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OpenSQL Reference Guide

INGRES[®]

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Chapter 1: Introduction

The *OpenSQL Reference Guide* describes OpenSQL usage and syntax. OpenSQL was specifically designed to be compatible across several SQL dialects. OpenSQL is functionally equivalent to Ingres SQL without the extensions specific to Ingres®. This guide is designed for programmers who write applications that are portable across all Advantage™ EDBC®, Advantage™ Enterprise Access, and Ingres servers.

Note: If you are working through an Enterprise Access product, see your Enterprise Access product documentation for information about syntax that may differ from that described in this guide.

Audience

The *OpenSQL Reference Guide* is intended for programmers and OpenSQL users who have a basic understanding of how Ingres and relational database systems work. In addition, the reader should have a basic understanding of the operating system. This guide is also intended as a reference for the database system administrator.

Conventions

Syntax

The following terminology distinctions are made when dealing with language items:

- A command is an operation that you execute from an Advantage™ OpenROAD® Development menu or at the operating system level.
- A statement is an operation that you place in a program or called procedure. Statements can be written in OpenROAD's fourth-generation language (4GL), a database query language (such as SQL), or a 3GL (like C or COBOL).

When representing language elements in *discussion text*, the following conventions are used:

Convention	Usage
UPPERCASE	Indicates constants (for example, TRUE, FALSE, and FB_DIMMED)

Convention	Usage
lowercase	Indicates 4GL keywords and statements (for example, begin keyword and callproc statement)
<i>italic, lowercase</i>	Indicates a variable name (for example, <i>cursor_variable</i>)
MixedCase/Initial Capitalization	Indicates class names, attributes, methods, or events (for example, DataStream class, ClientData attribute, FetchRow method, and WindowResized event)

When representing *syntax*, the following conventions are used:

Convention	Usage
Boldface	Indicates keywords, symbols, or punctuation that you must type as shown
<i>Italic</i>	Indicates a variable name for which you must supply an actual value—this convention is used in explanatory text, as well as syntax
<i>Italic, underline</i>	Indicates a variable name which can be used in a statement either dynamically (when you run the application) or statically (when you create the application)
[] (brackets)	Indicates an optional item
{ } (braces)	Indicates an optional item that you can repeat as many times as appropriate
(vertical bar)	Indicates a list of mutually exclusive items (that is, you can select only one item from the list)

The following example illustrates the syntax conventions:

```
select [all | distinct]
  resultexpression {, resultexpression}
  from tablename [corrname] {, tablename [corrname]}
  [where searchcondition]
  [group by columnname {, columnname}]
  [having searchcondition]
```

User Input Examples

The following conventions are used for user input:

- Literal information (text that the user must enter exactly as shown) is shown in bold:

Insert the CD-ROM into the CD-ROM drive and type
d:\install.

- Placeholder text (variable information a user must enter) is denoted by an italic typeface:
Enter login *username*.

Terminology

This guide observes the following distinction in terminology:

A *command* is an operation that is executed at the operating system level. An extended operation invoked by a command is often referred to as a *utility*.

A *statement* is an operation that is embedded in a program or executed interactively from the Terminal Monitor.

A statement can be written in Ingres 4GL, a host programming language (such as C), or a database query language (SQL or QUEL).

Syntax and User Input

When representing syntax and user input, the following conventions are used:

Convention	Usage
Boldface	Indicates any text that must be typed as shown.
<i>Italics</i>	Represent a variable name or placeholder for which you must supply an actual value—this convention is used in explanatory text, as well as syntax.
Fixed pitch font	Indicates text that is displayed on your screen, such as prompts and messages. For example, the following statement is a prompt: Enter database name:
Case Sensitivity	System command and environment variable names may be case-sensitive, depending on the requirements of your operating system.
[] (brackets)	Used to enclose an optional item.
{ } (braces)	Used to enclose an optional item that you can repeat as many times as appropriate.
(vertical bar)	Used between items in a list to indicate that you should choose one of the items.
% (percent sign)	At the beginning of a command line, indicates commands that are entered at the C-shell command line prompt. It should not be entered by the user.

UNIX

Convention	Usage
\$ (dollar sign)	<p>At the beginning of a command line, indicates commands that are entered at the Bourne-shell command line prompt. It should not be entered by the user.</p> <p>Note: This symbol is also used as a literal part of syntax when referring to environment variable names. When it appears anywhere except at the beginning of a command line, it must be entered exactly as shown. ■</p>

Example

The following example illustrates some of these conventions:

```
create table tablename (columnname format
  {,columnname format})
  [with_clause]
```

Embedded OpenSQL Examples

Examples of embedded OpenSQL code provided in this guide use the following conventions:

Convention	Usage
Margins	None are used.
; (semicolon)	Represents the statement terminator.
Labels	Appear on their own line and are followed by a colon (:). Control passes to the statement following the label.
Host language comments	Indicated by the OpenSQL comment indicator; for example:
	<pre>/* This is a comment. */</pre>
' (single quotes)	Surround character strings.
pseudocode	Represents host language statements in embedded OpenSQL. For example:
	<pre>exec sql begin declaration; variable declarations exec sql end declaration;</pre>

To determine the correct syntax for your programming language, see the *Embedded SQL Companion Guide*.

Chapter 2: Overview of OpenSQL

This chapter provides an introduction to the basics of OpenSQL including an overview of various Enterprise Access products and available OpenSQL features.

What Is OpenSQL?

SQL (Structured Query Language) is a language that allows you to manipulate and maintain data in a relational database. OpenSQL is a version of SQL that was specifically designed to be compatible across several SQL dialects. OpenSQL allows you to create applications that run on the following servers:

- The Ingres DBMS (for Ingres databases)
- Enterprise Access products (for access to other database management systems)
- Ingres Distributed Option (for distributed databases)
- EDBC servers

OpenSQL statements can be used in the following contexts:

- Terminal Monitor
- Embedded OpenSQL programs
- Applications built with Vision (a forms-based application development tool)
- Applications built with OpenROAD (a graphical user interface application development tool)

Use OpenSQL statements in the interactive Terminal Monitor or in embedded OpenSQL programs. OpenSQL statement syntax and results are consistent across supported host programming languages. This guide does not include specific information about host languages. For details, see the *Embedded SQL Companion Guide*.

Forms statements allow you to write embedded applications that interact with users through Visual Forms Editor forms. For details about forms statements, see the *Forms-based Application Development Tools User Guide*.

Enterprise Access Products

Enterprise Access products (formerly referred to as Gateways) are interfaces between Ingres applications and database management systems other than Ingres. The Enterprise Access products provide a variety of services, including:

- Translating between OpenSQL and host query interfaces, such as Rdb/VMS (for Alpha VMS), or DB2 UDB (for IBM DB2 Universal Database)
- Emulating SQL functions for non-relational databases such as IMS and RMS
- Converting between OpenSQL data types and data types that are native to other host database management systems
- Translating host DBMS error messages to Ingres generic errors

Enterprise Access products are *transparent*, meaning that host databases are presented as if they are Ingres databases.

Ingres Distributed Option

Ingres Distributed Option provides a single, consistent system view of multiple databases managed by either the Ingres DBMS Server or by Enterprise Access products.

Interactive OpenSQL

Interactive OpenSQL provides full access to Ingres databases, distributed databases (through Ingres Distributed Option), and other types of databases (through Enterprise Access products). Because interactive OpenSQL statements are similar to their embedded versions, use interactive OpenSQL to test the queries to be used in embedded programs. The user interface to interactive OpenSQL is the Terminal Monitor.

Embedded OpenSQL

Using embedded OpenSQL, OpenSQL statements can be mixed with host language statements. Use host language variables to specify values required by embedded OpenSQL statements. For information about the requirements of a specific host language, see the *Embedded SQL Companion Guide*.

Building Embedded OpenSQL Programs

The Embedded SQL preprocessor converts embedded OpenSQL statements in your program into host language source code statements. The resulting statements are calls to a runtime library that provides the interface to Ingres, Ingres Distributed Option, and Enterprise Access products. Non-SQL host language statements are passed through the preprocessor without being altered. After the program has been preprocessed, it must be compiled and linked as appropriate for the host language. For details on preprocessing an embedded OpenSQL program, see the *Embedded SQL Companion Guide*.

Retrieving Status Information

Status information is available to an embedded program from the SQL Communications Area (SQLCA). The SQLCA is a data structure that can be included in the program. The SQLCA contains information concerning the results of the last executed OpenSQL statement. Statements in embedded OpenSQL programs can refer to data in the SQLCA for execution of conditional actions. For information on the language-specific data structure of the SQLCA, see the *Embedded SQL Companion Guide*.

Specifying Parameters at Runtime

OpenSQL enables you to execute queries that are formulated at runtime (rather than before preprocessing). This is known as *dynamic OpenSQL*.

Differences between Embedded and Interactive OpenSQL

Embedded OpenSQL builds on the features and statements available in interactive OpenSQL. However, embedded OpenSQL differs from interactive OpenSQL in the following areas:

- **Host language variables** - Embedded OpenSQL allows host variables to be used in place of many syntactic elements. (There are no variables in interactive OpenSQL.)
- **Error and status information** - In interactive OpenSQL, error and status messages are sent directly to the terminal screen. In embedded OpenSQL, the SQL Communications Area (SQLCA) structure receives error and status information.
- **Data manipulation statements** - There are two embedded versions of the select statement. The first version is similar to the interactive select statement. The second version allows the retrieval and updating of an indeterminate number of rows, using cursors. The update and delete statements also have cursor versions. For more information about cursors, see [Data Manipulation with Cursors](#) in the chapter "Embedded OpenSQL."

- **Dynamic OpenSQL statements** - Embedded OpenSQL creates statements dynamically from individual components specified in program variables. These statements can be executed repeatedly with different values.
- **Additional database access statements** - Embedded OpenSQL includes several statements not required in interactive OpenSQL. These additional statements enable your embedded application to connect to a database and to control cursors.
- **Repeated queries** - A repeated query executes more quickly than other queries, because the server retains the query execution plan. Embedded OpenSQL allows you to specify a select, insert, update, or delete statement as repeated.

Features

The availability of some OpenSQL features depend on the version of OpenSQL supported by the host DBMS to which your application connects. To determine which version of OpenSQL the host DBMS supports, select the row containing the OPEN/SQL_LEVEL capability from the iidbcapabilities system catalog.

The following OpenSQL features are only available when the OPEN/SQL_LEVEL value in the iidbcapabilities system catalog is 00605 or higher:

- Create schema statement
- Grant and revoke statements
- Create table statement: column constraints and defaults
- Schema.table syntax
- Delimited identifiers
- The escape clause in the like predicate
- Database procedures

For Enterprise Access, newer OpenSQL features may be available even though the Open/SQL_LEVEL value is not at 00605 or higher. For the current availability of OpenSQL features, see the Enterprise Access documentation.

Object Names

The rules for naming OpenSQL objects (such as tables, columns, and views) are as follows:

- All keywords are reserved and cannot be used as variable or object names in OpenSQL. In addition, embedded OpenSQL reserves all words beginning with "ii". Enforcement of keywords may vary by Enterprise Access product.

- Names can contain only alphanumeric characters and must begin with an alphabetic character (A-Z).
- Names can contain (though not begin with) the special characters 0 through 9 and underscore (_).
- All names are converted as necessary to the proper case for the host DBMS. The host DBMS stores names in the system catalogs in one of three formats: uppercase, lowercase, or mixed case. For more information, see [The iidbcapabilities Catalog](#) in the chapter “OpenSQL Standard Catalogs.”
- The maximum length of an OpenSQL object name is 32 characters. To ensure application portability, limit names to a maximum of 18 characters. For names of objects managed by the Ingres tools (such as Query-By-Forms, Report-By-Forms, Vision, and Visual Forms Editor), the maximum is 32 characters. Examples of objects managed by the user interfaces are:
 - Forms
 - JoinDefs
 - QBFnames
 - Graphs
 - Reports

For more information about objects managed by the user interfaces, see the *Character-based Querying and Reporting Tools User Guide* or the guide that documents the specific user interfaces.

Regular and Delimited Identifiers

Identifiers in OpenSQL statements specify names for the following objects:

- User
- Column
- Correlation name
- Cursor
- Database procedure
- Database procedure parameter
- Index
- Prepared query
- Schema
- Table
- View

Specify these names using *regular* (unquoted) identifiers or *delimited* (double-quoted) identifiers. For example:

- Table name in a select statement specified using a regular identifier:
`select * from employees`
- Table name in a select statement specified using a delimited identifier:
`select * from "my table"`

Delimited identifiers allow special characters to be embedded in object names. OpenSQL restricts the use of special characters in regular identifiers.

Restrictions on Identifiers

For ANSI/ISO Entry SQL-92 standards compliance, identifiers should be no longer than 18 characters. The following table lists restrictions for each type of identifier:

Restriction	Regular Identifiers	Delimited Identifiers
Quotes	Specified without quotes	Specified in double quotes
Keywords	Cannot be a keyword	Can be a keyword
Case	Depends on host DBMS	Is significant
Valid Special Characters	"At" sign (@) (Ingres only) Crosshatch (#) (Ingres only) Dollar sign (\$) (Ingres only) Underscore (_)	Ampersand (&) Asterisk (*) "At" sign (@) Colon (;) Comma (,) Crosshatch (#) Dollar sign (\$) Double quotes (") Equal sign (=) Forward slash (/) Left and right caret (< >) Left and right parentheses Minus sign (-)

Restriction	Regular Identifiers	Delimited Identifiers
	Period (.)	
	Plus sign (+)	
	Question mark (?)	
	Semicolon (;)	
	Single quote (')	
	Space	
	Underscore (_)	
	Vertical bar ()	

The following characters cannot be embedded in object names using either regular or delimited identifiers:

- Backslash (\)
- Caret (^)
- Curly braces ({ })
- DEL (ASCII 127 or X'7F')
- Exclamation point (!)
- Left quote (ASCII 96 or X'60')
- Tilde (~)

To specify double quotes in a delimited identifier, the quotes must be repeated. For example:

""Identifier""Name"""

is interpreted by OpenSQL as:

"Identifier"Name"

Case Sensitivity of Identifiers

Case sensitivity for regular and delimited identifiers depends on the underlying DBMS. For compliance with ANSI/ISO Entry SQL-92 standards, delimited identifiers must be case sensitive.

