not correspond to actual data types, but are provided for your application programming convenience.

E.9 Decimal Digits

Decimal digits apply to decimal and numeric data types. They refer to the maximum number of digits to the right of the decimal point, or the scale of the data. Because the number of digits to the right of the decimal point is not fixed, the scale is undefined for approximate floating-point number columns or parameters. When datetime data contains a seconds component, the decimal digits are the number of digits to the right of the decimal point in the seconds component of the data.

Typically, the maximum scale matches the maximum precision for SQL_DECIMAL and SQL_NUMERIC data types. Some data sources, however, have their own maximum scale limit. An application can call `SQLGetTypeInfo` to determine the minimum and maximum scales allowed for a data type.

The following ODBC functions return parameter decimal attributes in an SQL statement data type or decimal attributes on a data source:

Table E.9. ODBC Functions' Return Parameter

ODBC Function	Returns...
`SQLDescribeCol`	Decimal digits of the columns it describes.
`SQLDescribeParam`	Decimal digits of the parameters it describes.
`SQLProcedureColumns`	Decimal digits in a column of a procedure.
`SQLColumns`	Decimal digits in specified tables (such as the base table, view, or a system table).
`SQLColAttribute`	Decimal digits of columns at the data source.
`SQLGetTypeInfo`	Minimum and maximum decimal digits of an SQL data type on a data source.

Note that `SQLBindParameter` sets the decimal digits for a parameter in an SQL statement.

The values returned by ODBC functions for decimal digits correspond to "scale" as defined in ODBC 2.x.

Descriptor fields describe the characteristics of a result set. They do not contain valid data values before statement execution. However, the decimal digits values returned by `SQLColumns`, `SQLProcedureColumns`, and `SQLGetTypeInfo`, do represent the characteristics of database objects, such as table columns and data types form the data source's catalog.

Each concise SQL data type has the following decimal digits definition as noted in the table below.

Table E.10. SQL Data Type Decimal Digits

SQL Type Identifier	Decimal Digits
All character and binary types [a]	N/A
SQL_DECIMAL SQL_NUMERIC	The defined number of digits to the right of the decimal point. For example, the scale of a column defined as NUMERIC(10,3) is 3. (In some implementations, this can be a negative number to support storage of very large numbers without using exponential notation; for example, "12000" could

SQL Type Identifier	Decimal Digits
	be stored as "12" with a scale of -3. However, IBM solidDB does not support negative scale.)
All exact numeric types other than SQL_DECIMAL and SQL_NUMERIC [a]	0
All approximate data types [a]	N/A

Explanations of Footnote Numbering in the Table Above

[a] `SQLBindParameter`'s DecimalDigits argument is ignored for this data type.

For decimal digits, the values returned do not correspond to the values in any one descriptor field. The values returned (for example, in `SQLColAttribute`) for the decimal digits can come from either the SQL_DESC_SCALE or the SQL_DESC_PRECISION field, depending on the data type, as shown in the following table:

Table E.11. Descriptor field corresponding to decimal digits

SQL Type Identifier	Descriptor field corresponding to decimal digits
All character and binary types	N/A
All exact numeric types	SCALE
All approximate numeric types	N/A
All datetime types	PRECISION

E.10 Transfer Octet Length

When data is transferred to its default C data type, an application receives a maximum number of bytes. This maximum is known as the transfer octet length of a column. For character data, space for the null-termination character is not included in the transfer octet length. Note that the transfer octet length in bytes can differ from the number of bytes needed to store the data on the data source.

The following ODBC functions return parameter decimal attributes in an SQL statement data type or decimal attributes on a data source:

Table E.12. ODBC Functions' Return parameter Decimal Attributes

ODBC Function	Returns
`SQLColumns`	Transfer octet length of a column in specified tables (such as the base table, view, or a system table).
`SQLColAttribute`	Transfer octet length of columns at the data source.
`SQLProcedureColumns`	Transfer octet length of a column in a procedure.

The values returned by ODBC functions for the transfer octet length may not correspond to the values returned in SQL_DESC_LENGTH. For all character and binary types, the values come from a descriptor field's SQL_DESC_OCTET_LENGTH. For other data types, there is no descriptor field that stores this information.

Descriptor fields describe the characteristics of a result set. They do not contain valid data values before statement execution. In its result set, `SQLColAttribute` returns the transfer octet length of columns at the data source; these values may not match the values in the SQL_DESC_OCTET_LENGTH descriptor fields. For more information on descriptor fields, see `SQLSetDescField` function description on the Microsoft ODBC Website.

Each concise SQL data type has the following transfer octet length definition as noted in the table below.

Table E.13. Transfer Octet Lengths

SQL Type Identifier	Transfer Octet Length
All character and binary types [a]	The defined or the maximum (for variable type) length of the column in bytes. This value matches the one in the SQL_DESC_OCTET_LENGTH descriptor field.
SQL_DECIMAL SQL_NUMERIC	The number of bytes required to hold the character representation of this data if the character set is ASCII, and twice this number if the character set is UNICODE. The character representation is the maximum number of digits plus two; the data is returned as a character string, where the characters are needed for digits, a sign, and a decimal point. For example, the transfer length of a column defined as NUMERIC(10,3) is 12 because there are 10 bytes for the digits, 1 byte for the sign, and 1 byte for the decimal point.
SQL_TINYINT	1
SQL_SMALLINT	2
SQL_INTEGER	4
SQL_BIGINT	The number of bytes required to hold the character representation of this data if the character set is ASCII, and twice this number if the character set

SQL Type Identifier	Transfer Octet Length
	is UNICODE. This data type is returned as a character string by default. The character representation consists of 20 characters for 19 digits and a sign (if signed), or 20 digits (if unsigned). The length is 20. IBM solidDB supports only signed, not unsigned, BIGINT.
SQL_REAL	4
SQL_FLOAT	8
SQL_DOUBLE	8
All binary types [a]	The number of bytes required to store the defined (for fixed types) or maximum (for variable types) number of characters.
SQL_TYPE_DATE SQL_TYPE_TIME	6 (size of the structures SQL_DATE_STRUCT or SQL_TIME_STRUCT).
SQL_TYPE_TIMESTAMP	16 (size of the structure SQL_TIMESTAMP_STRUCT).

Explanations of Footnote Numbering in the Table Above

[a] SQL_NO_TOTAL is returned when the driver cannot determine the column or parameter length for variable types.

E.11 Constraints of the Gregorian Calendar

The following table are the Gregorian calendar constraints for date and datetime data types.

Table E.14. Constraints of the Gregorian Calendar

Value	Requirement
month field	Must be between 1 and 12, inclusive.
day field	Range must be from 1 through the number of days in the month, which is determined from the values of the year and months fields and can be 28, 29, 30, or 31. A leap year can also affect the number of days in the month.
hour field	Must be between 0 and 23, inclusive.
minute field	Must be between 0 and 59, inclusive.
trailing seconds field	Must be between 0 and 61.9(n), inclusive, where n specifies the number of "9" digits and the value of n is the fractional seconds precision. (The range

Value	Requirement
	of seconds permits a maximum of two leap seconds to maintain synchronization of sidereal time.)

E.12 Converting Data from SQL to C Data Types

When an application calls `SQLFetch`, `SQLFetchScroll`, or `SQLGetData`, the driver retrieves the data from the data source. If necessary, it converts the data from the data type in which the driver retrieved it to the data type specified by the *`TargetType`* argument in `SQLBindCol` or `SQLGetData`. Finally, it stores the data in the location pointed to by the *`TargetValuePtr`* argument in `SQLBindCol` or `SQLGetData` (and the SQL_DESC_DATA_PTR field of the ARD).

The following table shows the supported conversions from ODBC SQL data types to ODBC C data types. A solid circle indicates the default conversion for an SQL data type (the C data type to which the data will be converted when the value of *`TargetType`* is SQL_C_DEFAULT). A hollow circle indicates a supported conversion.

For an ODBC 3.x application working with an ODBC 2.x driver, conversion from driver-specific data types might not be supported.

The format of the converted data is not affected by the Microsoft Windows country setting.

IBM solidDB supports only signed, not unsigned, integer data types (SQL_TINYINT, SQL_SMALLINT, SQL_INTEGER, SQL_BIGINT). You may bind an unsigned C variable to a signed SQL column, but you must make sure that the values you store fit within the range supported by both data types.

IBM solidDB does not support the BIT/SQL_BIT data type for SQL columns. However, you may bind a numeric SQL column to a BIT data type in your C application. For example, you may use a TINYINT column in your database and bind that column to a C variable of type SQL_C_BIT. The IBM solidDB ODBC driver will try to convert numeric types in the database to BIT data types for the C variables. The numeric data values must be 1 or 0 or NULL; other values cause a data conversion error. The table below does not discuss BIT/SQL_BIT data types.

Table E.15. C Data Type — SQL_C_datatype where Datatype Is:

SQL Data Type	CHAR	WCHAR	STINYINT	UTINYINT	TINYINT	SSHORT	USHORT	SHORT	SLONG	ULONG	LONG	SBIGINT	UBIGINT	FLOAT	DOUBLE	NUMERIC	BINARY	DATE	TIME	TIMESTAMP
SQL_CHAR	*	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
SQL_VARCHAR	*	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
SQL_LONGVARCHAR	*	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
SQL_WCHAR	o	*	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
SQL_WVARCHAR	o	*	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
SQL_WLONGVARCHAR	o	*	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
SQL_TINYINT (signed)	o	o	*	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
SQL_TINYINT (unsigned)	o	o	o	*	o	o	o	o	o	o	o	o	o	o	o	o	o			
SQL_SMALLINT (signed)	o	o	o	o	o	*	o	o	o	o	o	o	o	o	o	o	o			
SQL_SMALLINT (unsigned)	o	o	o	o	o	o	*	o	o	o	o	o	o	o	o	o	o			
SQL_INTEGER (signed)	o	o	o	o	o	o	o	o	*	o	o	o	o	o	o	o	o			
SQL_INTEGER (unsigned)	o	o	o	o	o	o	o	o	o	*	o	o	o	o	o	o	o			
SQL_BIGINT (signed)	o	o	o	o	o	o	o	o	o	o	o	*	o	o	o	o				
SQL_BIGINT (unsigned)	o	o	o	o	o	o	o	o	o	o	o	o	*	o	o	o	o			
SQL_REAL	o	o	o	o	o	o	o	o	o	o	o	o	o	*	o	o	o			
SQL_FLOAT	o	o	o	o	o	o	o	o	o	o	o	o	o	o	*	o	o			
SQL_DOUBLE	o	o	o	o	o	o	o	o	o	o	o	o	o	o	*	o	o			
SQL_DECIMAL	*	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
SQL_NUMERIC	*	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
SQL_BINARY	o	o															*			
SQL_VARBINARY	o	o															*			
SQL_LONGVARBINARY	o	o															*			

SQL Data Type	CHAR	WCHAR	STINYINT	UTINYINT	TINYINT	SSHORT	USHORT	SHORT	SLONG	ULONG	LONG	SBIGINT	UBIGINT	FLOAT	DOUBLE	NUMERIC	BINARY	DATE	TIME	TIMESTAMP
SQL_TYPE_DATE	o	o															o	*		o
SQL_TYPE_TIME	o	o															o		*	o
SQL_TYPE_TIMESTAMP	o	o															o	o	o	*

* These datatypes have the word "TYPE" in the datatype name. For example, SQL_C_TYPE_DATE, SQL_C_TYPE_TIME, and SQL_C_TYPE_TIMESTAMP.

KEY:

* Default Conversion, o Supported Conversion

Caution

Although the table above shows a wide range of ODBC conversions, including conversions involving unsigned data types, IBM solidDB supports only signed integer data types (e.g. TINYINT, SMALLINT, INTEGER, and BIGINT).