OpenSQL treats database and user names without regard to case.

Comment Delimiters

To indicate comments in interactive OpenSQL, use the following delimiters:

- “/*” and “*/” (left and right delimiters, respectively). For example:

```
/* This is a comment */
```

When using “/*...*/” to delimit a comment, the comment can continue over more than one line. For example,

```
/* Everything from here...
...to here is a comment */
```

- “--” (left side only). For example,

```
--This is a comment.
```

The “--” delimiter indicates that the rest of the line is a comment. A comment delimited by “--” cannot be continued to another line.

To indicate comments in embedded OpenSQL, use the following delimiters:

- “--”, with the same usage rules as interactive OpenSQL.
- Host language comment delimiters. For information about comment delimiters, see the *Embedded SQL Companion Guide*.

Statement Terminators

Statement terminators separate one OpenSQL statement from another. In interactive OpenSQL, the statement terminator is the semicolon (;).

Statements must be terminated with a semicolon when entering two or more OpenSQL statements before issuing the go command (\g), selecting the Go menu item, or issuing some other Terminal Monitor command.

In the following example, the first and second statements are terminated by semicolons. The third statement need not be terminated with a semicolon, because it is the final statement.

```
select * from addrlist;
select * from emp
where fname = 'john';
select * from emp
where mgrname = 'dempsey'\g
```

If only one statement is entered, the statement terminator is not required. For example, the following single statement does not require a semicolon:

```
select * from addrlist\g
```

In embedded OpenSQL applications, the use of a statement terminator is determined by the rules of the host language. For details, see the *Embedded SQL Companion Guide*.

Correlation Names

Correlation names are used in queries to clarify the table (or view) to which a column belongs. For example, the following query uses correlation names to join a table with itself:

```
select a.empname from emp a, emp b
  where a.mgrname = b.empname
    and a.salary > b.salary;
```

Correlation names can also be used to abbreviate long table names.

Specify correlation names in select statements. A single query can reference a maximum of 126 correlation and table names (including all base tables referenced by views specified in a query).

Note: The maximum number of tables referenced in a single query is dependent on the host DBMS. The 126 maximum listed here is for the Ingres DBMS; other DBMSs supported by Enterprise Access and EDBC may have a higher or lower limit.

If a correlation name is not specified, the table name implicitly becomes the correlation name. For example, in the following query:

```
select * from employee
  where salary > 100000;
```

OpenSQL assumes the correlation name, employee, for the salary column and interprets the preceding query as:

```
select * from employee
  where employee.salary > 100000;
```

If a correlation name is specified for a table, the correlation name (and not the actual table name) must be used within the query. For example, the following query generates a syntax error:

```
/*incorrect*/
select * from employee e
where employee.salary > 35000;
```

A correlation name must be unique. For example, the following statement is illegal because the same correlation name is specified for different tables:

```
/*incorrect*/
select e.ename from employee e, manager e
  where e.dept = e.dept;
```

A correlation name that is the same as a table that you own cannot be specified. If you own a table called mytable, the following query is illegal:

```
select * from othertable mytable...;
```

In nested queries, OpenSQL resolves unqualified column names by checking the tables specified in the nearest from clause, then the from clause at the next higher level, and so on, until all table references are resolved.

For example, in the following query, the dno column belongs to the deptsal table, and the dept column to the employee table:

```
select ename from employee
  where salary >
        (select avg(salary) from deptsal
         where dno = dept);
```

Because the columns are specified without correlation names, OpenSQL performs the following steps to determine to which table the columns belong:

Column	Action
dno	OpenSQL checks the table specified in the nearest from clause (the deptsal table). The dno column does belong to the deptsal table. OpenSQL interprets the column specification as deptsal.dno.
dept	OpenSQL checks the table specified in the nearest from clause (deptsal). The dept column does not belong to the deptsal table. OpenSQL checks the table specified in the from clause at the next higher level (the employee table). The dept column does belong to the employee table. OpenSQL interprets the column specification as employee.dept.

OpenSQL does not search across subqueries at the same level to resolve unqualified column names. For example, given the query:

```
select * from employee
  where
    dept = (select dept from sales_departments
             where mgrno=manager)
    or
    dept = (select dept from mktg_departments
             where mgrno=manager_id);
```

OpenSQL checks the description of the sales_departments table for the mgrno and manager columns. If they are not found, OpenSQL checks the employee table next, but will not check the mktg_departments table. Similarly, OpenSQL first checks the mktg_departments table for the mgrno and manager_id columns. If they are not found, OpenSQL will check the employee table, but will never check the sales_departments table.

Chapter 3: OpenSQL Data Types

This chapter describes OpenSQL data types, along with data type storage formats, literals, and OpenSQL constants.

OpenSQL Data Types

The following table lists the OpenSQL data types:

Class	Category	Data Type (Synonyms)
Character	Fixed length	character (char)
	Variable length	varchar (character varying)
		long varchar (clob, character large object, char large object)
Numeric	Exact numeric	integer (integer4, int) smallint (integer2) bigint (integer8) tinyint (integer1) decimal (dec, numeric)
	Approximate numeric	float (float8, double precision) real (float4)
	Abstract	date
		money
	Binary	long byte (blob, binary large object)

Character Data Types

Character data types are strings of ASCII characters. Upper and lower case alphabetic characters are accepted literally. OpenSQL supports one fixed-length character data type, character, and two variable-length character data types, varchar and long varchar.

The maximum size of a character column varies according to the DBMS being accessed. Additional space requirements for character columns are as follows:

- Varchar columns require two additional bytes to store a length specifier.
- Nullable columns require one additional byte to store a null indicator.

Note: Unicode data types are an extended feature of OpenSQL, which means that not all OpenSQL servers support Unicode. If an OpenSQL server supports Unicode, the iidbcapabilities catalog has a row with a cap_capability of NATIONAL_CHARACTER_SET and a cap_value of Y. To see if a particular OpenSQL server supports Unicode, refer to the documentation for that server.

Character

Character strings are fixed-length strings that can contain any printing or non-printing character, and the null character ('\0'). For example, if you enter ABC into a character(5) column, five bytes will be stored, as follows:

'ABC' '

Leading and embedded blanks are significant when comparing character strings. For example, OpenSQL considers the following character strings to be different:

'A B C'
'ABC'

When selecting character strings using the underscore (_) wildcard character of the like predicate, any trailing blanks you want to match must be included. For example, to select the following character string:

'ABC' '

the wildcard specification must also contain trailing blanks:

'____'

Length is not significant when comparing character strings. The shorter string is (logically) padded to the length of the longer. For example, OpenSQL considers the following character strings equal:

'ABC'
'ABC' '

Char is a synonym for character.

Varchar

Varchar strings are variable-length strings, returned to applications as a 2-byte length specifier followed by character data. The varchar data type can contain any character, including non-printing characters and the ASCII null character ('\0').

Blanks are significant in the varchar data type. For example, OpenSQL does not consider the following two varchar strings equal:

'the store is closed'

and

'thestoreisclosed'

If the strings being compared are unequal in length, the shorter string is padded with trailing blanks until it equals the length of the longer string.

For example, the following two varchar strings:

'abcde' and 'abcd'

are compared as

'abcde' and 'abcd '

Long Varchar

The long varchar data type has the same characteristics as the varchar data type, but can accommodate strings up to two GB in length. Do not declare a length for long varchar columns. In embedded SQL *data handlers* can be created, which are routines to read and write the data for long varchar (and long byte) columns. For details about data handlers, see [Data Handlers for Large Objects](#) in the "Embedded SQL" chapter, and the *Embedded SQL Companion Guide*.

Restrictions

The following restrictions apply to long varchar columns:

- They cannot be part of a table key.
- They do not declare a length.
- They cannot be part of a secondary index.
- They cannot be used in the order by or group by clause in a select statement.
- They cannot have query optimization statistics. For details about query optimization statistics, see the discussion of the optimizedb utility in the *Command Reference Guide*.

- The following string functions do not work with long varchar columns:
 - Locate
 - Pad
 - Shift
 - Squeeze
 - Trim
 - Notrim
 - Charextract
- These columns cannot be directly compared to other string data types. To compare a long varchar column to another string data type, apply a coercion function.
- A string literal of more than 2000 characters cannot be assigned to a long varchar column. Details about assigning long strings to these columns are found in the description of data handlers in the *Embedded SQL Companion Guide* or the *OpenAPI User Guide*.

Numeric Data Types

OpenSQL has two categories of numeric data types: *exact* and *approximate*. The exact numeric data types are the integer data types and the decimal data type. The approximate numeric data types are the floating-point data types.

Integer

There are four integer data types:

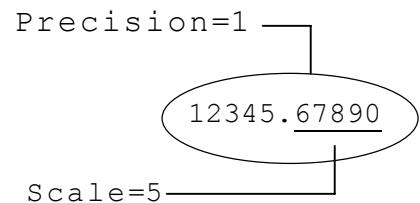
- tinyint (one-byte)
- smallint (two-byte)
- integer (four-byte)
- bigint (eight-byte)

The following table lists the ranges of values for each integer data type:

Integer Data Type	Lowest Possible Value	Highest Possible Value
tinyint (integer1)	-128	+127
smallint (integer2)	-32,768	+32,767
integer (integer4)	-2,147,483,648	+2,147,483,647
bigint (integer8)	-9,223,372,036,854,775,808	+9,223,372,036,854,775,807

Decimal

The decimal data type is an exact numeric data type defined in terms of its *precision* (total number of digits) and *scale* (number of digits to the right of the decimal point). The following figure illustrates precision and scale in decimal values:



The minimum precision for a decimal value is 1 and the maximum is 31. The scale of a decimal value cannot exceed its precision. Scale can be 0 (no digits to the right of the decimal point).

Specify the declaration using the following syntax:

decimal(*p,s*)

where

p=precision

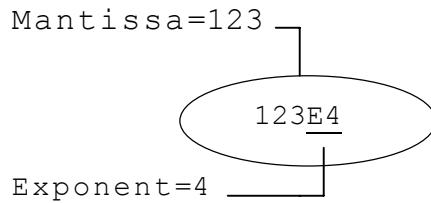
s=scale

Valid synonyms for the decimal data type are dec and numeric.

Note: The decimal data type is suitable for storing currency data. Note that, for display purposes, a currency sign cannot be specified for decimal values.

Floating-point

A floating-point value is represented either as whole plus fractional digits (like decimal values) or as a mantissa plus an exponent. The following figure illustrates the mantissa and exponent parts of floating-point values:



There are two floating-point data types:

- real (4-byte)
- float (8-byte)

Note: Float4 is a synonym for real. Float8 and double precision are synonyms for float.

Floating-point numbers are double-precision quantities stored in four or eight bytes. The range of float values is processor-dependent, and the precision is approximately 16 significant digits.

Specify the precision (number of significant bits) for a floating-point value using the following (optional) syntax:

float(*n*)

where *n* is a value from 0 to 53.

OpenSQL allocates storage according to the precision you specify, depending on the host DBMS and hardware. For information about the correct notation for a floating-point numeric literal, see [Numeric](#) in this chapter.

Abstract Data Types

The abstract data types include the date and money data types.

Date

OpenSQL supports date data types for sessions connected to:

- The Ingres DBMS
- An Enterprise Access product to a host DBMS that supports date data types (for example, DB2 UDB, Oracle, or Rdb)

If the host DBMS supports date data types, the `iidbcapabilities` standard catalog table includes a row where `cap_capability` is set to `OPEN_SQL_DATES`, and `cap_value` is set to `LEVEL 1`.

Tables created in OpenSQL with date columns are mapped to the date format of the host DBMS. For example, OpenSQL date would map to Rdb date and to IBM timestamp.

On input, date constants in queries must be specified using the OpenSQL `date()` function.

OpenSQL supports the following operations on date data:

- Ordering on date columns
- Comparing two date columns
- Comparing a date column to a date constant

Absolute Date Input Formats

Dates are specified as quoted character strings. A date can be entered by itself or together with a time value. For more information about date and time display, see [Date and Time Display Formats](#) in this chapter.

The legal formats for absolute date values are determined by the `II_DATE_FORMAT` setting, summarized in the following table. If `II_DATE_FORMAT` is not set, the US formats are the default input formats. `II_DATE_FORMAT` can be set on a session basis. For information on setting `II_DATE_FORMAT`, see the *System Administrator Guide*.