E.12.1 Table Description - SQL to C

The tables in the following sections describe how the driver or data source converts data retrieved from the data source; drivers are required to support conversions to all ODBC C data types from the ODBC SQL data types that they support. In the table:

- For a given ODBC SQL data type, the first column of the table lists the legal input values of the *`Target-Type`* argument in `SQLBindCol` and `SQLGetData`.
- The second column lists the outcomes of a test, often using the BufferLength argument specified in `SQLBindCol` or `SQLGetData`, which the driver performs to determine if it can convert the data.
- For each outcome, the third and fourth columns list the values placed in the buffers specified by the *`TargetValuePtr`* and *`StrLen_or_IndPtr`* arguments specified in `SQLBindCol` or `SQLGetData`

after the driver has attempted to convert the data. (The *StrLen_or_IndPtr* argument corresponds to the SQL_DESC_OCTET_LENGTH_PTR field of the ARD.)

- The last column lists the SQLSTATE returned for each outcome by SQLFetch, SQLFetchScroll, or SQLGetData.

If the *TargetType* argument in SQLBindCol or SQLGetData contains a value for an ODBC C data type not shown in the table for a given ODBC SQL data type, SQLFetch, SQLFetchScroll, or SQLGetData returns SQLSTATE 07006 (Restricted data type attribute violation). If the *TargetType* argument contains a value that specifies a conversion from a driver-specific SQL data type to an ODBC C data type and this conversion is not supported by the driver, SQLFetch, SQLFetchScroll, or SQLGetData returns SQLSTATE HYC00 (Optional feature not implemented).

Although it is not shown in the tables, the driver returns SQL_NULL_DATA in the buffer specified by the *StrLen_or_IndPtr* argument when the SQL data value is NULL. Note that the length specified by *StrLen_or_IndPtr* does not include the null-termination byte. If *TargetValuePtr* is a null pointer, SQLGetData returns SQLSTATE HY009 (Invalid use of null pointer); in SQLBindCol, this unbinds the columns.

The following terms and conventions are used in the tables:

- Byte length of data is the number of bytes of C data available to return in **TargetValuePtr*, whether or not the data will be truncated before it is returned to the application. For string data, this does not include the space for the null-termination character.
- Character byte length is the total number of bytes needed to display the data in character format.
- Words in italics represent function arguments or elements of the SQL grammar. See Appendix D, *SQL Minimum Grammar* for the syntax of grammar elements.

E.12.1.1 SQL to C: Character

The character ODBC SQL data types are:

```
SQL_CHAR
SQL_VARCHAR
SQL_LONGVARCHAR
SQL_WCHAR
```

SQL_WVARCHAR
SQL_WLONGVARCHAR

The following table shows the ODBC C data types to which character SQL data may be converted. For an explanation of the columns and terms in the table, see Section E.12.1, “Table Description - SQL to C”.

Table E.16. Character SQL Data to ODBC C Data Types

C Type Identifier	Test	*TargetValuePtr	*StrLen_or_IndPtr	SQLSTATE
SQL_C_CHAR	Byte length of data < BufferLength Byte length of data >= BufferLength	Data Truncated data	Length of data in bytes Length of data in bytes	N/A 01004
SQL_C_WCHAR	Character length of data < BufferLength (Character length of data) >= BufferLength	Data Truncated data	Length of data in characters Length of data in characters	N/A 01004
EXACT NUMERIC TYPES [h] SQL_C_STINYINT SQL_C_UTINYINT SQL_C_TINYINT SQL_C_SSHORT SQL_C_USHORT SQL_C_SHORT SQL_C_SLONG SQL_C_ULONG SQL_C_LONG SQL_C_SBIGINT	Data converted without truncation [b] Data converted with truncation of fractional digits [a] Conversion of data would result in loss of whole (as opposed to fractional) digits [b] Data is not a numeric-literal [b]	Data Truncated data Undefined Undefined	Number of bytes of the C data type Number of bytes of the C data type Undefined Undefined	N/A 01S07 22003 22018

C Type Identifier	Test	*Target-ValuePtr	*StrLen_or_IndPtr	SQL-STATE
SQL_C_UBIGINT SQL_C_NUMERIC				
APPROXIMATE NUMERIC TYPES [h] SQL_C_FLOAT SQL_C_DOUBLE	Data is within the range of the data type to which the number is being converted [a] Data is outside the range of the data type to which the number is being converted [a] Data is not a numeric-literal [b]	Data Undefined Undefined	Size of the C data type Undefined Undefined	N/A 2003 22018
SQL_C_BINARY	Byte length of data <= BufferLength Byte length of data > BufferLength	Data Truncated data	Length of data Length of data	N/A 01004
SQL_C_TYPE_DATE	Data value is a valid date-value [a] Data value is a valid timestamp-value; time portion is zero [a] Data value is a valid timestamp-value; time portion is nonzero [a], [c], Data value is not a valid date-value or timestamp_value [a]	Data Data Truncated data Undefined	6 [b] 6 [b] 6 [b] Undefined	N/A N/A 01S07 22018
SQL_C_TYPE_TIME	Data value is a valid time-value and the fractional seconds value is 0 [a] Data value is a valid timestamp-value or a valid time_value; fractional seconds portion is zero [a],[d] Data value is a valid timestamp-value ; fractional seconds portion is nonzero [a], [d], [e] Data value is not a valid timestamp-value or time_value [a]	Data Data Truncated data Undefined	6 [b] 6 [b] 6 [b] Undefined	N/A N/A 01S07 22018

C Type Identifier	Test	*Target-ValuePtr	*StrLen_or_IndPtr	SQL-STATE
SQL_C_TYPE_TIMESTAMP	Data value is a valid timestamp-value or a valid time_value; fractional seconds portion not truncated [a], [d] Data value is a valid timestamp-value or a valid time_value; fractional seconds portion truncated [a] Data value is a valid date-value [a] Data value is a valid time_value [a] Data value is not a valid date_value, time_value, or timestamp_value [a]	Data Truncated data Data [f] Data [g] Undefined	16 [b] 16 [b] 16 [b] 16 [b] Undefined	N/A 01S07 N/A N/A 22018

Explanations of Footnote Numbering in the Table Above

[a] The value of BufferLength is ignored for this conversion. The driver assumes that the size of *`*TargetValuePtr`* is the size of the C data type.

[b] This is the size of the corresponding C data type.

[c] The time portion of the timestamp-value is truncated.

[d] The date portion of the timestamp-value is ignored.

[e] The fractional seconds portion of the timestamp is truncated.

[f] The time fields of the timestamp structure are set to zero.

[g] The date fields of the timestamp structure are set to the current date.

[h] The exact numeric types include NUMERIC/DECIMAL as well as integer. These data types store the exact value that you specify, as long as it is within the precision of the data type. The approximate data types include FLOAT/REAL, which store only approximately the value that you specify (in some cases, the least significant digit may be slightly different from what you specified).

When character SQL data is converted to numeric, date, time, or timestamp C data, leading and trailing spaces are ignored.

E.12.1.2 SQL to C: Numeric

The numeric ODBC SQL data types are:

```
SQL_DECIMAL     SQL_BIGINT
SQL_NUMERIC     SQL_REAL
SQL_TINYINT     SQL_FLOAT
SQL_SMALLINT    SQL_DOUBLE
SQL_INTEGER
```

The following table shows the ODBC C data types to which numeric SQL data may be converted. For an explanation of the columns and terms in the table, see Section E.12.1, “Table Description - SQL to C”.

Table E.17. SQL Data to ODBC C Data Types

C Type Identifier	Test	*TargetValuePtr	*StrLen_or_IndPtr	SQLSTATE
SQL_C_CHAR	Character byte length < BufferLength Number of whole (as opposed to fractional) digits < BufferLength Number of whole (as opposed to fractional) digits ≥ BufferLength	Data Truncated data Undefined	Length of data in bytes Length of data in bytes Undefined	N/A 01004 22003
SQL_C_WCHAR	Character length < BufferLength Number of whole (as opposed to fractional) digits < BufferLength Number of whole (as opposed to fractional) digits ≥ BufferLength	Data Truncated data Undefined	Length of data in bytes Length of data in bytes Undefined	N/A 01004 22003
EXACT NUMERIC TYPES [c] SQL_C_STINYINT SQL_C_UTINYINT SQL_C_TINYINT SQL_C_SBIGINT	Data converted without truncation [a] Data converted with truncation of fractional digits [a] Conversion of data would result in loss of whole (as opposed to fractional) digits [a]	Data Truncated data Undefined	Size of the C data type Size of the C data type Undefined	N/A 01S07 22003

C Type Identifier	Test	*Target-ValuePtr	*StrLen_or_IndPtr	SQLSTATE
SQL_C_UBIGINT SQL_C_SSHORT SQL_C_USHORT SQL_C_SHORT a SQL_C_SLONG SQL_C_ULONG SQL_C_LONG SQL_C_NUMERIC				
APPROXIMATE NUMERIC TYPES [c] SQL_C_FLOAT SQL_C_DOUBLE	Data is within the range of the data type to which the number is being converted [a] Data is outside the range of the data type to which the number is being converted [a]	Data Undefined	Size of the C data type Undefined	N/A 22003
SQL_C_BINARY	Length of data ≤ BufferLength Length of data > BufferLength	Data Undefined	Length of data Undefined	N/A 22003

Explanations of Footnote Numbering in the Table Above

[a] The value of BufferLength is ignored for this conversion. The driver assumes that the size of *`*TargetValuePtr`* is the size of the C data type.

[b] This is the size of the corresponding C data type.

[c] The exact numeric types include NUMERIC/DECIMAL as well as integer. These data types store the exact value that you specify, as long as it is within the precision of the data type. The approximate data types include FLOAT/REAL, which store only approximately the value that you specify (in some cases, the least significant digit may be slightly different from what you specified).

E.12.1.3 SQL to C: Binary

The binary ODBC SQL data types are:

```
SQL_BINARY
SQL_VARBINARY
SQL_LONGVARBINARY
```

The following table shows the ODBC C data types to which binary SQL data may be converted. For an explanation of the columns and terms in the table, see Section E.12.1, “Table Description - SQL to C”.

Table E.18. Binary SQL Data to ODBC C Data Types

C Type Identifier	Test	*Target-ValuePtr	*StrLen_or_IndPtr	SQLSTATE
SQL_C_CHAR	(Byte length of data) * 2 < BufferLength (Byte length of data) * 2 >= BufferLength	Data Truncated data	Length of data in bytes Length of data in bytes	N/A 01004
SQL_C_WCHAR	(Character length of data) * 2 < BufferLength (Character length of data) * 2 >= BufferLength	Data Truncated data	Length of data in bytes Length of data in bytes	N/A 01004
SQL_C_BINARY	Byte length of data <= BufferLength Byte Length of data > BufferLength	Data Truncated data	Length of data in bytes Length of data in bytes	N/A 01004

When binary SQL data is converted to character C data, each byte (8 bits) of source data is represented as two ASCII characters. These characters are the ASCII character representation of the number in its hexadecimal form. For example, a binary 00000001 is converted to "01"and a binary 11111111 is converted to "FF".

T he driver always converts individual bytes to pairs of hexadecimal digits and terminates the character string with a null byte. Because of this, if BufferLength is even and is less than the length of the converted data, the last byte of the *`*TargetValuePtr`* buffer is not used. (The converted data requires an even number of bytes, the next-to-last byte is a null byte, and the last byte cannot be used.)

Application developers are discouraged from binding binary SQL data to a character C data type. This conversion is usually inefficient and slow.

E.12.1.4 SQL to C: Date

The date ODBC SQL data type is:

`SQL_DATE`

The following table shows the ODBC C data types to which date SQL data may be converted. For an explanation of the columns and terms in the table, see Section E.12.1, “Table Description - SQL to C”.

Table E.19. Date SQL Data to ODBC C Data Types

C Type Identifier	Test	*Target-ValuePtr	*StrLen_or_IndPtr	SQLSTATE
SQL_C_CHAR	BufferLength > Character byte length 11<= BufferLength <= Character byte length BufferLength < 11	Data Truncated data Undefined	10 Length of data in bytes Undefined	N/A 01004 22003
SQL_C_WCHAR	BufferLength > Character length 11<= BufferLength <= Character length BufferLength < 11	Data Truncated data Undefined	10 Length of data in bytes Undefined	N/A 01004 22003
SQL_C_BINARY	Byte length of data <= BufferLength Byte length of data > BufferLength	Data Undefined	Length of data in bytes Undefined	N/A 22003
SQL_C_DATE	None [a]	Data	6 [c]	N/A
SQL_C_TIMESTAMP	None [a]	Data [b]	16 [c]	N/A

Explanations of Footnote Numbering in the Table Above

[a] The value of BufferLength is ignored for this conversion. The driver assumes that the size of *`*TargetValuePtr`* is the size of the C data type.