II_DATE_FORMAT Setting	Valid Input Formats	Output
US (default format)	<i>mm/dd/yy</i> <i>mm/dd/yyyy</i> <i>dd-mmm-yyyy</i> <i>mm-dd-yyyy</i> <i>yyyy.mm.dd</i> <i>yyyy_mm_dd</i> <i>mmddyy</i> <i>mm-dd</i> <i>mm/dd</i>	<i>dd-mmm-yyyy</i>
MULTINATIONAL	<i>dd/mm/yy</i> all US formats except <i>mm/dd/yyyy</i>	<i>dd/mm/yy</i>
ISO	<i>yymmdd</i> <i>yymmdd</i> <i>yyyyymmdd</i> <i>mmd</i> <i>mdd</i> all US input formats except <i>mmddyy</i>	<i>yymmdd</i>
SWEDEN/FINLAND	<i>yyyy-mm-dd</i> all US input formats except <i>mm-dd-yyyy</i>	<i>yyyy-mm-dd</i>
GERMAN	<i>dd.mm.yyyy</i> <i>ddmmyy</i> <i>dmmyy</i> <i>dmmmyyy</i> <i>ddmmyyyy</i> and all US input formats except <i>yyyy.mm.dd</i> and <i>mmddyy</i>	<i>dd.mm.yyyy</i>
YMD	<i>mm/dd</i> <i>yyyy-mm-dd</i> <i>mmd</i> <i>yymdd</i> <i>yymmdd</i> <i>yyyymdd</i> <i>yyyyymmdd</i> <i>yyyy-mmm-dd</i>	<i>yyyy-mmm-dd</i>

II_DATE_FORMAT Setting	Valid Input Formats	Output
DMY	<i>dd/mm</i> <i>dd-mm-yyyy</i> <i>ddmm</i> <i>ddmyy</i> <i>ddmmyy</i> <i>ddmyyyy</i> <i>ddmmyyyy</i> <i>dd-mmm-yyyy</i>	<i>dd-mmm-yyyy</i>
MDY	<i>mm/dd</i> <i>dd-mm-yyyy</i> <i>mddd</i> <i>mddyy</i> <i>mmddyy</i> <i>mddyyyy</i> <i>mmddyyyy</i> <i>mmm-dd-yyyy</i>	<i>mmm-dd-yyyy</i>

Year defaults to the current year. In formats that include delimiters (such as forward slashes or dashes), specify the last two digits of the year. The first two digits default to the current century (2000). For example, if you enter the following date:

'03/21/00'

using the format *mm/dd/yyyy*, OpenSQL assumes that you are referring to March 21, 2000.

In three-character month formats, for example, *dd-mmm-yy*, OpenSQL requires three-letter abbreviations (for example, mar, apr, may).

To specify the current system date, use the constant today. For example:

```
select date('today');
```

To specify the current system time, use the constant now.

Absolute Time Input Formats

The legal format for inputting an absolute time is

'hh:mm[:ss] [am|pm] [timezone]'

Input formats for absolute times are assumed to be on a 24-hour clock. If a time is entered with an am or pm designation, then OpenSQL automatically converts the time to a 24-hour internal representation.

If *timezone* is omitted, OpenSQL assumes the local time zone designation. Times are displayed using the time zone adjustment specified by `II_TIMEZONE_NAME`.

If an absolute time is entered without a date, OpenSQL assumes the current system date.

Combined Date and Time Input

Any valid absolute date input format can be paired with a valid absolute time input format to form a valid date and time entry. The following table shows some examples of valid date and time entries using the US absolute date input formats:

Format	Example
<i>mm/dd/yy hh:mm:ss</i>	11/15/00 10:30:00
<i>dd-mmm-yy hh:mm:ss</i>	15-nov-98 10:30:00
<i>mm/dd/yy hh:mm:ss</i>	11/15/99 10:30:00
<i>dd-mmm-yy hh:mm:ss gmt</i>	15-nov-00 10:30:00 gmt
<i>dd-mmm-yy hh:mm:ss [am pm]</i>	15-nov-98 10:30:00 am
<i>mm/dd/yy hh:mm</i>	11/15/99 10:30
<i>dd-mmm-yy hh:mm</i>	15-nov-00 10:30
<i>mm/dd/yy hh:mm</i>	11/15/98 10:30
<i>dd-mmm-yy hh:mm</i>	15-nov-99 10:30

Date and Time Display Formats

OpenSQL outputs date values as strings of 25 characters with trailing blanks inserted.

To specify the output format of an absolute date and time, `II_DATE_FORMAT` must be set. For a list of `II_DATE_FORMAT` settings and associated formats, see [Absolute Date Input Formats](#) in this chapter. The display format for absolute time is:

hh:mm:ss

OpenSQL displays 24-hour times for the current time zone, which is determined when OpenSQL is installed. Dates are stored in Greenwich Mean Time (GMT) and adjusted for your time zone when they are displayed.

If seconds are omitted when entering a time, OpenSQL displays zeros in the seconds' place.

Money

The money data type is an abstract data type. Money values are stored significant to two decimal places. These values are rounded to their amounts in dollars and cents or other currency units on input and output, and arithmetic operations on the money data type retain two-decimal-place precision.

Money columns can accommodate the following range of values:

\$-999,999,999,999.99 to \$999,999,999,999.99

A money value can be specified as either:

- **A character string literal**—The format for character string input of a money value is `$sddddddddd.dd`. The dollar sign is optional and the algebraic sign(s) defaults to + if not specified. There is no need to specify a cents value of zero (.00).
- **A number**—Any valid integer or floating point number is acceptable. The number is converted to the money data type automatically.

On output, money values display as strings of 20 characters with a default precision of two decimal places. The display format is:

`$[-]ddddddddd.dd`

where:

`$` is the default currency symbol
`d` is a digit from 0 to 9

The following settings affect the display of money data. For details, see the *System Administrator Guide*:

Variable	Description
<code>II_MONEY_FORMAT</code>	Specifies the character displayed as the currency symbol. The default currency sign is the dollar sign (\$). <code>II_MONEY_FORMAT</code> also specifies whether the symbol appears before or after the amount.
<code>II_MONEY_PREC</code>	Specifies the number of digits displayed after the decimal point; valid settings are 0, 1, and 2.

Variable	Description
II_DECIMAL	<p>Specifies the character displayed as the decimal point; the default decimal point character is a period (.). II_DECIMAL also affects FLOAT, FLOAT4, and the DECIMAL data types.</p> <p>Note: If II_DECIMAL is set to comma, be sure that when SQL syntax requires a comma (such as a list of table columns or SQL functions with several parameters), that the comma is followed by a space. For example:</p> <pre>select col1, ifnull(col2, 0), left(col4, 22) from t1;</pre>

Binary Data Types

Binary columns can contain data such as graphic images, which cannot easily be stored using character or numeric data types.

Long Byte

The long byte data type has the same characteristics as the byte varying data type, but can accommodate binary data up to 2 GB in length. In embedded SQL, *data handlers* can be created, which are routines to read and write the data for long byte columns. For details about data handlers, see [Data Handlers for Large Objects](#) in the chapter “Embedded SQL” and the *Embedded SQL Companion Guide*.

Storage Formats of Data Types

The following table lists storage formats for OpenSQL data types:

Notation	Type	Range
character(1) - character(n)	character	<i>n</i> represents the lesser of the maximum configured row size and 32,000.
varchar(1) - varchar(<i>n</i>)	character	<i>n</i> represents the lesser of the maximum configured row size and 32,000.
long varchar	character	A string of 1 to 2 GB characters
tinyint	1-byte integer	-128 to +127

Notation	Type	Range
smallint	2-byte integer	-32,768 to +32,767
integer	4-byte integer	-2,147,483,648 to +2,147,483,647
bigint	8-byte integer	-9,223,372,036,854,775,808 to +9,223,372,036,854,775,807
decimal(<i>p, s</i>)	fixed-point exact numeric	Depends on precision and scale; default is (5,0): -99999 to +99999. Maximum number of digits is 31.
real	4-byte floating	-1.0e+38 to +1.0e+38 (7 digit precision)
float	8-byte floating	-1.0e+38 to +1.0e+38 (16 digit precision)
date	date (12 bytes)	1-jan-0001 to 30-dec-9999
money	money (8 bytes)	\$-999,999,999,999.99 to \$999,999,999,999.99
long byte	binary	1 to 2 GB of binary data

Note: If your hardware supports the IEEE standard for floating-point numbers, then the float type is accurate to 14 decimal precision (\$-ddddddddd.dd to \$+ddddddddd.dd) and ranges from -10**308 to +10**308.

Literals

A literal is an explicit representation of a value. OpenSQL supports two types of literals:

- String
- Numeric

String

String literals are specified by one or more characters enclosed in single quotes. The default data type for string literals is varchar, but a string literal can be assigned to any character data type or to the money or date data types without using a data type conversion function.

To compare a string literal with a non-character data type (A), you must either cast the string literal to the non-character data type A, or cast the non-character data type to the string literal type. Failure to do so may result in unexpected results if the non-character data type contains the 'NUL (0) value.

Quotes in Strings	To include a single quote inside a string literal, it must be doubled. For example: 'The following letter is quoted: ''A''. which evaluates to The following letter is quoted: 'A'.
-------------------	--

Numeric

Numeric literals specify numeric values. There are three types of numeric literals:

- Integer
- Decimal
- Floating-point

A numeric literal can be assigned to any of the numeric data types or the money data type without using an explicit conversion function. OpenSQL automatically converts the literal to the appropriate data type, if necessary.

By default, OpenSQL uses the period (.) to indicate the decimal when needed. This default can be changed by setting II_DECIMAL. For information about setting II_DECIMAL, see the *Database Administrator Guide*.

Note: If II_DECIMAL is set to comma, be sure that when OpenSQL syntax requires a comma (such as a list of table columns or OpenSQL functions with several parameters), that the comma is followed by a space. For example:

```
select col1, ifnull(col2, 0), left(col4, 22) from t1;
```

Integer Literals	Integer literals are specified by a sequence of up to 10 digits and an optional sign, in the following format:
------------------	--

[+|-] digit {digit} [e digit]

Integer literals are represented internally as either an integer or a smallint, depending on the value of the literal. If the literal is within the range -32,768 to +32,767, it is represented as a smallint. If its value is within the range -2,147,483,648 to +2,147,483,647 but outside the range of a smallint, then it is represented as an integer. Values that exceed the range of integers are represented as decimals.

Integers can be specified using a simplified scientific notation, similar to the way floating-point values are specified. To specify an exponent, follow the integer value with the letter "e" and the value of the exponent. This notation is useful for specifying large values. For example, to specify 100,000 use the following exponential notation:

1e5

Decimal Literals

Decimal literals are specified as signed or unsigned numbers of 1 to 31 digits that include a decimal point. The *precision* of a decimal number is the total number of digits, including leading and trailing zeros. The *scale* of a decimal literal is the total number of digits to the right of the decimal point, including trailing zeros. Decimal literals that exceed 31 digits are treated as floating-point values.

Examples of decimal literals are:

```
3.  
-10.  
1234567890.12345  
001.100
```

Floating-point

A floating-point literal must be specified using scientific notation. The format is:

```
[+|-] {digit} [.{digit}] e|E [+|-] {digit}
```

For example:

```
2.3e-02
```

At least one digit must be specified, either before or after the decimal point.

OpenSQL Constants

OpenSQL provides the following constants:

Special Constant	Meaning
now	Current date and time. Specify this constant in quotes only for servers and Enterprise Access products that support the date data type.
null	Indicates a missing or unknown value in a table.
today	Current date. Specify this constant in quotes. Valid only for servers and Enterprise Access products that support the date data type.
user	Effective user for the current session (the host DBMS user identifier, not the operating system user identifier).

These constants can be used in queries and expressions. For example:

```
select date('now');
insert into sales_order
(item_number, clerk, billing_date)
values ('123', user, date('today'));
```

Nulls

A null represents an undefined or unknown value and is specified by the keyword *null*. A null is not the same as a zero, a blank, or an empty string. A null can be assigned to any nullable column when no other value is specifically assigned. More information about defining nullable columns is provided in the Create Table section in the “OpenSQL Statements” chapter.

The `is null` predicate allows nulls to be handled in queries. For details, see [Exists](#) in the “OpenSQL Statements” chapter.

Nulls and Comparisons

Because a null is not a value, it cannot be compared to any other value (including another null value). For example, the following where clause evaluates to false if one or both of the columns is null:

```
where columna = columnb
```

Similarly, the where clause

```
where columna < 10 or columna >= 10
```

is true for all numeric values of columna, but false if columna is null. The one exception, `count()`, is described in the next section.

Nulls and Aggregate Functions

When executing an aggregate function against a column that contains nulls, the function ignores the nulls. This prevents unknown or inapplicable values from affecting the result of the aggregate.

For example, if you apply the aggregate function, `avg()`, to a column that holds the ages of your employees, you want to be sure that any ages that have not been entered in the table are not treated as zeros by the function. This would distort the true average age. If a null is assigned to any missing ages, then the aggregate returns a correct result: the average of all known employee ages.

Aggregate functions, except count(), return null for an aggregate over an empty set, even when the aggregate includes columns that are not nullable (in this case, count() returns 0). In the following example, the select returns null, since there are no rows in test:

```
create table test (col1 integer not null);
select max(col1) as x from test;
```

When specifying a column that contains nulls as a grouping column (that is, in the group by clause) for an aggregate function, OpenSQL considers all nulls in the column as equal for the purposes of grouping. This is the one exception to the rule that nulls are not equal to other nulls. For information about the group by clause, see [The Group By Clause](#) in the “OpenSQL Statements” chapter.

Chapter 4: Elements of OpenSQL Statements

This chapter describes the following elements of OpenSQL statements:

- Functions, operators, and predicates
- Arithmetic operations, assignments, and other basic operations
- Expressions and search conditions in queries

This chapter identifies the differences in syntax between embedded and interactive OpenSQL. If the embedded syntax is dependent on the host language, you are referred to the *Embedded SQL Companion Guide*.

Operators

OpenSQL supports three types of operators:

- Arithmetic
- Comparison
- Logical

Each of these is described in the following sections.

Arithmetic

Arithmetic operators are used to combine numeric expressions arithmetically to form other numeric expressions. Valid OpenSQL arithmetic operators are (in descending order of precedence):

Arithmetic Operator	Description
+ and -	plus, minus (unary)
* and /	multiplication, division (binary)
+ and -	addition, subtraction (binary)

Unary operators group from right to left and binary operators group from left to right. The unary minus (-) can be used to reverse the algebraic sign of a value.

Use parentheses to force the desired order of precedence. For example:

`(job.lowsal + 1000) * 12`

is an expression in which the parentheses force the addition operator (+) to take precedence over the multiplication operator (*).

Comparison

Comparison operators allow you to compare two expressions. OpenSQL includes the following comparison operators:

Operator	Description
=	equal to
<>	not equal to
>	greater than
>=	greater than or equal to
<	less than
<=	less than or equal to

All comparison operators are of equal precedence.

The equal sign (=) also serves as the assignment operator in assignment operations. For details, see [Assignment](#) in this chapter.

Logical

OpenSQL has three logical operators:

- Not (highest precedence)
- And (next precedence)
- Or (lowest precedence)

Parentheses can be used to change the precedence. For example, assume that the following appears in a query:

`exprA or exprB and exprC`

OpenSQL evaluates the above as if it were:

`exprA or (exprB and exprC)`

However, by using parentheses, the order in which OpenSQL evaluates the expressions can be changed. For example:

(exprA or exprB) and exprC

When parenthesized as shown, *(exprA or exprB)* is evaluated first, then the operator is used for that result with *exprC*.

Operations

This section describes the following basic operations that can be performed:

- Assignments
- Arithmetic operations

Assignment

An assignment operation is an operation that places a value in a column or variable. Assignment operations occur during the execution of insert, update, fetch, create table as...select, and embedded select statements.

When an assignment operation occurs, the data types of the assigned value and the receiving column or variable must either be the same or compatible. If the data types are compatible but not the same, OpenSQL performs a default type conversion.

All character data types are compatible with one another. A value from a string can be assigned to a date data item if the value in the string is formatted in a valid OpenSQL date input format. For information about valid input formats, see [Absolute Date Input Formats](#) in the chapter "OpenSQL Data Types."

Money is compatible with all of the numeric and string types.

All numeric types are compatible with one another. For example, assuming that the following table is created:

```
create table emp
(name    character(20),
salary   float not null,
hiredate date not null);
```

then this insert statement

```
insert into emp (name, salary, hiredate)
values ('John Smith', 40000, date('10/12/98'));
```

assigns the varchar string literal, 'John Smith', to the character name column, the integer literal 40000 to the float salary column, and the varchar string literal '10/12/98' to the date column, hiredate.

Other examples of assignments are:

```
update emp set name = 'Mary Smith'  
where name = 'Mary Jones';  
create table emp2 (name2, hiredate2) as  
select name, hiredate from emp;
```

In the following embedded OpenSQL example, the value in the name column is assigned to the variable, name_var, for each row that fulfills the where clause:

```
exec sql select name into :name_var from emp  
where empno = 125;
```

The following sections present some specific guidelines for assignments into each of the general data types, as well as null assignments. In addition, see the *Embedded SQL Companion Guide* for information about which host language data types are compatible with which OpenSQL data types if you are assigning to a host language variable.

Character String

The character and varchar character types are compatible. Any character string can be assigned to any column or variable of character data type. (If an assignment results in truncation, OpenSQL returns a warning.) The result of the assignment depends on the types of the assignment string and the receiving column or variable:

- If a character string is assigned to a varchar column or variable, trailing blanks are trimmed from the character string before it is assigned.
If the length of the receiving string is shorter than the fixed length string, OpenSQL truncates the fixed length string (from the right end) and, if the assignment was to a variable, a warning condition is indicated. For a discussion of the SQLWARN indicators, see the [The SQL Communications Area \(SQLCA\)](#) in the chapter "OpenSQL Features."
- If a string is assigned to a column or variable that is shorter than the fixed-length string, OpenSQL truncates the fixed-length string from the right end. If a fixed-length string is assigned to a fixed-length column or variable that is longer than the fixed-length string, OpenSQL pads it with blanks. If the assignment is to a variable and the string is truncated, a warning is indicated in the SQLCA.

Numeric

Any numeric data type can be assigned to any other numeric data type. In addition, a money value can be assigned to any numeric data type. OpenSQL may truncate leading zeros or all or part of the fractional part of a number if necessary. If it is necessary to truncate the non-fractional part of a value (other than leading zeros), an overflow error results. When a float or decimal value is assigned to an integer column or variable, the fractional part is truncated.

Date

Date values can be assigned to a date column. In addition, a string literal, a string host variable, or a string column value can be assigned to a date column if its value conforms to the valid OpenSQL input formats for dates.

When assigning character strings to date columns in OpenSQL, specify the string using the date() function. For example:

```
insert into transaction_log (employee, trxtime,  
    trxid) values (user, date('now'), 42);
```

When assigning a date value to a character string, OpenSQL converts the date to the standard OpenSQL output date format. For more information about date output formats, see [Date and Time Display Formats](#) in the chapter “OpenSQL Data Types.”

Null

A null can be assigned to a column of any data type if the column was defined as a nullable column. A null can also be assigned to a host language variable if there is an indicator variable associated with the host variable. For more information about indicator variables, see [Indicator Variables](#) in the chapter “Embedded OpenSQL.”

Arithmetic

An arithmetic operation combines two or more expressions using the arithmetic operators to form a resulting numeric expression.

Before performing any arithmetic operation, OpenSQL converts the participating expressions to identical data types. The result is returned as the selected data type. The following sections describe this data type conversion.

Default Type Conversion

When two numeric expressions are combined, the Enterprise Access product converts as necessary to make the data types of the expressions identical and assigns that same data type to the resulting expression. If it is necessary to convert the data type of an expression, the DBMS converts the expression having the data type of lower precedence to that of the higher.

The order of precedence among the numeric data types is, in highest-to-lowest order:

- Money
- Float
- Real
- Decimal
- Integer
- Smallint

For example, when OpenSQL operates on an integer and a floating-point number, the integer is converted to a floating-point number. If OpenSQL operates on two integers of different sizes, the smaller is converted to the size of the larger. All conversions are done before the operation is performed.

The following table summarizes the possible results of numeric combinations:

	smallint	integer	decimal	real	float	money
smallint	integer	integer	decimal	real	float	money
integer	integer	integer	decimal	real	float	money
decimal	decimal	decimal	decimal	real	float	money
real	real	real	real	real	float	money
float	float	float	float	float	float	money
money	money	money	money	money	money	money

For example, for this expression:

`(job.lowsal + 1000) * 12`

the first operator (+) combines a float expression (job.lowsal) with a smallint constant (1000). The result is float. The second operator (*) combines the float expression with a smallint constant (12), resulting in a float expression.

For money data type, if the above table conflicts with Host DBMS default type conversion, Host DBMS default type conversion has higher priority.

Arithmetic Operations on Decimal Data Types

In expressions that combine decimal values and return decimal results, the precision (total number of digits) and scale (number of digits to the right of the decimal point) of the result can be determined, as shown in the following table:

	Precision	Scale
Addition and subtraction	Larger number of fractional digits plus largest number of non-fractional digits + 1 (to a maximum of 31)	Scale of operand having the largest scale
Multiplication	Total of precisions to a maximum of 31	Total of scales to a maximum of 31
Division	31	(31 precision of first operand) + (scale of first operand) (scale of second operand)

For example, in the following decimal addition operation:

1.234 + 567.89

the scale and precision of the result is calculated as follows:

Precision = 7

Calculated as 3 (larger number of fractional digits) + 3 (larger number of non-fractional digits) + 1 = 7

Scale = 3

The first operand has the larger number of digits to the right of the decimal point

Result:

0569.124

Note: If the result of arithmetic using decimal data exceeds the declared precision or scale of the column to which it is assigned, OpenSQL truncates the result and does not issue an error.

Functions

The following sections describe OpenSQL scalar and aggregate functions.

Function Support for Enterprise Access Products

The overall level of function support for each Enterprise Access product is listed in the OPENSQ_L_SCALARS entry of the OpenSQL Standard Catalog Interface catalog. The Standard Catalog Interface catalog is a read-only view built on the system catalog of the underlying DBMS. The OPENSQ_L_SCALARS entry, located in the iidbcapabilities catalog section, can be one of three values: 'NATIVE', 'FULL' or 'LEVEL 1'. The default value is 'NATIVE'. 'NATIVE' indicates only native DBMS scalar functions are supported. 'FULL' indicates full Ingres function support is provided. 'LEVEL 1' indicates *some* mapping of Ingres functions. When OPENSQ_L_SCALARS is set to 'LEVEL 1', an additional table, iigwscalars, is provided which shows support details for individual functions.

To further determine the level of support provided for specific functions, see the documentation for your Enterprise Access product.

Scalar

There are six types of scalar functions:

- Data type conversion
- Numeric
- String
- Date
- Bit-wise
- Random number

The scalar functions require either one or more single-value arguments. In most instances, scalar functions can be nested to any level. Certain restrictions apply when using some Enterprise Access products. For details, see the documentation provided with your Enterprise Access product.

Note: If II_DECIMAL is set to comma, be sure that when OpenSQL syntax requires a comma (such as a list of table columns or OpenSQL functions with several parameters), that the comma is followed by a space.

For example:

```
Select col1, ifnull(col2, 0), left(col4, 22) from t1;
```

Data Type Conversion

The following table lists the data type conversion functions. (When converting decimal values to strings, the length of the result depends on the precision and scale of the decimal column.)

Name	Operand Type	Result Type	Description
byte(<i>expr</i> [, <i>len</i>])	any	byte	Converts the expression to byte binary data. If the optional length argument is specified, the function returns the leftmost <i>len</i> bytes. <i>Len</i> must be a positive integer value that does not exceed the length of the <i>expr</i> argument.
c(<i>expr</i> [, <i>len</i>])	any	c	Converts argument to c string. If the optional length argument is specified, the function returns the leftmost <i>len</i> characters. <i>Len</i> must be a positive integer value that does not exceed the length of the <i>expr</i> string.
char(<i>expr</i> [, <i>len</i>])	any	char	Converts argument to char string. If the optional length argument is specified, the function returns the leftmost <i>len</i> characters. <i>Len</i> must be a positive integer value that does not exceed the length of the <i>expr</i> string.
date(<i>expr</i>)	c, text, char, varchar	date	Converts a c, char, varchar or text string to internal date representation.

Name	Operand Type	Result Type	Description																
decimal(expr [,precision[,scale]])	any except date	decimal	<p>Converts any numeric expression to a decimal value. If <i>scale</i> (number of decimal digits) is omitted, the scale of the result is 0. If <i>precision</i> (total number of digits) is omitted, the precision of the result is determined by the data type of the operand, as follows:</p> <table> <thead> <tr> <th>Operand Datatype</th><th>Default Precision</th></tr> </thead> <tbody> <tr> <td>smallint</td><td>5</td></tr> <tr> <td>integer1</td><td>5</td></tr> <tr> <td>integer</td><td>11</td></tr> <tr> <td>float</td><td>15</td></tr> <tr> <td>float4</td><td>15</td></tr> <tr> <td>decimal</td><td>15</td></tr> <tr> <td>money</td><td>15</td></tr> </tbody> </table> <p>Decimal overflow occurs if the result contains more digits to the left of the decimal point than the specified or default precision and scale can accommodate.</p>	Operand Datatype	Default Precision	smallint	5	integer1	5	integer	11	float	15	float4	15	decimal	15	money	15
Operand Datatype	Default Precision																		
smallint	5																		
integer1	5																		
integer	11																		
float	15																		
float4	15																		
decimal	15																		
money	15																		
dow(expr)	date	c	Converts an absolute date into its day of week (for example, 'Mon,' 'Tue'). The result length is 3.																
float4(expr)	c, char, varchar, text, float, money, decimal, integer1, smallint, integer	float4	Converts the specified expression to float4.																
float8(expr)	c, char, varchar, text, float, money, decimal, integer1, smallint, integer	float	Converts the specified expression to float.																

Name	Operand Type	Result Type	Description
hex(<i>expr</i>)	varchar, char, c, text	varchar	Returns the hexadecimal representation of the argument string. The length of the result is twice the length of the argument, because the hexadecimal equivalent of each character requires two bytes. For example, hex('A') returns '61' (ASCII) or 'C1' (EBCDIC).
int1(<i>expr</i>)	c, char, varchar, text, float, money, decimal, integer1, smallint, integer	integer1	Converts the specified expression to integer1. Decimal and floating-point values are truncated. Numeric overflow will occur if the integer portion of a floating-point or decimal value is too large to be returned in the requested format.
int2(<i>expr</i>)	c, char, varchar, text, float, money, decimal, integer1, smallint, integer	smallint	Converts the specified expression to smallint. Decimal and floating-point values are truncated. Numeric overflow will occur if the integer portion of a floating-point or decimal value is too large to be returned in the requested format.
int4(<i>expr</i>)	c, char, varchar, text, float, money, decimal, integer1, smallint, integer	integer	Converts the specified expression to integer. Decimal and floating-point values are truncated. Numeric overflow will occur if the integer portion of a floating-point or decimal value is too large to be returned in the requested format.
long_byte (<i>expr</i>)	any	long byte	Converts the expression to long byte binary data.
long_varchar (<i>expr</i>)	any	long varchar	Converts the expression to a long varchar.
money(<i>expr</i>)	c, char, varchar, text, float, money, decimal, integer1, smallint, integer	money	Converts the specified expression to internal money representation. Rounds floating-point and decimal values, if necessary.