[b] The time fields of the timestamp structure are set to zero.

[c] This is the size of the corresponding C data type.

When date SQL data is converted to character C data, the resulting string is in the "yyyy-mm-dd"format. This format is not affected by the Microsoft Windows country setting.

E.12.1.5 SQL to C: Time

The time ODBC SQL data type is:

```
SQL_TIME
```

The following table shows the ODBC C data types to which time SQL data may be converted. For an explanation of the columns and terms in the table, see Section E.12.1, “Table Description - SQL to C”.

Table E.20. Time SQL Data to ODBC C Data Types

C Type Identifier	Test	*TargetValuePtr	*StrLen_or_IndPtr	SQLSTATE
SQL_C_CHAR	BufferLength > Character byte length 9 <= BufferLength <= Character byte length BufferLength < 9	Data Truncated data [a] Undefined	Length of data in bytes Length of data in bytes Undefined	N/A 01004 22003
SQL_C_WCHAR	BufferLength > Character byte length 9 <= BufferLength <= Character byte length BufferLength < 9	Data Truncated data [a] Undefined	Length of data in characters Length of data in characters Undefined	N/A 01004 22003
SQL_C_BINARY	Byte length of data <= BufferLength Byte length of data > BufferLength	Data Undefined	Length of data in bytes Undefined	N/A 22003
SQL_C_DATE	None [a]	Data	6 [c]	N/A
SQL_C_TIMESTAMP	None [a]	Data [b]	16 [c]	N/A

C Type Identifier	Test	*Target-ValuePtr	*StrLen_or_IndPtr	SQLSTATE
a: The fractional seconds of the time are truncated. b: The value of BufferLength is ignored for this conversion. The driver assumes that the size of *`Target-ValuePtr` is the size of the C data type. c: The date fields of the timestamp structure are set to the current date and the fractional seconds field of the timestamp structure is set to zero. d: This is the size of the corresponding C data type.				

When time SQL data is converted to character C data, the resulting string is in the "hh:mm:ss "format.

E.12.1.6 SQL to C: Timestamp

The timestamp ODBC SQL data type is:

`SQL_TIMESTAMP`

The following table shows the ODBC C data types to which timestamp SQL data may be converted. For an explanation of the columns and terms in the table, see Section E.12.1, “Table Description - SQL to C”.

Table E.21. Timestamp SQL Data to ODBC C Data Types

C Type Identifier	Test	*Target-ValuePtr	*StrLen_or_IndPtr	SQL-STATE
SQL_C_CHAR	BufferLength > Character byte length 20 <= BufferLength <= Character byte length BufferLength < 20	Data Truncated data [b] Undefined	Length of data in bytes Length of data in bytes Undefined	N/A 01004 22003
SQL_C_WCHAR	BufferLength > Character byte length 20 <= BufferLength <= Character byte length BufferLength < 20	Data Truncated data [b] Undefined	Length of data in characters Length of data in characters Undefined	N/A 01004 22003

C Type Identifier	Test	*Target-ValuePtr	*StrLen_or_IndPtr	SQL-STATE
SQL_C_BINARY	Byte length of data <= BufferLength Byte length of data > BufferLength	Data Undefined	Length of data in bytes Undefined	N/A 22003
SQL_C_TYPE_DATE	Time portion of timestamp is zero [a] Time portion of timestamp is non-zero [a]	Data Truncated data [c]	6 [f] 6 [f]	N/A 01S07
SQL_C_TYPE_TIME	Fractional seconds portion of timestamp is zero [a] Fractional seconds portion of timestamp is non-zero [a]	Data [d] Truncated data [d], [e]	6 [f] 6 [f]	N/A 01S07
SQL_C_TYPE_TIMESTAMP	Fractional seconds portion of timestamp is not truncated [a] Fractional seconds portion of timestamp is truncated [a]	Data [e] Truncated data [e]	6 [f] 6 [f]	N/A 01S07

Explanations of Footnote Numbering in the Table Above

[a] The value of BufferLength is ignored for this conversion. The driver assumes that the size of *`*TargetValuePtr`* is the size of the C data type.

[b] The fractional seconds of the timestamp are truncated.

[c] The time portion of the timestamp is truncated.

[d] The date portion of the timestamp is ignored.

[e] The fractional seconds portion of the timestamp is truncated.

[f] This is the size of the corresponding C data type.

When timestamp SQL data is converted to character C data, the resulting string is in the "yyyy-mm-dd hh:mm:ss [.f ...]"format, where up to nine digits may be used for fractional seconds. The format is not affected by the Microsoft Windows country setting. (Except for the decimal point and fractional seconds, the entire format must be used, regardless of the precision of the timestamp SQL data type.)

E.12.1.7 SQL to C Data Conversion Examples

The following examples illustrate how the driver converts SQL data to C data:

Table E.22. SQL to C Data Conversion Examples

SQL Type Identifier	SQL Data Values	C Type Identifier	Buffer Length	*TargetValuePtr	SQLSTATES
SQL_CHAR	abcdef	SQL_C_CHAR	7	abcdef\0 [a]	N/A
SQL_CHAR	abcdef	SQL_C_CHAR	6	abcde\0 [a]	01004
SQL_DECIMAL	1234.56	SQL_C_CHAR	8	1234.56\0 [a]	N/A
SQL_DECIMAL	1234.56	SQL_C_CHAR	5	1234\0 [a]	01004
SQL_DECIMAL	1234.56	SQL_C_CHAR	4	----	22003
SQL_DECIMAL	1234.56	SQL_C_FLOAT	ignored	1234.56	N/A
SQL_DECIMAL	1234.56	SQL_C_SSHORT	ignored	1234	01S07
SQL_DECIMAL	1234.56	SQL_C_STINYINT	ignored	----	22003
SQL_DOUBLE	1.2345678	SQL_C_DOUBLE	ignored	1.2345678	N/A
SQL_DOUBLE	1.2345678	SQL_C_FLOAT	ignored	1.234567	N/A
SQL_DOUBLE	1.2345678	SQL_C_STINYINT	ignored	1	N/A
SQL_TYPE_DATE	1992-12-31	SQL_C_CHAR	11	1992-12-31\0 [a]	N/A
SQL_TYPE_DATE	1992-12-31	SQL_C_CHAR	10	-----	22003
SQL_TYPE_DATE	1992-12-31	SQL_C_TIMESTAMP	ignored	1992,12,31, 0,0,0,0 [b]	N/A
SQL_TYPE_TIMESTAMP	1992-12-31 23:45:55.12	SQL_C_CHAR	23	1992-12-31 23:45:55.12\0 [a]	N/A
SQL_TYPE_TIMESTAMP	1992-12-31 23:45:55.12	SQL_C_CHAR	22	1992-12-31 23:45:55.1\0 [a]	01004

SQL Type Identifier	SQL Data Values	C Type Identifier	Buffer Length	*TargetValuePtr	SQLSTATES
SQL_TYPE_TIMESTAMP	1992-12-31 23:45:55.12	SQL_C_CHAR	18	----	22003

[a] "\0"represents a null-termination byte. The driver always null-terminates SQL_C_CHAR data.

[b] The numbers in this list are the numbers stored in the fields of the TIMESTAMP_STRUCT structure.

E.13 Converting Data from C to SQL Data Types

When an application calls `SQLExecute` or `SQLExecDirect`, the driver retrieves the data for any parameters bound with `SQLBindParameter` from storage locations in the application. For data-at-execution parameters, the application sends the parameter data with `SQLPutData`. If necessary, the driver converts the data from the data type specified by the *`ValueType`* argument in SQLBindParameter to the data type specified by the *`ParameterType`* argument in `SQLBindParameter`. Finally, the driver sends the data to the data source.

The following table shows the supported conversions from ODBC C data types to ODBC SQL data types. A solid circle indicates the default conversion for an SQL data type (the C data type from which the data will be converted when the value of *`ValueType`* or the SQL_DESC_CONCISE_TYPE descriptor field is SQL_C_DEFAULT). A hollow circle indicates a supported conversion.

The format of the converted data is not affected by the Microsoft Windows country setting.

IBM solidDB supports only signed, not unsigned, integer data types (SQL_TINYINT, SQL_SMALLINT, SQL_INTEGER, SQL_BIGINT). You may bind an unsigned C variable to a signed SQL column, but you must make sure that the values you store fit within the range supported by both data types.

IBM solidDB does not support the BIT/SQL_BIT data type for SQL columns. However, you may bind a numeric SQL column to a BIT data type in your C application. For example, you may use a TINYINT column in your database and bind that column to a C variable of type SQL_C_BIT. The IBM solidDB ODBC driver will try to convert numeric types in the database to BIT data types for the C variables. The numeric data values must be 1 or 0 or NULL; other values cause a data conversion error. The table below does not discuss BIT/SQL_BIT data types.

Table E.23. SQL Data Type — SQL_datatype where Datatype Is:

C Data Type	CHAR	VARCHAR	LONGVARCHAR	WCHAR	WVARCHAR	WLONGVARCHAR	DECIMAL	NUMERIC	TINYINT(signed)	TINYINT(unsigned)	SMALLINT(signed)	SMALLINT(unsigned)	INTEGER(signed)	INTEGER(unsigned)	BIGINT(signed)	BIGINT(unsigned)	REAL	FLOAT	DOUBLE	BINARY	VARBINARY	LONGVARBINARY	DATE	TIME	TIMESTAMP
SQL_C_CHAR	*	*	*	o	o	o	*	*	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
SQL_WCHAR	o	o	o	*	*	*	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
SQL_C_NUMERIC	*	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o						
SQL_C_STINYINT	o	o	o	o	o	o	o	o	*	o	o	o	o	o	o	o	o	o	o						
SQL_C_UTINYINT	o	o	o	o	o	o	o	o	o	*	o	o	o	o	o	o	o	o	o						
SQL_C_TINYINT	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o						
SQL_C_SSHORT	o	o	o	o	o	o	o	o	o	o	*	o	o	o	o	o	o	o	o						
SQL_C_USHORT	o	o	o	o	o	o	o	o	o	o	o	*	o	o	o	o	o	o	o						
SQL_C_SHORT	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o						
SQL_C_SLONG	o	o	o	o	o	o	o	o	o	o	o	o	*	o	o	o	o	o	o						
SQL_C_ULONG	o	o	o	o	o	o	o	o	o	o	o	o	o	*	o	o	o	o	o						
SQL_C_LONG	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o						
SQL_C_SBIGINT	o	o	o	o	o	o	o	o	o	o	o	o	o	o	*	*	o	o	o						
SQL_C_UBIGINT	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	*	o	o	o						
SQL_C_FLOAT	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	*	o	o						
SQL_C_DOUBLE	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	*	*						

C Data Type	CHAR	VARCHAR	LONGVARCHAR	WCHAR	WVARCHAR	WLONGVARCHAR	DECIMAL	NUMERIC	TINYINT(signed)	TINYINT(unsigned)	SMALLINT(signed)	SMALLINT(unsigned)	INTEGER(signed)	INTEGER(unsigned)	BIGINT(signed)	BIGINT(unsigned)	REAL	FLOAT	DOUBLE	BINARY	VARBINARY	LONGVARBINARY	DATE	TIME	TIMESTAMP
SQL_C_BINARY	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	*	*	*	o	o	o
SQL_C_DATE	o	o	o	o	o	o																	*		o
SQL_C_TIME	o	o	o	o	o	o																		*	o
SQL_C_TIMESTAMP	o	o	o	o	o	o																	o	o	*

KEY: * Default conversion, o Supported conversion

Caution

Although the table above shows a wide range of ODBC conversions, including conversions involving unsigned data types, IBM solidDB supports only signed integer data types (e.g. TINYINT, SMALLINT, INT, and BIGINT).

E.13.1 Table Description - C to SQL

The tables in the following sections describe how the driver or data source converts data sent to the data source; drivers are required to support conversions from all ODBC C data types to the ODBC SQL data types that they support. In the table:

- For a given ODBC C data type, the first column of the table lists the legal input values of the *ParameterType* argument in `SQLBindParameter`.

- The second column lists the outcomes of a test that the driver performs to determine if it can convert the data.

- The third column lists the SQLSTATE returned for each outcome by `SQLExecDirect`, `SQLExecute`, or `SQLPutData`. Data is sent to the data source only if SQL_SUCCESS is returned.

If the *`ParameterType`* argument in `SQLBindParameter` contains a value for an ODBC SQL data type that is not shown in the table for a given C data type, `SQLBindParameter` returns SQLSTATE 07006 (Restricted data type attribute violation). If the *`ParameterType`* argument contains a driver-specific value and the driver does not support the conversion from the specific ODBC C data type to that driver-specific SQL data type, `SQLBindParameter` returns SQLSTATE HYC00 (Optional feature not implemented).

If the *`ParameterValuePtr`* and *`StrLen_or_IndPtr`* arguments specified in `SQLBindParameter` are both null pointers, that function returns SQLSTATE HY009 (Invalid use of null pointer). Although it is not shown in the tables, an application sets the value pointed to by the *`StrLen_or_IndPtr`* argument of SQLBindParameter or the value of the *`StrLen_or_IndPtr`* argument to SQL_NULL_DATA to specify a NULL SQL data value. (The *`StrLen_or_IndPtr`* argument corresponds to the SQL_DESC_OCTET_LENGTH_PTR field of the APD.) The application sets these values to SQL_NTS to specify that the value in **ParameterValuePtr* in `SQLBindParameter` or **DataPtr* in `SQLPutData` (pointed to by the SQL_DESC_DATA_PTR field of the APD) is a null-terminated string.

The following terms are used in the tables:

- *Byte length of data* is the number of bytes of SQL data available to send to the data source, regardless of whether the data will be truncated before it is sent to the data source. For string data, this does not include the null-termination character.

- *Column byte length* is the number of bytes required to store the data at the data source.

- *Character byte length* is the maximum number of bytes needed to display data in character form.

- *Number of digits* is the number of characters used to represent a number, including the minus sign, decimal point, and exponent (if needed).

- Words in italics represent elements of the ODBC SQL grammar. See Appendix D, *SQL Minimum Grammar* for the syntax of grammar elements.

E.13.2 C to SQL: Character

The character ODBC C data type is:

SQL_C_CHAR SQL_C_WCHAR

The following table shows the ODBC SQL data types to which C character data may be converted. For an explanation of the columns and terms in the table, see Section E.13.1, “Table Description - C to SQL”.

Note

The length of the Unicode data type must be an even number when character C data is converted to Unicode SQL data.

Table E.24. C Character Data to ODBC SQL Data Types

SQL Type Identifier	test	SQLSTATE
SQL_CHAR SQL_VARCHAR SQL_LONGVARCHAR	Byte length of data <= Column length Byte length of data > Column length	N/A 22001
SQL_WCHAR SQL_WVARCHAR SQL_WLONGVARCHAR	Character length of data <= Column length Character length of data > Column length	N/A 22001
SQL_DECIMAL SQL_NUMERIC SQL_TINYINT SQL_SMALLINT SQL_INTEGER SQL_BIGINT	Data converted without truncation Data converted with truncation of fractional digits [e] Conversion of data would result in loss of whole (as opposed to fractional) digits [e] Data value is not a *numeric-literal*	N/A 22001 22001 22018
SQL_REAL SQL_FLOAT SQL_DOUBLE	Data is within the range of the data type to which the number is being converted Data is outside the range of the data type to which the number is being converted Data value is not a *numeric-literal*	N/A 22003 22005
SQL_BIT	Data is 0 or 1	N/A

SQL Type Identifier	test	SQLSTATE
	Data is greater than 0, less than 2, and not equal to 1	22001
	Data is less than 0 or greater than or equal to 2	22003
	Data is not a *numeric-literal*.	22018
	Note: IBM solidDB does not support SQL_BIT.	
SQL_BINARY	(Byte length of data) / 2 <= Column byte length	N/A
SQL_VARBINARY	(Byte length of data) / 2 > Column byte length	22001
SQL_LONG-VARBIN-ARY	Data value is not a hexadecimal value	22018
SQL_TYPE_DATE	Data value is a valid *ODBC_date_literal*	N/A
	Data value is a valid *ODBC_timestamp_literal*; time portion is zero	N/A
	Data value is a valid *ODBC_timestamp_literal*; time portion is non-zero [a]	22008
	Data value is not a valid *ODBC_date_literal* or *ODBC_timestamp_literal*	22018
SQL_TYPE_TIME	Data value is a *valid ODBC_time_literal*	N/A
	Data value is a valid *ODBC_timestamp_literal*; fractional seconds portion is zero [b]	N/A
	Data value is a valid *ODBC_timestamp_literal*; fractional seconds portion is non-zero [b]	22008
	Data value is not a valid *ODBC_time_literal* or *ODBC_timestamp_literal*	22018
SQL_TYPE_TIMESTAMP	Data value is a valid *ODBC_timestamp_literal*; fractional seconds portion not truncated	N/A
	Data value is a valid *ODBC-timestamp-literal*; fractional seconds portion truncated	22008
	Data value is a valid *ODBC-date-literal* [c]	N/A
		N/A

SQL Type Identifier	test	SQLSTATE
	Data value is a valid *ODBC-time-literal* [d] Data value is not a valid *ODBC-date-literal*, *ODBC-time-literal*, or *ODBC-timestamp-literal*	22018

Explanations of Footnote Numbering in the Table Above

[a] The time portion of the timestamp is truncated.

[b] The date portion of the timestamp is ignored.

[c] The time portion of the timestamp is set to zero.

[d] The date portion of the timestamp is set to the current date.

[e] The driver/data source effectively waits until the entire string has been received (even if the character data is sent in pieces by calls to `SQLPutData`) before attempting to perform the conversion.

When character C data is converted to numeric, date, time, or timestamp SQL data, leading and trailing blanks are ignored.

When character C data is converted to binary SQL data, each two bytes of character data are converted to a single byte (8 bits) of binary data. Each two bytes of character data represent a number in hexadecimal form. For example, "01"is converted to a binary 00000001 and "FF"is converted to a binary 11111111.

The driver always converts pairs of hexadecimal digits to individual bytes and ignores the null termination byte. Because of this, if the length of the character string is odd, the last byte of the string (excluding the null termination byte, if any) is not converted.

Note

Because binding character C data to a binary SQL data type is inefficient and slow, refrain from doing this.

E.13.3 C to SQL: Numeric

The numeric ODBC C data types are:

- SQL_C_STINYINT
- SQL_C_SLONG

- SQL_C_UTINYINT
- SQL_C_ULONG
- SQL_C_TINYINT
- SQL_C_LONG
- SQL_C_SSHORT
- SQL_C_FLOAT
- SQL_C_USHORT
- SQL_C_DOUBLE
- SQL_C_SHORT
- SQL_C_NUMERIC
- SQL_C_SBIGINT
- SQL_C_UBIGINT

For more information about the SQL_C_TINYINT, SQL_C_SHORT, and SQL_C_LONG data types, see "ODBC 1.0 C Data Types, "earlier in this appendix. The following table shows the ODBC SQL data types to which numeric C data may be converted. For an explanation of the columns and terms in the table, see Section E.13.1, “Table Description - C to SQL”.

Table E.25. Numeric C Data to ODBC SQL Data Types

ParameterType	Test	SQLSTATE
SQL_CHAR SQL_VARCHAR SQL_LONGVARCHAR	Number of digits <= Column byte length Number of digits > Column byte length	N/A 22001
SQL_WCHAR SQL_WVARCHAR SQL_WLONGVARCHAR	Number of characters <= Column character length Number of characters > Column character length	N/A 22001

ParameterType	Test	SQLSTATE
SQL_DECIMAL [a] SQL_NUMERIC [a] SQL_TINYINT [a] SQL_SMALLINT [a] SQL_INTEGER [a] SQL_BIGINT [a]	Data converted without truncation or with truncated of fractional digits Data converted with truncation of whole digits	N/A 22003
SQL_REAL SQL_FLOAT SQL_DOUBLE	Data is within the range of the data type to which the number is being converted Data is outside the range of the data type to which the number is being converted	N/A 22003

Explanations of Footnote Numbering in the Table Above

[a] For the "n/a" case, a driver may optionally return SQL_SUCCESS_WITH_INFO and 01S07 when there is a fractional truncation.

The driver ignores the length/indicator value when converting data from the numeric C data types and assumes that the size of the data buffer is the size of the numeric C data type. The length/indicator value is passed in the *`StrLen_or_IndPtr`* argument in `SQLPutData` and in the buffer specified with the *`StrLen_or_IndPtr`* argument in `SQLBindParameter`. The data buffer is specified with the *`DataPtr`* argument in `SQLPutData` and the *`ParameterValuePtr`* argument in `SQLBindParameter`.

E.13.4 C to SQL: Bit

The bit ODBC C data type is:

```
SQL_C_BIT
```

The following table shows the ODBC SQL data types to which bit C data may be converted. For an explanation of the columns and terms in the table, see Section E.13.1, “Table Description - C to SQL”.

Table E.26. Bit C Data to ODBC SQL Data Types

SQL Type Identifier	Test	SQLSTATE
SQL_CHAR SQL_VARCHAR SQL_LONGVARCHAR SQL_WCHAR SQL_WVARCHAR SQL_WLONGVARCHAR	None	N/A
SQL_DECIMAL SQL_NUMERIC SQL_TINYINT SQL_SMALLINT SQL_INTEGER SQL_BIGINT SQL_REAL SQL_FLOAT SQL_DOUBLE	None	N/A

The driver ignores the length/indicator value when converting data from the bit C data types and assumes that the size of the data buffer is the size of the bit C data type. The length/indicator value is passed in the *`StrLen_or_Ind`* argument in `SQLPutData` and in the buffer specified with the *`StrLen_or_IndPtr`* argument in `SQLBindParameter`. The data buffer is specified with the *`DataPtr`* argument in `SQLPutData` and the *`ParameterValuePtr`* argument in `SQLBindParameter`.

E.13.5 C to SQL: Binary

The binary ODBC C data type is:

SQL_C_BINARY

The following table shows the ODBC SQL data types to which binary C data may be converted. For an explanation of the columns and terms in the table, see Section E.13.1, “Table Description - C to SQL”.

Table E.27. Binary C Data to ODBC SQL Data Types

SQL Type Identifier	Test	SQLSTATE
SQL_CHAR	Byte length of data <= Column byte length	N/A
SQL_VARCHAR	Byte length of data > Column length	22001
SQL_LONGVARCHAR		
SQL_WCHAR	Character length of data <= Column character length	N/A
SQL_WVARCHAR	Character length of data > Column character length	22001
SQL_WLONGVARCHAR		
SQL_DECIMAL	Byte length of data = SQL data length	N/A
SQL_NUMERIC	Length of data <> SQL data length	22003
SQL_TINYINT		
SQL_SMALLINT		
SQL_INTEGER		
SQL_BIGINT		
SQL_REAL		
SQL_FLOAT		
SQL_DOUBLE		
SQL_TYPE_DATE		
SQL_TYPE_TIME		
SQL_TYPE_TIMESTAMP		
SQL_BINARY	Length of data <= Column length	N/A
SQL_VARBINARY	Length of data > Column length	22001

SQL Type Identifier	Test	SQLSTATE
SQL_LONGVARBINARY		

E.13.6 C to SQL: Date

The date ODBC C data type is:

```
SQL_C_DATE
```

The following table shows the ODBC SQL data types to which date C data may be converted. For an explanation of the columns and terms in the table, see Section E.13.1, “Table Description - C to SQL”.

Table E.28. Date C Data to ODBC SQL Data Types

SQL Type Identifier	Test	SQLSTATE
SQL_CHAR	Column byte length >= 10	N/A
SQL_VARCHAR	Column byte length < 10	22001
SQL_LONGVARCHAR	Data value is not a valid date	22008
SQL_CHAR	Column character length >= 10	N/A
SQL_VARCHAR	Column character length < 10	22001
SQL_LONGVARCHAR	Data value is not a valid date	22008
SQL_TYPE_DATE	Data value is a valid date	N/A
	Data value is not a valid date	22007
SQL_TYPE_TIMESTAMP	Data value is a valid date [a]	N/A
	Data value is not a valid date	22007

Explanations of Footnote Numbering in the Table Above

[a] The time portion of the timestamp is set to zero.