Name	Operand Type	Result Type	Description
nchar(expr [, len])	any	nchar	Converts argument to nchar unicode string. If the optional length argument is specified, the function returns the leftmost <i>len</i> characters. <i>Len</i> must be a positive integer value that does not exceed the length of the <i>expr</i> string.
nvarchar(expr [, len])	any	nvarchar	Converts argument to nvarchar unicode string. If the optional length argument is specified, the function returns the leftmost <i>len</i> characters. <i>Len</i> must be a positive integer value that does not exceed the length of the <i>expr</i> string.
long_varchar (expr)	c, char, varchar, text, long varchar, long byte	long varchar	Converts the expression to a long varchar.
object_key(expr)	varchar, char, c, text	object_key	Converts the operand to an object_key.
table_key(expr)	varchar, char, c, text	table_key	Converts the operand to a table_key.
text(expr [, len])	any	text	Converts argument to text string. If the optional length argument is specified, the function returns the leftmost <i>len</i> characters. <i>Len</i> must be a positive integer value that does not exceed the length of the <i>expr</i> string.
unhex(expr)	varchar, c, text	varchar	<p>Returns the opposite of the hex function. For example, unhex(x'61626320') returns 'abc' and unhex(x'01204161') returns '\001Aa'.</p> <p>Exceptions can occur when a "c" data type suppresses the display of certain stored characters, or when the output data type differs from the input type.</p> <p>Note: Typically one character is generated for every two hex digits being converted to a printable character. If the hex digit pair being converted does not translate to a printable character, then the value is converted to a backslash (\), followed by the numeric value of the hex digit pair as a three-digit octal value.</p>

Name	Operand Type	Result Type	Description
varbyte(expr [, len])	any	byte varying	Converts the expression to byte varying binary data. If the optional length argument is specified, the function returns the leftmost <i>len</i> bytes. <i>Len</i> must be a positive integer value that does not exceed the length of the <i>expr</i> argument.
varchar(expr [, len])	any	varchar	Converts argument to varchar string. If the optional length argument is specified, the function returns the leftmost <i>len</i> characters. <i>Len</i> must be a positive integer value that does not exceed the length of the <i>expr</i> string.

If the optional length parameter is omitted, the length of the result returned by the data type conversion functions *c()*, *char()*, *varchar()*, and *text()* are as follows:

Data Type or Argument	Result Length
byte	Length of operand
byte varying	Length of operand
c	Length of operand
char	Length of operand
date	25 characters
decimal	Depends on precision and scale of column
float & float4	11 characters; 12 characters on IEEE computers
integer1 (smallint)	6 characters
integer	6 characters
integer4	13 characters
long varbyte	Length of operand
long varchar	Length of operand
money	20 characters
text	Length of operand
varchar	Length of operand

Numeric

OpenSQL supports the numeric functions listed in the following table:

Name	Operand Type	Result Type	Description
<code>abs(<i>n</i>)</code>	all numeric types and money	same as <i>n</i>	Absolute value of <i>n</i> .
<code>atan(<i>n</i>)</code>	all numeric types	float	Arctangent of <i>n</i> ; returns a value from $(-\pi/2)$ to $\pi/2$.
<code>cos(<i>n</i>)</code>	all numeric types	float	Cosine of <i>n</i> ; returns a value from -1 to 1.
<code>exp(<i>n</i>)</code>	all numeric types and money	float	Exponential of <i>n</i> .
<code>log(<i>n</i>)</code> <code>ln(<i>n</i>)</code>	all numeric types and money	float	Natural logarithm of <i>n</i> .
<code>mod(<i>n,b</i>)</code>	integer, smallint, integer1, decimal	same as <i>b</i>	<i>n</i> modulo <i>b</i> . The result is the same data type as <i>b</i> . Decimal values are truncated.
<code>power(<i>x,y</i>)</code>	all numeric types	float	<i>x</i> to the power of <i>y</i> (identical to <i>x</i> $\text{** } y$)
<code>sin(<i>n</i>)</code>	all numeric types	float	Sine of <i>n</i> ; returns a value from -1 to 1.
<code>sqrt(<i>n</i>)</code>	all numeric types and money	float	Square root of <i>n</i> .

For trigonometric functions (`atan()`, `cos()`, and `sin()`), specify arguments in radians. To convert degrees to radians, use the following formula:

`radians = degrees/360 * 2 * pi`

To obtain a tangent, divide `sin()` by `cos()`.

String

String functions perform a variety of operations on character data. String functions can be nested. For example:

```
left(right(x.name, size(x.name) - 1), 3)
```

returns the substring of x.name from character positions 2 through 4, and
concat(concat(x.lastname, ', '), x.firstname)

concatenates x.lastname with a comma and then concatenates x.firstname with the first concatenation result. The **+** operator can also be used to concatenate strings:

```
x.lastname + ', ' + x.firstname
```

The following string functions do not accept long varchar or long byte columns:

- Locate
- Pad
- Shift
- Squeeze
- Trim
- Notrim
- Charextract

To apply any of the preceding functions to a long varchar or long byte column, first coerce the column to an acceptable data type. For example:

```
squeeze(varchar(long_varchar_column))
```

If a coercion function is applied to a long varchar or long byte value that is longer than 2008 characters or bytes, the result is truncated to 2008 characters or bytes.

The following table lists the string functions supported in OpenSQL. The expressions *c1* and *c2*, representing the arguments, can be any of the string types, except where noted. The expressions *len* and *nshift* represent integer arguments.

Name	Result Type	Description
charextract(<i>c1,n</i>)	char	Returns the <i>n</i> th byte of <i>c1</i> . If <i>n</i> is larger than the length of the string, then the result is a blank character.
concat(<i>c1,c2</i>)	any character data type, byte	Concatenates one string to another. The result size is the sum of the sizes of the two arguments. If the result is a c or char string, it is padded with blanks to achieve the proper length. To determine the data type results of concatenating strings, see the table regarding results of string concatenation.
left(<i>c1,len</i>)	any character data type	Returns the leftmost <i>len</i> characters of <i>c1</i> . If the result is a fixed-length c or char string, it is the same length as <i>c1</i> , padded with blanks. The result format is the same as <i>c1</i> .
length(<i>c1</i>)	smallint (for long varchar, returns 4-byte integer)	If <i>c1</i> is a fixed-length c or char string, returns the length of <i>c1</i> without trailing blanks. If <i>c1</i> is a variable-length string, returns the number of characters actually in <i>c1</i> .
locate(<i>c1,c2</i>)	smallint	Returns the location of the first occurrence of <i>c2</i> in <i>c1</i> , including trailing blanks from <i>c2</i> . The location is in the range 1 to size(<i>c1</i>). If <i>c2</i> is not found, the function returns size(<i>c1</i>) + 1. The function size() is described below, in this table. If <i>c1</i> and <i>c2</i> are different string data types, <i>c2</i> is coerced into the <i>c1</i> data type.
lowercase(<i>c1</i>) or lower(<i>c1</i>)	any character data type	Converts all upper case characters in <i>c1</i> to lower case.
pad(<i>c1</i>)	text or varchar	Returns <i>c1</i> with trailing blanks appended to <i>c1</i> ; for instance, if <i>c1</i> is a varchar string that could hold fifty characters but only has two characters, then pad(<i>c1</i>) appends 48 trailing blanks to <i>c1</i> to form the result.

Name	Result Type	Description
right($c1, len$)	any character data type	Returns the rightmost len characters of $c1$. Trailing blanks are not removed first. If $c1$ is a fixed-length character string, the result is padded to the same length as $c1$. If $c1$ is a variable-length character string, no padding occurs. The result format is the same as $c1$.
shift($c1, nshift$)	any character data type	Shifts the string $nshift$ places to the right if $nshift > 0$ and to the left if $nshift < 0$. If $c1$ is a fixed-length character string, the result is padded with blanks to the length of $c1$. If $c1$ is a variable-length character string, no padding occurs. The result format is the same as $c1$.
size($c1$)	smallint	Returns the <i>declared size</i> of $c1$ without removal of trailing blanks.
soundex($c1$)	any character data type	<p>Returns a $c1$ four-character field that can be used to find similar sounding strings. For example, SMITH and SMYTHE produce the same soundex code. If there are less than three characters, the result is padded by trailing zero(s). If there are more than three characters, the result is achieved by dropping the rightmost digit(s).</p> <p>This function is useful for finding like-sounding strings quickly. A list of similar sounding strings can be shown in a search list rather than just the next strings in the index.</p>

Name	Result Type	Description
<code>squeeze(<i>c1</i>)</code>	text or varchar	<p>Compresses white space. White space is defined as any sequence of blanks, null characters, newlines (line feeds), carriage returns, horizontal tabs and form feeds (vertical tabs). Trims white space from the beginning and end of the string, and replaces all other white space with single blanks.</p> <p>This function is useful for comparisons. The value for <i>c1</i> must be a string of variable-length character string data type (not fixed-length character data type). The result is the same length as the argument.</p>
<code>substring(<i>c1</i> from <i>loc</i>[FOR <i>len</i>])</code>	varchar	Selects part of <i>c1</i> starting at the <i>loc</i> position and either extending to the end of the string or for the number of characters in the <i>len</i> operand. The result format is a varchar the size of <i>c1</i> .
<code>substring(<i>c1</i> from <i>n1</i> [for <i>n2</i>])</code>	varchar or nvarchar	Returns a substring of parameter <i>c1</i> starting at offset <i>n1</i> . If <i>n2</i> is specified, the resulting string is $\min(n2, \text{length}(c1)-n1)$ in length. If <i>n1</i> is 0 or negative, the resulting substring starts with the 1 st byte of <i>c1</i> . If <i>n1</i> > $\text{length}(c1)$, the resulting string has length 0. If <i>n2</i> is negative, an error is returned.
<code>trim(<i>c1</i>)</code>	text or varchar	Returns <i>c1</i> without trailing blanks. The result has the same length as <i>c1</i> .
<code>notrim(<i>c1</i>)</code>	any character string variable	Retains trailing blanks when placing a value in a varchar column. This function can only be used in an embedded OpenSQL program. For more information, see the <i>Embedded SQL Companion Guide</i> .
<code>uppercase(<i>c1</i>)</code> or <code>upper(<i>c1</i>)</code>	any character data type	Converts all lower case characters in <i>c1</i> to upper case.

String Concatenation Results

The following table shows the results of concatenating expressions of various character data types:

1st String	2nd String	Trim Blanks		Result Type
		from 1st?	from 2nd?	
c	c	Yes	--	c
c	text	Yes	--	c
c	char	Yes	--	c
c	varchar	Yes	--	c
c	long varchar	Yes	No	long varchar
text	c	No	--	c
char	c	Yes	--	c
varchar	c	No	--	c
long varchar	c	No	No	long varchar
text	text	No	No	text
text	char	No	Yes	text
text	varchar	No	No	text
text	long varchar	No	No	long varchar
char	text	Yes	No	text
varchar	text	No	No	text
long varchar	text	No	No	long varchar
char	char	No	--	char
char	varchar	No	--	char
char	long varchar	No	No	long varchar
varchar	char	No	--	char
long varchar	char	No	No	long varchar
varchar	varchar	No	No	varchar
long varchar	long varchar	No	No	long varchar

When concatenating more than two operands, expressions are evaluated from left to right. For example:

varchar + char + varchar

is evaluated as:

(varchar+char)+varchar

To control concatenation results for strings with trailing blanks, use the trim, notrim, and pad functions.

Date

OpenSQL supports functions that derive values from absolute dates and from interval dates. These functions operate on columns that contain date values. An additional function, dow(), returns the day of the week (mon, tue, and so on) for a specified date. For a description of the dow() function, see [Data Type Conversion](#) in this chapter.

Some date functions require you to specify a unit parameter; unit parameters must be specified using a quoted string. The following table lists valid unit parameters:

Date Portion	How Specified
Second	second, seconds, sec, secs
Minute	minute, minutes, min, mins
Hour	hour, hours, hr, hrs
Day	day, days
Week	week, weeks, wk, wks
ISO-Week	iso-week, iso-wk
Month	month, months, mo, mos
Quarter	quarter, quarters, qtr, qtrs
Year	year, years, yr, yrs

The following table lists the date functions:

Name	Format (Result)	Description
date_trunc(<i>unit</i> , <i>date</i>)	date	Returns a date value truncated to the specified <i>unit</i> .
date_part(<i>unit</i> , <i>date</i>)	integer	Returns an integer containing the specified (<i>unit</i>) component of the input date.