For information about what values are valid in an SQL_C_TYPE_DATE structure, see "C Data Types" earlier in this appendix.

When date C data is converted to character SQL data, the resulting character data is in the "yyyy-mm-dd "format.

The driver ignores the length/indicator value when converting data from the date C data types and assumes that the size of the data buffer is the size of the date C data type. The length/indicator value is passed in the *StrLen_or_Ind* argument in SQLPutData and in the buffer specified with the *StrLen_or_IndPtr* argument in SQLBindParameter. The data buffer is specified with the *DataPtr* argument in SQLPutData and the *ParameterValuePtr* argument in SQLBindParameter.

E.13.7 C to SQL: Time

The time ODBC C data type is:

SQL_C_TIME

T he following table shows the ODBC SQL data types to which time C data may be converted. For an explanation of the columns and terms in the table, see Section E.13.1, “Table Description - C to SQL”.

Table E.29. Time C Data to ODBC SQL Data Types

SQL Type Identifier	Test	SQLSTATE
SQL_CHAR	Column byte length >= 8	N/A
SQL_VARCHAR SQL_LONGVARCHAR	Column byte length < 8	22001
	Data value is not a valid time	22008
SQL_WCHAR	Column character length >= 8	N/A
SQL_WVARCHAR	Column character length < 8	22001
SQL_WLONGVARCHAR	Data value is not a valid time	22008
SQL_TYPE_TIME	Data value is a valid time	N/A
	Data value is not a valid time	22007
SQL_TYPE_TIMESTAMP	Data value is a valid time [a]	N/A
	Data value is not a valid time	22007

Explanations of Footnote Numbering in the Table Above

[a] The date portion of the timestamp is set to the current date and the fractional seconds portion of the timestamp is set to zero.

For information about what values are valid in an SQL_C_TYPE_TIME structure, see "C Data Types" earlier in this appendix.

When time C data is converted to character SQL data, the resulting character data is in the "hh:mm:ss" format.

The driver ignores the length/indicator value when converting data from the time C data types and assumes that the size of the data buffer is the size of the time C data type. The length/indicator value is passed in the *StrLen_or_Ind* argument in SQLPutData and in the buffer specified with the *StrLen_or_IndPtr* argument in SQLBindParameter. The data buffer is specified with the *DataPtr* argument in SQLPutData and the *ParameterValuePtr* argument in SQLBindParameter.

E.13.8 C to SQL: Timestamp

The timestamp ODBC C data type is:

SQL_C_TIMESTAMP

The following table shows the ODBC SQL data types to which timestamp C data may be converted. For an explanation of the columns and terms in the table, see Section E.13.1, “Table Description - C to SQL”.

Table E.30. Timestamp C Data to ODBC SQL Data Ttypes

SQL Type Identifier	Test	SQLSTATE
SQL_CHAR SQL_VARCHAR SQL_LONGVARCHAR	Column byte length >= Character byte length 19 <= Column byte length < Character byte length Column byte length < 19 Data value is not a valid date	N/A 22001 22001 22008
SQL_WCHAR SQL_WVARCHAR SQL_WLONGVARCHAR	Column character length >= Character length of data 19 <= Column character length < Character length of data Column character length < 19 Data value is not a valid timestamp	N/A 22001 22001 22008
SQL_TYPE_DATE	Time fields are zero	N/A

SQL Type Identifier	Test	SQLSTATE
	Time fields are non-zero	22008
	Data value does not contain a valid date	22007
SQL_TYPE_TIME	Fractional seconds fields are zero [a]	N/A
	Fractional seconds fields are non-zero [a]	22008
	Data value does not contain a valid time	22007
SQL_TYPE_TIMESTAMP	Fractional seconds fields are not truncated	N/A
	Fractional seconds fields are truncated	22008
	Data value is not a valid timestamp	22007

Explanations of Footnote Numbering in the Table Above

[a] The date fields of the timestamp structure are ignored.

For information about what values are valid in an SQL_C_TIMESTAMP structure, see "C Data Types" earlier in this appendix.

When timestamp C data is converted to character SQL data, the resulting character data is in the "yyyy-mm-dd hh:mm:ss [.f. ..]"format.

The driver ignores the length/indicator value when converting data from the timestamp C data types and assumes that the size of the data buffer is the size of the timestamp C data type. The length/indicator value is passed in the *StrLen_or_Ind* argument in `SQLPutData` and in the buffer specified with the *StrLen_or_IndPtr* argument in `SQLBindParameter`. The data buffer is specified with the *DataPtr* argument in `SQLPutData` and the *ParameterValuePtr* argument in `SQLBindParameter`.

E.13.9 C to SQL Data Conversion Examples

The following examples illustrate how the driver converts C data to SQL data:

Table E.31. C Data to SQL Data

C Data Type	C Data Value	SQL Data Type	Column Length	SQL Data Value	SQLSTATE
SQL_C_CHAR	abcdef\0 a	SQL_CHAR	6	abcdef	N/A
SQL_C_CHAR	abcdef\0 a	SQL_CHAR	5	abcde	22001

C Data Type	C Data Value	SQL Data Type	Column Length	SQL Data Value	SQLSTATE
SQL_C_CHAR	1234.56\0 a	SQL_DECIMAL	8 b	1234.56	N/A
SQL_C_CHAR	1234.56\0 a	SQL_DECIMAL	7 b	1234.5	22001
SQL_C_CHAR	1234.56\0 a	SQL_DECIMAL	4	----	22003
SQL_C_FLOAT	1234.56	SQL_FLOAT	not applic-able	1234.56	N/A
SQL_C_FLOAT	1234.56	SQL_INTEGER	not applic-able	1234	22001
SQL_C_FLOAT	1234.56	SQL_TINYINT	not applic-able	----	22003
SQL_C_TYPE_DATE	1992,12,31 c	SQL_CHAR	10	1992-12-31	N/A
SQL_C_TYPE_DATE	1992,12,31 c	SQL_CHAR	9	----	22003
SQL_C_TYPE_DATE	1992,12,31 c	SQL_TIMESTAMP	not applic-able	1992-12-31 00:00:00.0	N/A
SQL_C_TYPE TIMESTAMP	1992,12,31, 23,45,55, 120000000 d	SQL_CHAR	22	1992-12-31 23:45:55.12	N/A
SQL_C_TYPE TIMESTAMP	1992,12,31, 23,45,55, 120000000 d	SQL_CHAR	21	1992-12-31 23:45:55.1	22001
SQL_C_TYPE TIMESTAMP	1992,12,31, 23,45,55, 120000000 d	SQL_CHAR	18	----	22003

Explanations of Footnote Numbering in the Table Above

[a] "\0"represents a null-termination byte. The null-termination byte is required only if the length of the data is SQL_NTS.

[b] In addition to bytes for numbers, one byte is required for a sign and another byte is required for the decimal point.

[c] The numbers in this list are the numbers stored in the fields of the SQL_DATE_STRUCT structure.

[d] The numbers in this list are the numbers stored in the fields of the SQL_TIMESTAMP_STRUCT structure.

Appendix F. Scalar Functions

ODBC specifies five types of scalar functions:

- String functions
- Numeric functions
- Time and date functions
- System functions
- Data type conversion functions

A scalar function is a function that returns one value for each row in the query. Functions like `SQRT()` and `ABS()` are scalar functions. Functions like `SUM()` and `AVG()` are not scalar functions because they return a single value even if they process more than one row.

This appendix includes tables for each scalar function category. Within each table, functions have been added in ODBC 3.0 to align with SQL-92. Each table also provides the version number when the function was introduced.

F.1 ODBC and SQL-92 Scalar Functions

Because functions are often data-source-specific, ODBC does not require a data type for return values from scalar functions. To force data type conversion, applications should use the CONVERT scalar function.

Note

Keep in mind the different ways in which ODBC and SQL-92 classify functions. ODBC classifies scalar functions by argument type, whereas SQL-92 classifies them by return value. For example, in ODBC, the EXTRACT function is classified as a timedate function because the extract-field argument is a timedate keyword and the extract_source argument is a timedate or interval expression. In SQL-92, however, the EXTRACT function is classified as a numeric scalar function because the return value is numeric.

Applications need to call `SQLGetInfo` to determine which scalar functions a driver supports. ODBC and SQL-92 information types are available for scalar function classifications. Because ODBC and SQL-92 use different classfications, the information types for the same function may differ between ODBC and SQL-92. For example, to determine support for the EXTRACT function requires SQL_TIMEDATE_FUNCTIONS

information type in ODBC and SQL_SQL92_NUMERIC_VALUE_FUNCTIONS information type in SQL-92.

F.2 String Functions

This section lists string manipulation functions. Applications can call `SQLGetInfo` with the SQL_STRING_FUNCTIONS information type to determine which string functions are supported by a driver.

F.2.1 String Function Arguments

Table F.1. String Function Arguments

Arguments denoted as...	Definition
`string_exp`	can be the name of a column, a string literal, or the result of another scalar function, where the underlying data type can be represented as SQL_CHAR, SQL_VARCHAR, or SQL_LONGVARCHAR.
`start`, *`length`* or *`count`*	can be a numeric literal or the result of another scalar function, where the underlying data type can be represented as SQL_TINYINT, SQL_SMALLINT, or SQL_INTEGER
`character_exp`	are a variable-length character string

The following string functions are 1-based, that is, the first character in the string is character 1, not character 0.

Note

BIT_LENGTH, CHAR_LENGTH, CHARACTER_LENGTH, OCTET_LENGTH, and POSITION string scalar functions were added in ODBC 3.0 to align with SQL-92.

F.2.2 List of String Functions

Table F.2. List of String Functions

Function	Description
`ASCII(`*`string_exp`*`)` (ODBC 1.0)	Returns the ASCII code value of the leftmost character of *`string_exp`* as an integer.
`BIT_LENGTH(`*`string_exp`*`)`	Returns the length in bits of string expression.

Function	Description
(ODBC 3.0)	
CHAR(code) (ODBC 1.0)	Returns the character that has the ASCII code value specified by code. The value of *code* should be between 0 and 255; otherwise, the return value is data source-dependent.
CHAR_LENGTH(*string_exp*) (ODBC 3.0)	Returns the length in characters of the string expression, if the string expression is of a character data type; otherwise, returns the length in bytes of the string expression (the smallest integer not less than the number of bits divided by 8). (This function is the same as CHARACTER_LENGTH function.)
CHARACTER_LENGTH(*string_exp*) (ODBC 3.0)	Returns the length in characters of the string expression, if the string expression is of a character data type; otherwise, returns the length in bytes of the string expression (the smallest integer not less than the number of bits divided by 8). (This function is the same as the CHAR_LENGTH function.)
CONCAT(*string_exp1*, , *string_exp2*) (ODBC 1.0)	Returns a character string that is the result of concatenating *string_exp2* to *string_exp1*. The resulting string is DBMS-dependent.
DIFFERENCE(*string_exp1*, , *string_exp2*) (ODBC 2.0)	The function returns the difference between the soundex (see soundex function below) values of two character expressions, as an integer. The integer returned is the number of characters in the soundex values that are the same. The return value ranges from 0 through 4: 0 indicates little or no similarity, and 4 indicates strong similarity or identical values.
INSERT(*string_exp1*, , *start*, , *length*, , *string_exp2*) (ODBC 1.0)	Returns a character string where *length* characters have been deleted from *string_exp1* beginning at *start* and where *string_exp2* has been inserted into *string_exp*, beginning at *start*.
LCASE(*string_exp*) (ODBC 1.0)	Returns a string equal to that *string_exp*, with all uppercase characters converted to lowercase.
LEFT(*string_exp*, , *count*) (ODBC 1.0)	Returns the leftmost *count* of characters of *string_exp*.
LENGTH(*string_exp*) (ODBC 1.0)	Returns the number of characters in *string_exp*, excluding trailing blanks.

Function	Description
LOCATE(*string_exp1*, , *string_exp2*, [, *start*])	Returns the starting position of the first occurrence of *string_exp1* within *string_exp2*. The search for the first occurrence of *string_exp1* begins with the first character position in *string_exp2* unless the optional argument, *start*, is specified. If *start* is specified, the search begins with the character position indicated by the value of *start*. The first character position in *string_exp2* is indicated by the value 1. If *string_exp1* is not found within *string_exp2*, the value 0 is returned. If an application can call the LOCATE scalar function with the *string_exp1*, *string_exp2*, and *start* arguments, the driver returns SQL_FN_STR_LOCATE when SQLGetInfo is called with an option of SQL_STRING_FUNCTIONS. If the application can call the LOCATE scalar function with only the *string_exp1* and *string_exp2* arguments, the driver returns SQL_FN_STR_LOCATE_2 when SQLGetInfo is called with an option of SQL_STRING_FUNCTIONS. Drivers that support calling the LOCATE function with either two or three arguments return both SQL_FN_STR_LOCATE and SQL_FN_STR_LOCATE_2.
LTRIM(*string_exp*) (ODBC 1.0)	Returns the characters of *string_exp*, with leading blanks removed.
OCTET_LENGTH(*string_exp*) (ODBC 3.0)	Returns the length in bytes of the string expression. The result is the smallest integer not less than the number of bits divided by 8.
POSITION(*character_exp*, IN *character_exp*) (ODBC 3.0)	Returns the position of the first character expression in the second character expression. The result is an exact numeric with an implementation-defined precision and a scale of 0.
REPEAT(*string_exp*, , *count*) (ODBC 1.0)	Returns a character string composed of *string_exp* repeated *count* times.
REPLACE(*string_exp1*, , *string_exp2*, , *string_exp3*) (ODBC 1.0)	Search *string_exp1* for occurrences of *string_exp2*, and replace with *string_exp3*.

Function	Description
RIGHT(*string_exp*, , *count*) (ODBC 1.0)	Returns the rightmost *count* of characters of *string_exp*.
RTRIM(*string_exp*) (ODBC 1.0)	Returns the characters of *string_exp* with trailing blanks removed.
SOUNDEX(*string_exp1*) (ODBC 2.0)	Returns a character string containing the phonetic representation of the argument. This function lets you compare words that are spelled differently, but sound alike in English. If you supply a word to Soundex, it returns a 4-character phonetic code used by the U.S.Census Bureau since 1930s.
SPACE(*count*) (ODBC 2.0)	Returns a character string consisting of *count* spaces.
SUBSTRING(*string_exp*, , *start*, , *length*) (ODBC 1.0)	Returns a character string that is derived from *string_exp*, beginning at the character position specified by *start* for *length* characters.
TRIM(*string_exp*)	Returns the characters of *string_exp* with leading blanks and trailing blanks removed.
UCASE(*string_exp*) (ODBC 1.0)	Returns a string equal to that in *string_exp*, with all lowercase characters converted to uppercase.

F.3 Numeric Functions

This section describes numeric functions that are included in the ODBC scalar function set. Applications can call SQLGetInfo with the SQL_NUMERIC_FUNCTIONS information type to determine which string functions are supported by a driver.

Except for ABS, ROUND, TRUNCATE, SIGN, FLOOR, and CEILING (which return values of the same data type as the input parameters), all numeric functions return values of data type SQL_FLOAT.

F.3.1 Numeric Function Arguments

Table F.3. Numeric Function Arguments

Arguments denoted as...	Definition
numeric_exp	can be the name of a column, the result of another scalar function, or a numeric literal, where the underlying data type could be represented as SQL_NUMERIC, SQL_DECIMAL, SQL_TINYINT, SQL_SMALLINT, SQL_INTEGER, SQL_BIGINT, SQL_FLOAT, SQL_REAL, or SQL_DOUBLE
float_exp	can be the name of a column, the result of another scalar function, or a numeric literal, where the underlying data type can be represented as SQL_FLOAT.
integer_exp	can be the name of a column, the result of another scalar function, or a numeric literal, where the underlying data type can be represented as SQL_TINYINT, SQL_SMALLINT, SQL_INTEGER, or SQL_BIGINT

F.3.2 List of Numeric Functions

Table F.4. List of Numeric Functions

Function	Description
ABS(*numeric_exp*) (ODBC 1.0)	Returns the absolute value of *numeric_exp*.
ACOS(*float_exp*) (ODBC 1.0)	Returns the arccosine of *float_exp* as an angle, expressed in radians.
ASIN(*float_exp*) (ODBC 1.0)	Returns the arcsine of *float_exp* as an angle, expressed in radians.
ATAN(*float_exp*) (ODBC 1.0)	Returns the arctangent of *float_exp* as an angle, expressed in radians.
ATAN2(*float_exp1*, , *float_exp2*) (ODBC 2.0)	Returns the arctangent of the x and y coordinates, specified by *float_exp1* and *float_exp2*, respectively, as an angle, expressed in radians.

Function	Description
CEILING(*numeric_exp*) (ODBC 1.0)	Returns the smallest integer greater than or equal to *numeric_exp*. The return value is of the same data type as the input parameter.
COS(*float_exp*) (ODBC 1.0)	Returns the cosine of *float_exp*, where *float_exp* is an angle expressed in radians.
COT(*float_exp*) (ODBC 1.0)	Returns the cotangent of *float_exp*, where *float_exp* is an angle expressed in radians.
DEGREES(*numeric_exp*) (ODBC 2.0)	Returns the number of degrees converted from *numeric_exp* radians.
EXP(*float_exp*) (ODBC 1.0)	Returns the exponential value of *float_exp*.
FLOOR(*numeric_exp*) (ODBC 1.0)	Returns largest integer less than or equal to *numeric_exp*. The return value is of the same data type as the input parameter.
LOG(*float_exp*) (ODBC 1.0)	Returns the natural logarithm of *float_exp*.
LOG10(*float_exp*) (ODBC 2.0)	Returns the base 10 logarithm of *float_exp*.
MOD(*integer_exp1*, , *integer_exp2*) (ODBC 1.0)	Returns the remainder (modulus) of *integer_exp1* divided by *integer_exp2*.
PI( ) (ODBC 1.0)	Returns the constant value of pi as a floating point value.
POWER(*numeric_exp*, , *integer_exp*)	Returns the value of *numeric_exp* to the power of *integer_exp*.
RADIANS(*numeric_exp*) (ODBC 2.0)	Returns the number of radians converted from *numeric_exp* degrees.

Function	Description
ROUND(*numeric_exp*, , *integer_exp*) (ODBC 2.0)	Returns *numeric_exp* rounded to *integer_exp* places right of the decimal point. If *integer_exp* is negative, *numeric_exp* is rounded to |*integer_exp*| places to the left of the decimal point.
SIGN(*numeric_exp*) (ODBC 1.0)	Returns an indicator or the sign of *numeric_exp*. If *numeric_exp* is less than zero, -1 is returned. If *numeric_exp* equals zero, 0 is returned. If *numeric_exp* is greater than zero, 1 is returned.
SIN(*float_exp*) (ODBC 1.0)	Returns the sine of *float_exp*, where *float_exp* is an angle expressed in radians.
SQRT(*float_exp*) (ODBC 1.0)	Returns the square root of *float_exp*.
TAN(*float_exp*) (ODBC 1.0)	Returns the tangent of *float_exp*, where *float_exp* is an angle expressed in radians.
TRUNCATE(*numeric_exp*, , *integer_exp*) (ODBC 2.0)	Returns *numeric_exp* truncated to *integer_exp* places right of the decimal point. If *integer_exp* is negative, *numeric_exp* is truncated to |*integer_exp*| places to the left of the decimal point.

F.4 Time and Date Functions

This section lists time and date functions that are included in the ODBC scalar function set. Applications can call SQLGetInfo with the SQL_TIMEDATE_FUNCTIONS information type to determine which time and date functions are supported by a driver.

F.4.1 Time and Data Arguments

Table F.5. Time and Data Arguments

Arguments denoted as...	Definition
timestamp_exp	can be the name of a column, the result of another scalar function, or an *ODBC_time_escape*, *ODBC_date_escape*, or *ODBC_timestamp_escape*, where the underlying data type could be represented as SQL_CHAR, SQL_VARCHAR, SQL_TYPE_TIME, SQL_TYPE_DATE, or SQL_TYPE_TIMESTAMP.

Arguments denoted as...	Definition
date_exp	can be the name of a column, the result of another scalar function, or an *ODBC_date_escape* or *ODBC_timestamp_escape*, where the underlying data type could be represented as SQL_CHAR, SQL_VARCHAR, SQL_TYPE_DATE, or SQL_TYPE_TIMESTAMP.
time_exp	can be the name of a column, the result of another scalar function, or an *ODBC_time_escape* or *ODBC_timestamp_escape*, where the underlying data type could be represented as SQL_CHAR, SQL_VARCHAR, SQL_TYPE_TIME, or SQL_TYPE_TIMESTAMP

Note

CURRENT_DATE, CURRENT_TIME, and CURRENT_TIMESTAMP timedate scalar functions were added in ODBC 3.0 to align with SQL-92.

F.4.2 List of Time and Date Functions

Table F.6. List of Time and Date Functions

Function	Description
CURRENTTIME [(*time_precision*)] (ODBC 3.0)	Returns the current local time as a time value. The time_precision argument determines the seconds precision of the returned value.
CURRENT_TIMESTAMP [(*timestamp_precision*)] (ODBC 3.0)	Returns the current local data and local time as a timestamp value. The timestamp_precision argument determines the seconds precision of the returned timestamp.
CURDATE( ) (ODBC 1.0)	Returns the current date.
CURTIME( ) (ODBC 1.0)	Returns the current local time.
DAYNAME(*date_exp*) (ODBC 2.0)	Returns a character string containing the data source-specific name of the day (for example, Sunday, through Saturday or Sun. through Sat. for a data source that uses English, or Sonntag through Samstag for a data source that uses German) for the day portion of *date_exp*.

Function	Description
DAYOFMONTH(*date_exp*) (ODBC 1.0)	Returns the day of the month in *date_exp* as an integer value in the range of 1-31.
DAYOFWEEK(*date_exp*) (ODBC 1.0)	Returns the day of the week based on the week field in *date_exp* as an integer value in the range of 1-7, where 1 represents Sunday.
DAYOFYEAR(*date_exp*) (ODBC 1.0)	Returns the day of the year based on the year field in *date_exp* as an integer value in the range of 1-366.
EXTRACT(*extract_field*, FROM *extract_source*) (ODBC 3.0)	Returns the *extract_field* portion of the *extract_source*. The extract_source argument is a datetime or interval xpression. The *extract_field* argument can be one of the following keywords" YEAR MONTH DAY HOUR MINUTE SECOND The precision of the returned value is implementation-defined. The scale is 0 unless SECOND is specified, in which case the scale is not less than the fractional seconds precision of the extract_source field.
HOUR(*time_exp*) (ODBC 1.0)	Returns the hour based on the hour field in *time_exp* as an integer value in the range of 0-23.
MINUTE(*time_exp*) (ODBC 1.0)	Returns the minute based on the minute field in *time_exp* as an integer value in the range of 0-59.
MONTH(*date_exp*) (ODBC 1.0)	Returns the month based on the month field in *date_exp* as an integer value in the range of 1-12.
MONTHNAME(*date_exp*) (ODBC 2.0)	Returns a character string containing the data source-specific name of the month (for example, January through December or Jan. through Dec. for a data source that uses English, or Januar through Dezember for a data source that uses German) for the month portion of *date_exp*.