Name	Format (Result)	Description
date_gmt(<i>date</i>)	any character data type	<p>Converts an absolute date into the Greenwich Mean Time character equivalent with the format <i>yyyy_mm_dd hh:mm:ss</i> GMT. If the absolute date does not include a time, the time portion of the result is returned as 00:00:00.</p>
		<p>For example, the query:</p>
		<pre>select date_gmt('1-1-98 10:13 PM PST')</pre>
		<p>returns the following value:</p>
		<p>1998_01_01 06:13:00 GMT</p>
		<p>while the query:</p>
		<pre>select date_gmt('1-1-1998')</pre>
		<p>returns:</p>
		<p>1998_01_01 00:00:00 GMT</p>
gmt_timestamp(<i>s</i>)	any character data type	<p>Returns a twenty-three-character string giving the date <i>s</i> seconds after January 1, 1970 GMT. The output format is '<i>yyyy_mm_dd hh:mm:ss</i> GMT'.</p>
		<p>For example, the query:</p>
		<pre>select (gmt_timestamp (1234567890))</pre>
		<p>returns the following value:</p>
		<p>2009_02_13 23:31:30 GMT</p>
		<p>while the query:</p>
		<pre>(II_TIMEZONE_NAME = AUSTRALIA_ QUEENSLAND)</pre>
		<pre>select date(gmt_timestamp (1234567890))</pre>
		<p>returns:</p>
		<p>14-feb-2009 09:31:30</p>
interval (<i>unit,date_interval</i>) float		<p>Converts a date interval into a floating-point constant expressed in the unit of measurement specified by <i>unit</i>. The interval function assumes that there are 30.436875 days per month and 365.2425 days per year when using the mos, qtrs, and yrs specifications.</p>
		<p>For example, the query:</p>
		<pre>select(interval('days', '5 years'))</pre>
		<p>returns the following value:</p>
		<p>1826.213</p>
		<p>This function is not supported for the Oracle and MS SQL Enterprise Access products.</p>

Name	Format (Result)	Description
<code>_date(s)</code>	any character data type	<p>Returns a nine-character string giving the date <i>s</i> seconds after January 1, 1970 GMT. The output format is <i>dd-mmm-yy</i>.</p> <p>For example, the query:</p> <pre>select _date(123456)</pre> <p>returns the following value:</p> <p>2-jan-70</p>
<code>_date4(s)</code>	any character data type	<p>Returns an eleven-character string giving the date <i>s</i> seconds after January 1, 1970 GMT. The output format is controlled by the II_DATE_FORMAT setting.</p> <p>For example, with II_DATE_FORMAT set to US, the query:</p> <pre>select _date4(123456)</pre> <p>returns the following value:</p> <p>02-jan-1970</p> <p>while with II_DATE_FORMAT set to MULTINATIONAL, the query:</p> <pre>select _date4(123456)</pre> <p>returns this value:</p> <p>02/01/1970</p>
<code>_time(s)</code>	any character data type	<p>Returns a five-character string giving the time <i>s</i> seconds after January 1, 1970 GMT. The output format is <i>hh:mm</i> (seconds are truncated).</p> <p>For example, the query:</p> <pre>select _time(123456)</pre> <p>returns the following value:</p> <p>02:17</p>

Using Date_trunc

Use the date_trunc function to group all the dates in the same month or year, and so forth. For example:

```
date_trunc('month',date('23-oct-1998 12:33'))
```

returns 1-oct-1998, and

```
date_trunc('year',date('23-oct-1998'))
```

returns 1-jan-1998.

Truncation takes place in terms of calendar years and quarters (1-jan, 1-apr, 1-jun, and 1-oct).

To truncate in terms of a fiscal year, offset the calendar date by the number of months between the beginning of your fiscal year and the beginning of the next calendar year (6 mos for a fiscal year beginning July 1, or 4 mos for a fiscal year beginning September 1):

```
date_trunc('year',date+'4 mos') - '4 mos'
```

Weeks start on Monday. The beginning of a week for an early January date may fall into the previous year.

Using Date_part

This function is useful in set functions and in assuring correct ordering in complex date manipulation. For example, if date_field contains the value 23-oct-1998, then:

```
date_part('month',date(date_field))
```

returns a value of 10 (representing October), and

```
date_part('day',date(date_field))
```

returns a value of 23.

Months are numbered 1 to 12, starting with January.

Hours are returned according to the 24-hour clock.

Quarters are numbered 1 through 4.

Week 1 begins on the first Monday of the year. Dates before the first Monday of the year are considered to be in week 0. However, if you specify ISO-Week, which is ISO 8601 compliant, the week begins on Monday, but the first week is the week that has the first Thursday. The weeks are numbered 1 through 53.

Therefore, if you are using Week and the date falls before the first Monday in the current year, date_part returns 0. If you are using ISO-Week and the date falls before the week containing the first Thursday of the year, that date is considered part of the last week of the previous year, and date_part returns either 52 or 53.

The following table illustrates the difference between Week and ISO-Week:

Date Column	Day of Week	Week	ISO-Week
02-jan-1998	Fri	0	1
04-jan-1998	Sun	0	1
02-jan-1999	Sat	0	53
04-jan-1999	Mon	1	1
02-jan-2000	Sun	0	52
04-jan-2000	Tue	1	1
02-jan-2001	Tue	1	1
04-jan-2001	Thu	1	1

Bit-wise

Bit-wise functions operate from right to left, with shorter operands padded with hex zeroes to the left. Each result is a byte field the size of the longer operand, except `bit_not`, which takes a single byte operand and returns the same-sized operand.

There are six external bit-wise functions:

- **bit_add** – The logical "add" of two byte operands; any overflow is disregarded.
- **bit_and** – The logical "and" of two byte operands. For example, if two bits are 1, then the answer is 1, otherwise the answer is 0.
- **bit_not** – The logical "not" of two byte operands.
- **bit_or** – The logical "or" of two byte operands. For example, if either or both bits are 1, then the answer is 1.
- **bit_xor** – The logical "xor" of two byte operands. For example, if either bit is 1, then the answer is 1.
- **intextract (byte,int)** – Similar to `charextract`. Returns the nth byte of `b1` as an integer. If `n` is larger than `b1`, then 0 is returned.

Hash

This function is used to generate a four-byte numeric value from expressions of all data types except long data types. Note that the implicit size for the expression can affect the result. For example:

```
select hash(1), hash(int1(1)), hash(int2(1)), hash(int4(1))\g
```

returns the following single row:

Col1	Col2	Col3	Col4
-920527466	1526341860	-920527466	-1447292811

Note: Since the constant 1 is implicitly a short integer, only the return values for Hash(1) and Hash(int2(1)) match. For the remaining columns, the difference in the number of bytes holding the integer leads to a different hash value. Also note that the generated hash value is not guaranteed unique, even if the input values are unique. The hash function is not supported for Enterprise Access products.

Random Number

The random number function is used to generate random values. Use the following statement to set the beginning value for the random functions:

```
[exec sql] set random_seed [value]
```

There is a global seed value and local seed values. The global value is used until you issue “set random_seed,” which changes the value of the local seed. Once changed, the local seed is used for the whole session. If you are using the global seed value, the seed is changed whenever a random function executes. This means that other users issuing random calls will enhance the “randomness” of the returned value. Note that the seed value can be any integer.

If you omit the value, then Ingres multiplies the process ID by the number of seconds past 1/1/1970 until now. This value generates a random starting point. You can use *value* to run a regression test from a static start and get identical results.

There are four random number functions:

- `random()` - Returns a random integer based on a seed value.
- `randomf()` - Returns a random float based on a seed value between 0 and 1. This is slower than `random`, but produces a more random number.
- `random(l,h)` - Returns a random integer in the specified range (that is, $l \geq x \leq h$).

- `randomf(l,h)` – Passing two integer values generates an integer result in the specified range; passing two floats generates a float in the specified range; passing an int and a float causes them to be coerced to an int and generates an integer result in the specified range (that is, $l \geq x \leq h$).

Aggregate

Aggregate functions include the following:

- Unary
- Binary
- Count

The types are described in the following sections.

Unary Aggregate Functions

A unary aggregate function returns a single value based on the contents of a column. Aggregate functions are also called *set* functions.

Note: For OpenROAD users, aggregate functions used within OpenROAD can only be coded inside SQL statements.

The following example uses the sum aggregate function to calculate the total of salaries for employees in department 23:

```
select sum (employee.salary)
      from employee
     where employee.dept = 23;
```

The following table lists SQL aggregate functions:

Name	Result Data Type	Description
any	integer	Returns 1 if any row in the table fulfills the where clause, or 0 if no rows fulfill the where clause.
avg	float, money, date (interval only)	Average (sum/count) The sum of the values must be within the range of the result data type.
count	integer	Count of non-null occurrences
max	same as argument	Maximum value
min	same as argument	Minimum value

Name	Result Data Type	Description
sum	integer, float, money, date (interval only)	Column total
stddev_pop	float	Compute the population form of the standard deviation (square root of the population variance of the group).
stddev_samp	float	Computes the sample form of the standard deviation (square root of the sample variance of the group).
var_pop	float	Computes the population form of the variance (sum of the squares of the difference of each argument value in the group from the mean of the values, divided by the count of the values).
var_samp	float	Computes the sample form of the variance (sum of the squares of the difference of each argument value in the group from the mean of the values, divided by the count of the values minus 1).

The general syntax of an aggregate function is as follows:

*function_name ([**distinct** | **all**] *expr*)*

where *function_name* denotes an aggregate function and *expr* denotes any expression that does not include an aggregate function reference (at any level of nesting).

To eliminate duplicate values, specify **distinct**. To retain duplicate values, specify **all** (this is the default.) **Distinct** is not meaningful with the functions **min** and **max**, because these functions return single values (and not a set of values).

Nulls are ignored by the aggregate functions, with the exception of **count**, as described in **The Count Function and Nulls** in this chapter.

Binary Aggregate Functions

Ingres supports a variety of binary aggregate functions that perform a variety of regression and correlation analysis.

For all of the binary aggregate functions, the first argument is the independent variable and the second argument is the dependent variable.

The following table lists binary aggregate functions:

Name	Result Data Type	Description
regr_count	integer	Count of rows with non-null values for both dependent and independent variables.
covar_pop	float	Population covariance (sum of the products of the difference of the independent variable from its mean, times the difference of the dependent variable from its mean, divided by the number of rows).
covar_samp	float	Sample covariance (sum of the products of the difference of the independent variable from its mean, times the difference of the dependent variable from its mean, divided by the number of rows minus 1).
corr	float	Correlation coefficient (ratio of the population covariance divided by the product of the population standard deviation of the independent variable and the population standard deviation of the dependent variable).
regr_r2	float	Square of the correlation coefficient.
regr_slope	float	Slope of the least-squares-fit linear equation determined by the (independent variable, dependent variable) pairs.
regr_intercept	float	Y-intercept of the least-squares-fit linear equation determined by the (independent variable, dependent variable) pairs.
regr_sxx	float	Sum of the squares of the independent variable.

Name	Result Data Type	Description
regr_syy	float	Sum of the squares of the dependent variable.
regr_sxy	float	Sum of the product of the independent variable and the dependent variable.
regr_avgx	float	Average of the independent variables.
regr_avgy	float	Average of the dependent variables.

Count(*) Function

Count can take the wildcard character, *, as an argument. This character is used to count the number of rows in a result table, including rows that contain nulls. For example, the statement:

```
select count(*)
  from employee
  where dept = 23;
```

counts the number of employees in department 23. The asterisk (*) argument cannot be qualified with all or distinct.

Because count(*) counts rows rather than columns, count(*) does not ignore nulls. Consider the following table:

Name	Exemptions
Smith	0
Jones	2
Tanghetti	4
Fong	Null
Stevens	Null

Running

count(exemptions)

returns the value of 3, whereas

count(*)

returns 5.

Except count, if the argument to an aggregate function evaluates to an empty set, the function returns a null. The count function returns a zero.

Aggregate Functions and Decimal Data

Given decimal arguments, aggregate functions (with the exception of count) return decimal results.

The following table explains how to determine the scale and precision of results returned for aggregates with decimal arguments:

Name	Precision of Result	Scale of Result
count	Not applicable	Not applicable
sum	31	Same as argument
avg	31	Scale of argument + 1 (to a maximum of 31)
max	Same as argument	Same as argument
min	Same as argument	Same as argument

Using Group By Clause with Aggregate Functions

The group by clause allows aggregate functions to be performed on subsets of the rows in the table. The subsets are defined by the group by clause. For example, the following statement selects rows from a table of political candidates, groups the rows by party, and returns the name of each party and the average funding for the candidates in that party.

```
select party, avg(funding)
  from candidates
 group by party;
```

Restrictions on the Use of Aggregate Functions

The following restrictions apply to the use of aggregate functions:

- Aggregate functions cannot be nested.
- Aggregate functions can only be used in select or having clauses.
- If a select or having clause contains an aggregate function, columns not specified in the aggregate must be specified in the group by clause. For example:

```
select dept, avg(emp_age)
  from employee
 group by dept;
```

The above select statement specifies two columns, dept and emp_age, but only emp_age is referenced by the aggregate function, avg. The dept column is specified in the group by clause.

Ifnull Function

The ifnull function specifies a value other than a null that is returned to your application when a null is encountered. The ifnull function is specified as follows:

ifnull(v1,v2)

If the value of the first argument is not null, ifnull returns the value of the first argument. If the first argument evaluates to a null, ifnull returns the second argument.

For example, the sum, avg, max, and min aggregate functions return a null if the argument to the function evaluates to an empty set. To receive a value instead of a null when the function evaluates to an empty set, use the ifnull function, as in this example:

```
ifnull(sum(employee.salary)/25, -1)
```

Ifnull returns the value of the expression sum(employee.salary)/25 unless that expression is null. If the expression is null, the ifnull function returns -1.

Note that if an attempt is made to use the ifnull function with data types that are not nullable, such as system_maintained logical keys, a runtime error is returned.

Note: If II_DECIMAL is set to comma, be sure that when SQL syntax requires a comma (such as a list of table columns or SQL functions with several parameters), that the comma is followed by a space. For example:

```
select col1, ifnull(col2, 0), left(col4, 22) from t1;
```

Data Type of Result

If the arguments are of the same data type, the result is of that data type. If the two arguments are of different data types, they must be of comparable data types.

When the arguments are of different but comparable data types, the DBMS Server uses the following rules to determine the data type of the result:

- The result type is always the higher of the two data types; the order of precedence of the data types is as follows:

date > money > float4 > float > decimal > integer >
smallint > integer1

and

c > text > char > varchar > long varchar > byte >
byte varying > long byte

- The result length is taken from the longest value. For example:
`ifnull (varchar (5), c10)`
results in `c10`.

The result is nullable if either argument is nullable. The first argument is not required to be nullable, though in most applications it is nullable.