Function	Description
NOW( ) (ODBC 1.0)	Returns current date and time as a timestamp value.
QUARTER(*date_exp*) (ODBC 1.0)	Returns the quarter in *date_exp* as an integer value in the range of 1- 4, where 1 represents January 1 through March 31.
SECOND(*time_exp*) (ODBC 1.0)	Returns the second in *time_exp* as an integer value in the range of 0-59.
TIMESTAMPADD(*interval*, , *integer_exp*, , *timestamp_exp*) (ODBC 2.0)	Returns the timestamp calculated by adding *integer_exp* intervals of type interval to *timestamp_exp*. Valid values of interval are the following keywords: SQL_TSI_FRAC_SECOND SQL_TSI_SECOND SQL_TSI_MINUTE SQL_TSI_HOUR SQL_TSI_DAY SQL_TSI_WEEK SQL_TSI_MONTH SQL_TSI_QUARTER SQL_TSI_YEAR where fractional seconds are expressed in billionths of a second (nanoseconds). For example, the following SQL statement returns the name of each employee and his or her one-year anniversary date: SELECT NAME, {fn TIMESTAMPADD(SQL_TSI_YEAR, 1, HIRE_DATE)} FROM EMPLOYEES If *timestamp_exp* is a time value and interval specifies day, weeks, months, quarters, or years, the date portion of *timestamp_exp* is set to the current date before calculating the resulting timestamp.

Function	Description
	If *timestamp_exp* is a date value and interval specifies fractional seconds, seconds, minutes, or hours, the time portion of *timestamp_exp* is set to 0 before calculating the resulting timestamp. An application determines which intervals a data source supports by calling SQLGetInfo with the SQL_TIMEDATE_ADD_INTERVALS option.
TIMESTAMPDIFF(*interval*, , *timestamp_exp1*, , *timestamp_exp2*) (ODBC 2.0)	Returns the integer number of intervals of type interval as the amount of full units between *timestamp_exp1* and *timestamp_exp2*. If an application relies on the old TIMESTAMPDIFF semantics, the old behavior can be emulated by the following configuration setting in the SQL section of the solid.ini file. [SQL] EmulateOldTIMESTAMPDIFF=YES Note that the old semantics returns the integer number of intervals of type interval by which *timestamp_exp2* is greater than *timestamp_exp1*. Valid values of interval are the following keywords: SQL_TSI_FRAC_SECOND SQL_TSI_SECOND SQL_TSI_MINUTE SQL_TSI_HOUR SQL_TSI_DAY SQL_TSI_WEEK SQL_TSI_MONTH SQL_TSI_QUARTER SQL_TSI_YEAR where fractional seconds are expressed in billionths of a second (nano-seconds). For example, the following SQL statement returns the name of each employee and the number of years they have been employed: SELECT NAME, {fn

Function	Description
	`TIMESTAMPDIFF(SQL_TSI_YEAR, {fn CURDATE()}, HIRE_DATE)} FROM EMPLOYEES` If either timestamp expression is a time value and interval specifies days, weeks, months, quarters, or years, the date portion of that timestamp is set to the current date before calculating the difference between the timestamps. If either timestamp expression is a date value and interval specifies fractional seconds, seconds, minutes, or hours, the time portion of that timestamp is set to 0 before calculating the difference between the timestamps. An application determines which intervals a data source supports by calling `SQLGetInfo` with the SQL_TIMEDATE_DIFF_INTERVALS option.
`WEEK(`*`date_exp`*`)` (ODBC 1.0)	Returns the week of the year based on the week field in *`date_exp`* as an integer value in the range of 1-53.
`YEAR(`*`date_exp`*`)` (ODBC 1.0)	Returns the year based on the year field in *`date_exp`* as an integer value. The range is data source-dependent.

F.5 System Functions

This section lists system functions that are included in the ODBC scalar function set. Applications can call `SQLGetInfo` with the SQL_SYSTEM_FUNCTIONS information type to determine which string functions are supported by a driver.

F.5.1 System Functions Arguments

Table F.7. System Function Arguments

Arguments denoted as...	Definition
exp	can be the name of a column, the result of another scalar function, or a literal, where the underlying data type could be represented as SQL_NUMERIC, SQL_DECIMAL, SQL_TINYINT, SQL_SMALLINT, SQL_INTEGER, SQL_BIGINT, SQL_FLOAT, SQL_REAL, SQL_DOUBLE, SQL_TYPE_DATE, SQL_TYPE_TIME, or SQL_TYPE_TIMESTAMP.

Arguments denoted as...	Definition
value	can be a literal constant, where the underlying data type can be represented as SQL_NUMERIC, SQL_DECIMAL, SQL_TINYINT, SQL_SMALLINT, SQL_INTEGER, SQL_BIGINT, SQL_FLOAT, SQL_REAL, SQL_DOUBLE, SQL_TYPE_DATE, SQL_TYPE_TIME, or SQL_TYPE_TIMESTAMP.
integer_exp	can be the name of a column, the result of another scalar function, or a numeric literal, where the underlying data type can be represented as SQL_TINYINT, SQL_SMALLINT, SQL_INTEGER, or SQL_BIGINT

Values returned are represented as ODBC data types

F.5.2 List of System Functions

Table F.8. List of System Functions

Function	Description
`DATABASE( )` (ODBC 1.0)	Returns the name of the database corresponding to the connection handle. (The name of the database is also available by calling `SQLGetConnectOption` with the SQL_CURRENT_QUALIFIER connection option.)
`IFNULL(`*`exp, , value`*`)` (ODBC 1.0)	If exp is null, value is returned. If exp is not null, exp is returned. The possible data type(s) of value must be compatible with the data type of exp
`USER( )` (ODBC 1.0)	Returns the user's name in the DBMS. (The user's authorization name is also available via `SQLGetInfo` by specifying the information type: SQL_USER_NAME.) This can be different from the login time.

F.6 Explicit Data Type Conversion

Explicit data type conversion is specified in terms of SQL data type definitions.

The ODBC syntax for the explicit data type conversion function does not restrict conversions. The validity of specific conversions of one data type to another data type is dependent on each driver-specific implementation. The driver, as it translates the ODBC syntax into the native syntax, reject those conversions that, although legal in the ODBC syntax, are not supported by the data source. Applications can call the ODBC function `SQLGetInfo` to inquire about conversions supported by the data source.

The format of the CONVERT function is:

CONVERT(*value_exp*, *data_type*)

The function returns the value specified by value_exp converted to the specified data_type, where data_type is one of the following keywords:

- SQL_BIGINT
- SQL_SMALLINT
- SQL_BINARY
- SQL_DATE
- SQL_CHAR
- SQL_TIME
- SQL_DECIMAL
- SQL_TIMESTAMP
- SQL_DOUBLE
- SQL_TINYINT
- SQL_FLOAT
- SQL_VARBINARY
- SQL_INTEGER
- SQL_VARCHAR
- SQL_LONGVARBINARY
- SQL_WCHAR
- SQL_LONGVARCHAR
- SQL_WLONGVARCHAR
- SQL_NUMERIC
- SQL_WVARCHAR

- SQL_REAL

The ODBC syntax for the explicit data type conversion function does not support specification of conversion format. If specification of explicit formats is supported by the underlying data source, a driver must specify a default value or implement format specification.

The argument value_exp can be a column name, the result of another scalar function, or a numeric or string literal. For example:

```
{ fn CONVERT( { fn CURDATE() }, SQL_CHAR) }
```

converts the output of the CURDATE scalar function to a character string.

ODBC does not require a data type for return values from scalar functions (because the functions are often data source-specific); applications should use the `CONVERT` scalar function whenever possible to force data type conversion.

The following two examples illustrate the use of the CONVERT function. These examples assume the existence of a table called EMPLOYEES, with an EMPNO column of type SQL_SMALLINT and an EMPNAME column of type SQL_CHAR.

If an application specifies the following:

```
SELECT EMPNO FROM EMPLOYEES WHERE {fn CONVERT(EMPNO,SQL_CHAR)}LIKE '1%'
```

IBM solidDB ODBC driver translates the request to:

```
SELECT EMPNO FROM EMPLOYEES WHERE CONVERT_CHAR(EMPNO) LIKE '1%'
```

F.7 SQL-92 CAST Function

The ODBC CONVERT function has an equivalent function in SQL-92: the CAST function. The syntax for these equivalent functions are:

```
{ fn CONVERT (value_exp, data_type)} /* ODBC */
CAST (value_exp AS data_type) /* SQL 92 */
```

Support for the `CAST` function is at the FIPS Transitional level. For details on data type conversion in the `CAST` function, see the SQL-92 specification.

To determine application support for the `CAST` function, call `SQLGetInfo` with the SQL_SQL_CONFORMANCE information type. The `CAST` function is supported if the return value for the information type is:

- SQL_SC_FIPS127_2_TRANSITIONAL
- SQL_SC_SQL92_INTERMEDIATE
- SQL_SC_SQL92_FULL

If the return value is SQL_SC_ENTRY or 0, call `SQLGetInfo` with the SQL_SQL92_VALUE_EXPRESSIONS information type. If the SQL_SVE_CAST bit is set, the `CAST` function is supported.

Appendix G. Timeout Controls

In IBM solidDB, some actions can get timed out. A timeout can be activated by the main server, the client drivers, the Primary or Secondary server, or the Master or Replica server.

Timeouts have factory default values and they can usually be set with different .ini parameters. Some startup defaults can be dynamically changed with different controls, by using SQL, or by using the driver interfaces and connection string parameters.

G.1 Client Timeouts

Timeouts related to the database client are introduced in this chapter.

G.1.1 Login Timeout

This timeout refers to the number of seconds the driver waits for the login (`SQLConnect`) to succeed. The default value is driver-dependent. If the value (or ValuePtr in ODBC) is 0, the timeout is disabled and a connection attempt will wait indefinitely. If the specified timeout exceeds the maximum login timeout in the data source, the driver substitutes that value and returns SQLSTATE 01S02 (Option value changed).

This timeout applies for the TCP protocol only.

Table G.1. Login Timeouts

INI parameter	Overridden with SQL	Driver	Connection string
		ODBC: *`SQL_ATTR_LOGIN_TIMEOUT`* (in seconds) *`SQL_ATTR_LOGIN_TIMEOUT_MS (in milliseconds, non-standard)`* JDBC: Method *`DriverManger.setLoginTimeout(seconds);`* Connection property	-c milliseconds

INI parameter	Overridden with SQL	Driver	Connection string
		solid_login_timeout_ms (milliseconds, non-standard)	
(client-side) [Com] Connect-Timeout (in milliseconds) or: Connect -c option (in milliseconds)			

Timeout error code and message:

ODBC:

HYT00, Timeout expired

G.1.2 Connection Timeout

This timeout refers to the number of seconds (or milliseconds) the driver waits for any request on the connection to complete. This timeout is not associated with the query execution or login. Upon timeout, the driver disconnects from the IBM solidDB server.

The driver returns SQLSTATE HYT00 (Timeout expired) if it is possible to time out in a situation not associated with query execution or login. If the value (or ValuePtr in ODBC) is 0 (the default value), there is no timeout.

This timeout applies to all ODBC functions (ODBC 3.5 specifications) except:

```
SQLDrivers
```

```
SQLDataSources
SQLGetEnvAttr
SQLSetEnvAttr
```

Table G.2. Connection Timeout

INI parameter	Overridden with SQL	Driver	Connection string
(server-side) [Com] Listen -r option (in milliseconds) (client-side) [Com] ClientReadTimeout (in milliseconds) or: Connect (-r option) (in milliseconds)		ODBC: *SQL_ATTR_CONNECTION_TIMEOUT (in seconds)* JDBC: Non-standard: Property "*solid_connection_timeout_ms*" (milliseconds) or method: `SolidConnection.setConnectionTimeout()` (milliseconds)	-r milliseconds

Note

This timeout has also been implemented on the server, which means that the server will cancel the outstanding request and disconnect the client.

Timeout error code and message:

ODBC:

HYT01, Connection timeout expired

See also:

```
SOLID Server Error 14518:
Connection to the server is broken, connection lost.

SOLID Communication Error 21328 and SOLID Session Error 20024:
Timeout while resolving host name.

SOLID Communication Error 21329 and SOLID Session Error 20025:
Timeout while connecting to a remote host.
```

G.1.3 Query Timeout

This timeout refers to the number of seconds the driver waits for an SQL statement to execute. If the value (or ValuePtr in ODBC) is 0 (the default value), there is no timeout.

If the specified timeout exceeds the maximum timeout in the data source, or if the specified timeout is smaller than the minimum timeout, `SQLSetStmtAttr` substitutes that value and returns SQLSTATE 01S02 (Option value changed).

This timeout applies to the ODBC functions (ODBC 3.5 specifications) as follows:

`SQLBrowseConnect`

`SQLBulkOperations`

`SQLColumnPrivileges`

`SQLColumns`

`SQLConnect`

`SQLDriverConnect`

`SQLExecDirect`

`SQLExecute`

`SQLExtendedFetch`

`SQLForeignKeys`

`SQLGetTypeInfo`

`SQLParamData`

`SQLPrepare`

`SQLPrimaryKeys`

`SQLProcedureColumns`

`SQLProcedures`

`SQLSetPos`

`SQLSpecialColumns`

`SQLStatistics`

`SQLTablePrivileges`

`SQLTables`

Note

The application need not call `SQLCloseCursor` to reuse the statement if a SELECT statement timed out. The query timeout set in this statement attribute is valid in both synchronous and asynchronous modes.

Table G.3. Query Timeout

INI parameter	Overridden with SQL	Driver	Connection string
		ODBC: *`SQL_ATTR_QUERY_TIMEOUT`*	

Timeout error code and message:

ODBC:

HYT00, Timeout expired

G.2 Server Timeouts

Timeouts related to the database server are introduced in this chapter.

G.2.1 SQL Statement Execution Timeout

The server can control the amount of time spent on the execution of one SQL statement. When the time expires, the server aborts the statements and returns a corresponding error code. This timeout applies to the following calls (ODBC 3.5 specifications):

- `SQLExecute()`
- `SQLExecDirect()`
- `SQLPrepare()`
- `SQLForeignKeys()`
- `SQLColumns()`
- `SQLProcedureColumns()`
- `SQLSpecialColumns()`
- `SQLStatistics()`
- `SQLPrimaryKeys()`
- `SQLProcedures()`
- `SQLTables()`
- `SQLTablePrivileges()`
- `SQLColumnPrivileges()`
- `SQLGetTypeInfo()`

The timeout also applies to the corresponding JDBC calls.

Table G.4. SQL statement execution timeouts

INI parameter	Overridden with SQL	Driver	Connection string
	`SET STATEMENT MAXTIME minutes`	ODBC: *`SQL_ATTR_QUERY_TIMEOUT seconds`*	

INI parameter	Overridden with SQL	Driver	Connection string
		JDBC: `statement.setQueryTimeout()`	

Timeout error code and message:

HYT00, Timeout expired

See also:

```
SOLID Server Error 14518:
Connection to the server is broken, connection lost.

SOLID Server Error 14529:
The operation timed out.
```

G.2.2 Lock Wait Timeout

This timeout specifies the time in seconds (or milliseconds) that the engine waits for a lock to be released. When the timeout interval is reached, IBM solidDB terminates the timed-out transaction. The default value is 30 seconds, and the parameter access mode is read/write.

Lock wait timeout is used in deadlock resolution. In that case, the oldest transaction participating in a deadlock is aborted.

Table G.5. Lock Wait Timeout

INI parameter	Overridden with SQL	Driver	Connection string
[General] *LockWaitTimeOut seconds*	*SET LOCK TIMEOUT {seconds | milliseconds MS}*		

Timeout error code and message:

```
SOLID Database Error 10006:
Concurrency conflict, two transactions updated or deleted the same row.
```

G.2.3 Optimistic Lock Timeout

This timeout specifies the optimistic lock timeout. Optimistic lock is an additional lock that can be enacted in order to ensure that SELECT FOR UPDATE will always lead to successful updates, in the optimistic concurrency mode. The default is zero whereby no optimistic lock is used, and a transaction may be aborted after each statement, as a result of early transaction validation. When the timeout is set to a non-zero value, SELECT FOR UPDATE will wait until the lock is obtained, or it is timed-out and aborted. When set, the timeout affects also all DELETE and UPDATE statements.

Table G.6. Optimistic Lock Wait Timeout

INI parameter	Overridden with SQL	Driver	Connection string
	SET OPTIMISTIC LOCK TIMEOUT {seconds | milliseconds MS}		

Timeout error code and message:

```
SOLID Database Error 10006:
Concurrency conflict, two transactions updated or deleted the same row.
```

G.2.4 Table Lock Wait Timeout

Occasionally, the transaction will acquire an exclusive lock to a table. This may be result of a lock escalation, an attempt to execute the ALTER TABLE statement, or as a side effect of some advanced replication commands. If there is a table-level conflict, this setting provides the transaction's wait period until the exclusive or shared lock is released. The unit is seconds, the default value is 30 seconds, and the parameter access mode is read/write.

To be more specific, table level locks are used when the PESSIMISTIC keyword is explicitly provided in the following commands:

```
IMPORT SUBSCRIPTIONMESSAGE message_name EXECUTE
(only with NO EXECUTE option)
MESSAGE message_name FORWARD
```

```
MESSAGE message_name GET REPLY
DROP SUBSCRIPTION.
```

Table G.7. Table Lock Wait Timeout

INI parameter	Overridden with SQL	Driver	Connection string
[General] *TableLockWaitTimeout seconds*			

Timeout error code and message:

```
SOLID Database Error 10006:
Concurrency conflict, two transactions updated or deleted the same row.
```

G.2.5 Transaction Idle Timeout

This timeout specifies the time in minutes after an idle transaction is aborted; a negative or zero value means infinite. The unit is minutes, the default value is 120 minutes, and the access mode is read/write.

Table G.8. Transaction Idle Timeout

INI parameter	Overridden with SQL	Driver	Connection string
[Srv] *AbortTimeOut*			

Timeout error code and message:

```
SOLID Database Error 10026:
 Transaction is timed out.
```

G.2.6 Connection Idle Timeout

This timeout specifies the continuous idle time in minutes (or seconds/milliseconds in a statement) after which a connection is dropped (by the server); negative or zero value indicates an infinite value. The parameter unit is minutes, the default value is 480 minutes, and the access mode is read/write.

Table G.9. Connection Idle Timeout

INI parameter	Overridden with SQL	Driver	Connection string
[Srv] *ConnectTimeOut minutes*	*SET IDLE TIMEOUT {seconds | milliseconds MS}*		

Timeout error code and message:

```
SOLID Communication Error 21308:
Connection is broken (protocol read/write
operation failed with code internal code).
```

See also the `solmsg.out` file.

If the SET IDLE TIMEOUT has been set and the transaction is idle for the given period, the error below is given:

```
SOLID Database Error 10026:
Transaction is timed out
```

G.3 HotStandby Timeouts

Timeouts related to the HotStandby server are introduced in this chapter.

G.3.1 Connect Timeout

By specifying a connect timeout value, you can set the maximum time in milliseconds that a HotStandby connect operation waits for a connection to a remote machine. The ConnectTimeout parameter is only used with certain administration commands. These are:

```
hotstandby connect
hotstandby switch primary
hotstandby switch secondary
```

The unit is milliseconds, the default value is 3000, and the access mode is read/write.

Table G.10. Connect Timeout

INI parameter	Overridden with SQL	Driver	Connection string
[HotStandby] *ConnectTimeout milliseconds*			

G.3.2 Ping Timeout

This parameter specifies how long a server waits before concluding that the other server is down or inaccessible. The unit is milliseconds, the default value is 4000, and the access mode is read/write.

Table G.11. Ping Timeout

INI parameter	Overridden with SQL	Driver	Connection string
[HotStandby] *PingTimeout milliseconds*			

Appendix H. Client-Side Configuration Parameters

The client-side configuration parameters are stored in the `solid.ini` configuration file and are read when the client starts.

Generally, the factory value settings offer the best performance and operability, but in some special cases modifying a parameter will improve performance. You can change the parameters by editing the configuration file `solid.ini`.

The parameter values set in the client side configuration file come to effect each time an application issues a call to the `SqlConnect` ODBC function. If the values are changed in the file during the program's run time, they affect the connections established thereafter.

H.1 Setting Client-Side Parameters through the `solid.ini` Configuration File

When the IBM solidDB is started, it attempts to open the configuration file `solid.ini`. If the file does not exist, IBM solidDB will use the factory values for the parameters. If the file exists, but a value for a particular parameter is not set in the `solid.ini` file, IBM solidDB will use a factory value for that parameter. The factory values may depend on the operating system you are using.

By default, the client looks for the `solid.ini` file in the current working directory, which is normally the directory from which you started the client. When searching for the file, the IBM solidDB uses the following precedence (from high to low):

- location specified by the *`SOLIDDIR`* environment variable (if this environment variable is set)
- current working directory

H.1.1 Rules for Formatting the Client-Side `solid.ini` File

When you format the client-side `solid.ini` file, the same rules apply as for the server-side `solid.ini` file. For more information, refer to section *Rules for Formatting the solid.ini File* in *IBM solidDB Administration Guide*.

Example H.1. Client-Side solid.ini File

```
[Com]
;use this connect string of no data source given
Listen = tcp host1.acme.com 1315

[Client]
;at SQLConnect, timeout after this time (ms)
ConnectTimeout = 5000

;at any ODBC network request, timeout after this time (ms)
ClientReadTimeout = 10000

[DataSources]
Primary_Server = tcp irix1 1315, The Primary Server
Secondary_Server = tcp irix2 1315, The Secondary Server
```

H.2 Descriptions of Client-Side Configuration Parameters

There is one table below for each section of the `solid.ini` file. The sections (and tables) are:

- Com
- Data Sources
- Client

H.3 Communication Section

Table H.1. Communication Parameters

[Com]	Description	Factory Value
ClientReadTimeout	This parameter defines the connection (or read) timeout in milliseconds. A network request fails if no response is received during the time specified. The value 0 sets the timeout to infinite. This value can be overridden with	60 000

[Com]	Description	Factory Value
	the connect string option `-r` and, further on, with the ODBC attribute *SQL_ATTR_CONNECTION_TIMEOUT*. Note: applies for the TCP protocol only.	
Connect	The *Connect* parameter defines the default network name (connect string) for a client to connect to when it establishes a connection to a server. This value is used when the `SQLConnect()` call is issued with an empty data source name.	tcp localhost 1964
ConnectTimeout	The *ConnectTimeout* parameter defines the login timeout in milliseconds. This value can be overridden with the connect string option `-c` and, further on, with the ODBC attribute *SQL_ATTR_LOGIN_TIMEOUT*. Note: applies for the TCP protocol only.	OS-specific
ODBCHandleValidation	The *ODBCHandleValidation* parameter switches ODBC handle validation on/off. See also in section "ODBC Handle Validation" in *IBM solidDB Programmer Guide* for more information on the `SQL_ATTR_HANDLE_VALIDATION` ODBC attribute.	No
Trace	If this parameter is set to yes, trace information on network messages for the established network connection is written to a file specified with the *TraceFile* parameter. The factory value for the *TraceFile* parameter is `soltrace.out`.	no
TraceFile	If the *Trace* parameter is set to yes, trace information on network messages is written to a file specified with this *TraceFile* parameter.	`soltrace.out` (written to the current working directory of the server or client depending on which end the tracing is started)

H.4 Data Sources

Table H.2. Data Source Parameters

[Data Sources]	Description	Factory Value	Access Mode
logical name = network name, Description	These parameters can be used to give a logical name to a IBM solidDB server in a `solid.ini` file of the client application. For details, read section *Logical Data Source Names* in *IBM solidDB Administration Guide.*		N/A

H.5 Client

Table H.3. Client Parameters

[Client]	Description	Factory Value
ExecRowsPerMessage	This parameter specifies how many result rows are sent (pre-fetched) to the client driver in response to the `SQLExecute` call with a SELECT statement. The result rows are subsequently returned to the application with the first `SQLFetch` calls issued by the application. The default value of 2 allows for pre-fetching of single-row results. If your SELECT statements usually return larger number of rows, setting this to an appropriate value can improve performance significantly. See also the *RowsPerMessage* configuration parameter.	decided by the server
NoAssertMessages	This parameter is relevant to the Windows platform only. If set to Yes, the Windows run-time error dialog is not shown.	No
RowsPerMessage	Specifies the number of rows returned from the server in one network message when an `SQLFetch` call is executed (and there are no pre-fetched rows). See also the *ExecRowsPerMessage* configuration parameter.	decided by the server

[Client]	**Description**	**Factory Value**
StatementCache	Statement cache is an internal memory storing a few previously prepared SQL statements. With this parameter, you can set the number of cached statements per session.	6

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