Ifnull and Decimal Data

If both arguments are decimal, the data type of the result returned by `ifnull` is decimal, and the precision (total number of digits) and scale (number of digits to the right of the decimal point) of the result is determined as follows:

- **Precision**—The largest number of digits to the left of the decimal point (precision - scale) plus largest scale (to a maximum of 31).
- **Scale**—The largest scale.

UUID

A Universal Unique Identifier (UUID) is a 128 bit, unique identifier generated by the local system. It is unique across both space and time with respect to the space of all UUIDs.

Benefits of Using a UUID

No centralized authority is responsible for assigning UUIDs. They can be generated on demand (10 million per second per machine if needed).

A UUID can be used for multiple purposes:

- Tagging objects that have a brief life
- Reliably identifying persistent objects across a network
- Assigning as unique values to transactions as transaction IDs in a distributed system

UUIDs are fixed-sized (128-bits), which is small relative to other alternatives. This fixed small size lends itself well to sorting, ordering, and hashing of all sorts, sorting in databases, simple allocation, and ease of programming.

The basic format of a unique 128-bits (16 octets) UUID:

Field	Data Type	Octet Number	Note
time_low	unsigned 32 bit integer	0-3	The low field of the timestamp.
time_mid	unsigned 16 bit integer	4-5	Time middle field of the timestamp.
time_hi_and_version	unsigned 16 bit integer	6-7	The high field of the timestamp multiplex with the release number.
clock_seq_hi_and_reserved	unsigned 8 bit integer	8	The high field of the clock sequence multiplex with the variant.
clock_seq_low	unsigned 8 bit integer	9	The low field of the clock sequence.
node	unsigned 48 bit integer	10-15	The spatially unique node identifier.

Ingres implements the following SQL procedures to create, convert and compare UUIDs:

- `uuid_create()`;
- `uuid_to_char(u)`;
- `uuid_from_char(c)`;
- `uuid_compare(uuid1, uuid2)`;

`uuid_create()` Creates a 128 bit UUID.

Example:

```
> createdb uiddb
> sql uiddb
* create table uidtable (u1 byte (16), u2 byte(16)); \g
* insert into uidtable values (uuid_create(), uuid_create())\g
//
// verify length in byte format
//
* select length(u1) from uidtable;\g

P,.,,T
.col1
5,.,,6
.
16.
F,.,,G
```

Length returned equals 16 bytes.

`uuid_to_char(u)` Converts a generated UUID into its character representation.

Example:

```
* select uuid_to_char(u1) from uidtable;\g
```

```

P,,,,,,,,,,T
.col1
5,,,,,,,,,,6
.2dd33cd2-b358-01d5-bf8d-00805fc13ce5.
F,,,,,,,,,,G

//
// verify length of  UUID in  character format.
//
* select length(uuid_to_char(u1))  from uuidtable\g

P,,,T
.col1
5,,,6
.      36.
F,,,G

```

A UUID contains 36 characters.

uuid_from_char(c) Converts a generated UUID from character representation into byte representation.

Example:

```

//
// Inserts a generated UUID in character format.
//

* insert into uuidtochar values ();\g

* select * from  uuidtochar;\g

P,,,,,,,,,,T
.c1
5,,,,,,,,,,6
.f703c440-b35c-01d5-8637-00805fc13ce5.
F,,,,,,,,,,G

//
// converts  UUID into byte representation
//
* select uuid_from_char (u1) from uuidtochar;\g

P,,,,,T
.col1
5,,,,,6
.æ\003Ã@³\\001ð\2067\221\0134;\221\013.
F,,,,,G

```

uuid_compare(uuid1, uuid2) Upon completion, returns an integer value of:

RETURN	MEANING
(-1)	uuid1 < uuid2
(0)	uuid1 == uuid2
(+1)	uuid1 > uuid2

* select uuid_compare(u1,u2) from uuidtable\g

```

P,,,T
.col1
5,,,6
.
.
.
F,,,G

```

UUID Usage

A UUID can be used to tag records to ensure that the database records are uniquely identified regardless of which database they are stored in, for example, in a system where there are two separate physical databases containing accounting data from two different physical locations.

Expressions

Expressions are composed of various operators and operands that evaluate to either a single value or a set of values. Some expressions do not use operators. For example, a column name is an expression. Constants are expressions also. Expressions are used in many contexts, such as specifying values to be retrieved (in a select clause) or compared (in a where clause). For example:

```

select empname, empage from employee
      where salary      <String `75000'>  >

```

In this example, empname and empage are expressions representing the column values to be retrieved, salary is an expression representing a column value to be compared, and 75000 is an integer literal expression.

An expression can be enclosed in parentheses, such as ('J. J. Jones'), without affecting its meaning.

Predicates

Predicates are keywords that specify a relationship between two expressions:

expression_1 predicate expression_2

OpenSQL supports the following types of predicates:

- [not] like
- [not] between
- [not] in
- all | any | some

- exists
- is [not] null

The second expression can be a subquery. If the subquery does not return any rows, then the comparison evaluates to false. For details about subqueries, see [Subqueries](#) in this chapter.

Note: The is null predicate is the only predicate that can be used with long varchar and long byte data.

Like

The like predicate performs pattern matching for the character data types (character and varchar). The like predicate has the following syntax:

`expression [not] like pattern [escape escape_character]`

The expression can be a column name or an expression involving string functions.

The *pattern* parameter must be a string literal. The pattern- matching (wild card) characters are the percent sign (%) to denote 0 or more arbitrary characters, and the underscore (_) to denote exactly one arbitrary character.

The like predicate does not handle trailing blanks. If matching a character data type or if the value has user-inserted trailing blanks, these trailing blanks must be included in your pattern. For example, if you are searching a character(10) column for any rows that have the name harold, use the following syntax for the like predicate:

```
name like 'harold      '
```

Four blanks are added to the pattern after the name in order to include the trailing blanks.

Because blanks are not significant when performing comparisons of c data types, the like predicate will return a correct result regardless of whether trailing blanks are included in the pattern.

If the escape clause is specified, the escape character suppresses any special meaning for the following character, allowing the character to be entered literally. The following characters can be escaped:

- The pattern matching characters % and _.
- The escape character itself. To enter the escape character literally, type it twice.
- Brackets []. In escaped brackets ([and]), specify a series of individual characters or a range of characters separated by a dash (-).

The following examples illustrate some uses of the pattern matching capabilities of the like predicate:

To match any string starting with 'a':

```
name like 'a%'
```

To match any string starting with A through Z:

```
name like '\[A-Z\]%' escape '\'
```

To match any two characters followed by '25%':

```
name like '__25\%' escape '\'
```

To match a string starting with a backslash:

```
name like '\%'
```

Because there is no escape clause, the backslash is taken literally.

To match a string starting with a backslash and ending with a percent:

```
name like '\%\%' escape '\'
```

To match any string starting with 0 through 4, followed by an uppercase letter, then a [, any two characters and a final]:

```
name like '\[01234\]\[A-Z\]\[__\]' escape '\'
```

To detect names starting with 'S' and ending with 'h', disregarding any leading or trailing spaces:

```
trim(name) like 'S%h'
```

To detect a single quote, the quote must be repeated:

```
name like ' '' '
```

Between

The following table explains the operators between and not between:

Operator	Meaning
$y \text{ between } x \text{ and } z$	$x \leq y \text{ and } y \leq z$
$y \text{ not between } x \text{ and } z$	$\text{not } (y \text{ between } x \text{ and } z)$

x , y , and z are expressions and cannot be subqueries.

In

The following table explains the operators, in and not in:

Operator	Meaning
$y \text{ in } (x, \dots, z)$	$y = x \text{ or } \dots \text{ or } y = z$ (x, \dots, z) represents a list of expressions, each of which evaluates to a single value. None of the expressions (y , x , or z) can be subqueries. The in predicate returns true if y is equal to one of the values in the list represented by (x, \dots, z) .
$y \text{ not in } (x, \dots, z)$	$\text{not } (y \text{ in } (x, \dots, z))$ (x, \dots, z) represents a list of expressions, each of which evaluates to a single value. The not in predicate returns true if y is not equal to any value in the list represented by (x, \dots, z) . None of the expressions (y , x , or z) can be subqueries.
$y \text{ in } (\text{subquery})$	The subquery must be specified in parentheses and can refer to only one column in its select clause. The predicate returns true if y is equal to one of the values returned by the subquery.
$y \text{ not in } (\text{subquery})$	The subquery must be specified in parentheses and can refer to only one column in its select clause. The predicate returns true if y is not equal to any of the values returned by the subquery.

Any-or-All

An any-or-all predicate takes the form

any-or-all-operator **(subquery)**

The subquery must have exactly one element in the target list of its outermost subselect (so that it evaluates to a set of single values rather than a set of rows).

The any-or-all operator must be one of the following:

=any	=all
<>any	<>all
<any	<all
<=any	<=all

```
>any      >all
>=any     >=all
```

Let $\$$ denote any one of the comparison operators $=, <>, <, <=, >, >=$. Then the predicate:

$x \$ \text{any} (\text{subquery})$

evaluates to true if the comparison predicate:

$x \$ y$

is true for at least one value y in the set of values represented by *subquery*. If the subquery is empty, the $\$$ any comparison fails (evaluates to false).

Likewise, the predicate:

$x \$ \text{all} (\text{subquery})$

is true if the comparison predicate:

$x \$ y$

is true for all values y in the set of values represented by *subquery*. If the subquery is empty, the $\$$ all comparison evaluates to true.

The operator $=\text{any}$ is equivalent to the operator in . For example:

```
select ename
from employee
where dept = any
  (select dno
  from dept
  where floor = 3);
```

can be rewritten as:

```
select ename
from employee
where dept in
  (select dno
  from dept
  where floor = 3);
```

The operator some is a synonym for operator any . For example:

```
select ename
from employee
where dept = some
  (select dno from dept where floor = 3);
```

Exists

An exists predicate takes the form:

exists (subquery)

An exists predicate expression evaluates to true if the set represented by subquery is non-empty. For example:

```
select ename
from employee
where exists
  (select *
   from dept
   where dno = employee.dept
   and floor = 3);
```

It is typical, but not required, for the subquery argument to exists to be of the form select *.

Is Null

The is null predicate takes the form:

is [not] null

For example:

x is null

is true if *x* is a null. Because you cannot test for null using the “=” comparison operator, the null predicate must be used to determine whether an expression is null.

Search Conditions

Search conditions are used in where and having clauses to qualify the selection of data. Search conditions are composed of one or more predicates. Multiple predicates can be combined using parentheses and the logical operators (and, or, and not). The following examples illustrate possible combinations of search conditions:

Description	Example
Simple predicate	salary between 10000 and 20000
Predicate with not operator	eddept not like 'eng_%'

Description	Example
Predicates combined using or operator	eddept like 'eng_%' or eddept like 'admin_%'
Predicates combined using and operator	salary between 10000 and 20000 and eddept like 'eng_%'
Predicates combined using parentheses to specify evaluation	(salary between 10000 and 20000 and eddept like 'eng_%') or eddept like 'admin_%'

Predicates evaluate to true, false, or unknown. They evaluate to unknown if one or both operands are null (the is null predicate is the exception). When predicates are combined using logical operators (not, and, and or) to form a search condition, the search condition evaluates to true, false, or unknown as shown in the following tables:

and	true	false	unknown
true	true	false	unknown
false	false	false	false
unknown	unknown	false	unknown

or	true	false	unknown
true	true	true	true
false	true	false	unknown
unknown	true	unknown	unknown

Not(true) is false, not(false) is true, not(unknown) is unknown.

After all search conditions are evaluated, the value of the where or having clause is determined. The where or having clause can be true or false only. Unknown values are considered false. For more information about predicates and logical operators, see [Predicates](#) and [Logical](#) in this chapter.

Subqueries

Subqueries are select statements nested in other select statements. For example:

```
select ename
  from employee
 where dept in
   (select dno
    from dept
   where floor = 3);
```

Use subqueries in a where clause to qualify a specified column against a set of rows. In the previous example, the subquery returns the department numbers for departments on the third floor. The outer query then retrieves the names of employees who work in those departments.

Subqueries often take the place of expressions in predicates. Subqueries can be used in place of expressions only in the specific instances outlined in the descriptions of predicates earlier in this chapter. The select clause of a subquery must contain only one element.

A subquery can refer to correlation names defined (explicitly or implicitly) outside the subquery. For example:

```
select ename
  from employee empx
 where salary
   > (select avg(salary)
      from employee empy
     where empy.dept = empx.dept);
```

The preceding subquery uses a correlation name (empx) defined in the outer query. The reference, empx.dept, must be explicitly qualified here, or it would be implicitly qualified by empy. The query is evaluated by assigning empx each of its values (that is, letting it range over the employee table), and evaluating the subquery for each value of empx. At least one of the correlation names must be specified in this example—either empx or empy, but not both, can be allowed to default to employee.

For more information about using correlation names in nested subqueries, see [Correlation Names](#) in the chapter “OpenSQL Data Types.”

Chapter 5: Embedded OpenSQL

This chapter explains how to use host language variables and cursors in embedded OpenSQL, and describes the syntax of embedded OpenSQL statements and the typical structure of an embedded OpenSQL program.

The term *embedded OpenSQL* refers to OpenSQL statements embedded in a host language such as C or Fortran. Embedded OpenSQL statements include most interactive OpenSQL statements, plus a number of statements that serve the specific needs of an embedded program. (In addition, forms statements can be used to develop forms-based applications. For details about forms statements, see the *Forms-based Application Development Tools User Guide*.)

Embedded OpenSQL programs must be processed by the embedded SQL preprocessor, which converts the statements into host language source code statements. The host language statements are primarily calls to a runtime library that provides the interface to the Enterprise Access product or server. (Non-SQL host language statements are not processed by the preprocessor.)

After the program has been preprocessed, compile and link it according to the requirements of the host language. For details about compiling and linking an embedded OpenSQL program, see the *Embedded SQL Companion Guide*.

The examples in this chapter use italics to indicate pseudocode that specifies the program statements that must be provided in the host language. All of the examples use the semicolon (;) as the statement terminator. However, in an actual program, the statement terminator is determined by the host language.

Syntax of an Embedded OpenSQL Statement

The syntax of an embedded OpenSQL statement is as follows:

[margin] **exec sql** *OpenSQL_statement* [terminator]

When writing embedded OpenSQL statements, keep the following points in mind:

- The margin, consisting of spaces or tabs, is the margin that the host language compiler requires before the regular host code. Not all languages require margins. To determine if a margin is required, see the *Embedded SQL Companion Guide*.
- The keywords, exec sql, must precede the OpenSQL statement itself. These words must appear together on a single line. They signal the preprocessor that the statement is an embedded OpenSQL statement. The preprocessor ignores statements that are not preceded by exec sql.
- The statement terminator depends on the requirements of the host language. Different host languages require different terminators. Some host languages, such as Fortran, do not require a statement terminator.
- Embedded OpenSQL statements can be continued across multiple lines, according to the host language's rules for line continuation.
- Labels can precede the embedded statement if a host language statement in the same place can be preceded by a label. The label must be at the correct margin for labels and no syntactic element (including comments) can appear between it and the exec keyword.
- Host language comments must follow the rules for the host language.
- Some host languages allow you to place a line number in the margin.

For information about language-dependent syntax, see the *Embedded SQL Companion Guide*.

Structure of Embedded OpenSQL Programs

In general, OpenSQL statements can be embedded anywhere in a program that host language statements are allowed. The following example shows a simple embedded OpenSQL program that retrieves an employee's name and salary from the database and prints them on a standard output device. The statements that begin with the words, exec sql, are embedded OpenSQL statements.

```
begin program

exec sql include sqlca;

exec sql begin declare section;
  name  character_string(15);
  salary float;
exec sql end declare section;

exec sql whenever sqlerror stop;

exec sql connect 'personnel/db2udb';

exec sql select ename, sal
  into :name, :salary
  from employee
  where eno = 23;

print name, salary;

exec sql disconnect;

end program
```

The sequence of statements in the above example illustrates the typical structure of embedded OpenSQL programs. The first OpenSQL statement to appear is:

```
exec sql include sqlca;
```

This statement incorporates the OpenSQL error and status handling mechanism—the SQL Communications Area (SQLCA)—into the program. The SQLCA is required by the whenever statement appearing later in the example.

Next is an OpenSQL declaration section. Host language variables to OpenSQL must be declared before using the variables in embedded OpenSQL statements.

The whenever statement that follows uses information from the SQLCA to control program execution under error or exception conditions. An error handling mechanism should precede all executable embedded OpenSQL statements in a program. For details about error handling, see [Error Handling](#) in the chapter “OpenSQL Features.”

Following the whenever statement is a series of OpenSQL and host language statements. The first statement:

```
exec sql connect 'personnel/db2udb';
```

initiates access to the DB2 UDB personnel database through an Enterprise Access product. Your application must connect to a database before attempting to access the database. The slash (/) separates the database name from the server class. (The default server class is INGRES.) For details about server class, see your Enterprise Access product guide.

After connecting to the personnel database, the application issues the select statement. The into clause specifies the host language variables into which the select statement retrieves values from the database. In the example, the variables are name and salary.

Following the select statement is a host language statement that prints the values contained in the variables. Host language and embedded OpenSQL statements can be mixed in an application.

Finally, the application program disconnects from the database.

Host Language Variables

Embedded OpenSQL allows host language variables to be used for many elements of embedded OpenSQL statements. Host language variables can be used to transfer data from the database into the program and vice versa. Host language variables can also replace the search condition in a where clause.

Host language variables can be used to specify:

- **Database expressions** - Variables can generally be used wherever expressions are allowed in embedded OpenSQL statements, such as in target lists and predicates. Variables must contain constant values and cannot represent names of database columns or include any operators.
- **Search conditions** - A where clause can be specified in a variable. The entire where clause must be contained in the variable. For example, to retrieve all columns for employees who earn more than the average salary:

```
wherevar = 'salary > (select avg(salary)
                     from employee)'
exec sql select ename
      into :name
      from employee
      where :wherevar
```

- **Receiving variables** - A host variable can be used to specify the objects of the into clause of the select and fetch statements. The into clause is the means by which values retrieved from the database are transferred to host language variables.
- **Other statement arguments** - The statement descriptions in this guide note which arguments can be specified using host language variables.

A host language variable can be a single variable or a structure.

All host language variables must be declared to embedded OpenSQL before you can use them in embedded OpenSQL statements. The names of these variables cannot be keywords reserved by Ingres.

The following sections describe how to use host language variables. For language-specific details, see the *Embedded SQL Companion Guide*.

Declaring Variables

Host language variables must be declared to OpenSQL before using them in any embedded OpenSQL statements. Host language variables are declared to OpenSQL in a *declaration section* that has the following syntax:

```
exec sql begin declare section;
      host variable declarations
exec sql end declare section;
```

A program can contain multiple declaration sections. The preprocessor treats variables that are declared in each declaration section as global to the embedded OpenSQL program from the point of declaration forward.

The variable declarations are identical to any variable declarations in the host language. The data types of the declared variables must belong to a subset of host language data types that are compatible with embedded OpenSQL data types. OpenSQL converts between host language data types and OpenSQL data types.

For a list of valid embedded OpenSQL data types and a discussion of data type conversion, see the *Embedded SQL Companion Guide*.

The embedded OpenSQL preprocessor is concerned only with host language variables that are declared to OpenSQL. Host language variables that are not declared to OpenSQL are invisible to the preprocessor and therefore can include data types that the preprocessor does not understand.

The Include Statement

The embedded OpenSQL include statement lets you include external files in your source code. The syntax of the include statement is as follows:

```
exec sql include filename;
```

This statement is commonly used to include an external file containing variable declarations. For example, assuming you have a file, myvars.dec, that contains a group of variable declarations, you can use the include statement in the following manner:

```
exec sql begin declare section;
exec sql include 'myvars.dec';
exec sql end declare section;
```

This is the functional equivalent of listing all the declarations in the myvars.dec file in the declaration section itself.

For details about the include statement, see [Include](#) in the chapter “OpenSQL Statements.”

Variable Usage

After host language variables are declared, they can be used in embedded statements. Host language variables must be preceded by a colon. For example:

```
exec sql select ename, sal
  into :name, :salary
  from employee
  where eno = :empnum;
```

The into clause contains two host language variables, name and salary and the where clause contains one, empnum.

A host variable can have the same name as a database object, such as a column. The preceding colon distinguishes the variable from a database object of the same name.

If the application issues a query intended to retrieve values from a table into a host variable and the query returns no value (for example, no row in the table fulfilled the query), the contents of the variable are not modified.

Variable Structures

To simplify the transfer of data between database tables and embedded programs, variable structures can be used in the select, fetch, and insert statements. Variable structures are specified, like single variables, according to the rules of the host language and must be declared in an embedded OpenSQL declare section. The number, data type, and ordering of the structure's elements must correspond to the number, data type, and ordering of the result columns associated with a select, fetch, or insert statement.

For example, for a database table, employee, with the columns ename (data type character(20)) and eno (integer), declare the variable structure:

```
emprec
  ename character_string(20),
  eno integer;
```

and issue the select statement

```
exec sql select *
  into :emprec.ename, :emprec.eno
  from employee
  where eno = 23;
```

Rather than specifying individual variables, you can specify the structure name in the select statement. To specify the preceding example using a structure name, use the following select statement:

```
exec sql select *
  into :emprec
  from employee
  where eno = 23;
```

The embedded OpenSQL preprocessor expands the structure name into the names of the individual members. Therefore, placing a structure name in the into clause is equivalent to enumerating all members of the structure in the order in which they were declared.

You can also use a structure to insert values in the database table. For example:

```
exec sql insert into employee (ename, eno)
  values (:emprec);
```

For details on the declaration and use of variable structures, see the *Embedded SQL Companion Guide*.

The Dclgen Utility

Dclgen (“Declaration Generator”) is a structure-generating utility that maps the columns of a database table into a structure that can be included in a variable declaration. Invoke dclgen from the operating system level with the following command:

dclgen *language dbname tablename filename structurename*

where:

language is the host language (for example, “C”).

dbname is the name of the database containing the table.

tablename is the name of the database table.

filename is the output file generated by dclgen containing the structure declaration.

structurename is the name of the generated host language structure.

Dclgen creates the declaration file, *filename*, containing a structure corresponding to the database table. The file also includes a declare table statement that identifies the database table and columns from which the structure was generated. After the file has been generated, an embedded OpenSQL include statement can be used to incorporate the file into the variable declaration section.

For details on the dclgen utility, see the *Embedded SQL Companion Guide*.

Indicator Variables

An *indicator variable* is a two-byte integer variable associated with a host language variable in an embedded OpenSQL statement. Indicator variables enable the application to:

- Detect when a null has been retrieved into a host variable. (When used to detect or assign a null, indicator variables are referred to as *null indicator variables*.)
- Assign a null to a table column.
- Detect character string truncation (when retrieving from a table into a host variable).

Indicator variable must be declared to embedded OpenSQL in a declare section.

In an embedded OpenSQL statement, the indicator variable is specified immediately after the host variable, with a colon separating the two:

host_variable:indicator_variable

The optional keyword indicator can be used in the syntax:

host_variable indicator:indicator_variable

Indicator variables can be associated with host language variables that contain the value of a database column or a constant database expression. For example, the following statement associates null indicators with variables that contain values retrieved from table columns:

```
exec sql select ename, esal
  into :name:name_null, :salary:sal_null
  from employee;
```

Null Indicators and Data Retrieval

When OpenSQL retrieves a null for a host variable that has an associated indicator variable, it sets the indicator variable to -1 and does not change the value of the host variable. If the value retrieved is not a null, then the indicator variable is set to 0 and the value is assigned to the host variable.

If the value retrieved is null and the program does not supply a null indicator, an error results.

Null indicator variables can be associated with the following:

- Select into and fetch into result variables
- Data handlers for long varchar and long byte values

The following example illustrates the use of a null indicator when retrieving data from a database. This program retrieves employee information, then updates a roster. If a null phone number is detected (using the indicator variable `phone_null`), the program places the string, N/A, in the roster's phone column.

```
exec sql fetch emp_cursor into :name,
  :phone:phone_null, :id;
if (phone_null = -1) then
  update_roster(name, 'N/A', id);
else
  update_roster(name, phone, id);
end if;
```

Using Null Indicators to Assign Nulls

An indicator variable can be used with a host variable to assign a null value to a table column. When OpenSQL performs the assignment, it checks the value of the host variable's associated indicator variable. If the indicator variable's value is -1, then OpenSQL assigns a null to the column and ignores the value of the host variable. If the indicator variable does not contain -1, OpenSQL assigns the value of the host variable to the column. If the indicator value is -1 and the column is not nullable, then OpenSQL returns an error.

The following example demonstrates the use of an indicator variable and the null constant with the `insert` statement:

```
read name, phone number, and id from terminal;
if (phone = ' ') then
  phone_null = -1;
else
  phone_null = 0;
end if;
exec sql insert into newemp (name, phone, id,
  comment) values (:name, :phone:phone_null,
  :id, null);
```

This second example retrieves data from a form and updates the data in the database:

```
exec frs getform empform (:name:name_null = name,  :id:id_null = id);
exec sql update employee
set name = :name:name_null, id = :id:id_null
where current of emp_cursor;
```

Use null indicators to assign nulls in:

- The insert values list
- The update set list
- Constant expressions in select target lists used in embedded select statements or subselect clauses

All constant expressions in the above list can include the keyword `null`. Specifying the word `null` is equivalent to specifying a null indicator with the value -1.

Indicator Variables and Character Data Retrieval

If OpenSQL retrieves a character string into a host variable that is too small to hold the string, the data is truncated to fit. (If the data was retrieved from the database, OpenSQL sets the `sqlwarn1` field to "W".) If the host variable has an associated indicator variable, the indicator is set to the original length of the data. For example, the following statement sets the variable, `char_ind`, to 6 because it is attempting to retrieve a 6-character string into a 3-byte host variable, `char_3`:

```
exec sql select 'abcdef' into :char_3:char_ind;
```

Note: If a long varchar or long byte column is truncated into a host language variable, the indicator variable is set to 0. The maximum size of a long varchar or long byte column (2 GB) is too large to fit in an indicator variable.

Null Indicator Arrays and Host Structures

Use host structures to hold the data to be retrieved or written by select, fetch, and insert statements. In combination with host structures, an indicator array can be used to detect whether a particular member of the host structure contains a null.

An indicator array is an array of 2-byte integers that is associated with a host variable structure. Generally, indicator arrays are declared in the same declare section as their associated host variable structure. For example, the following code declares a host variable structure, emprec, and its associated indicator array, empind:

```
emprec
  ename  character(20),
  eid    integer,
  esal   float;
empind array(3) of short_integer;
```

The preceding structure and indicator array might be used as follows:

```
exec sql select name, id, sal
  into :emprec:empind
  from employee
  where number = 12;
```

A particular element of the indicator array is associated with the corresponding ordered member of the host structure: you do not need to specify each array element separately. The embedded OpenSQL preprocessor enumerates the elements in the array when expanding the structure into its members.

Data Manipulation with Cursors

Cursors enable embedded OpenSQL programs to process the result rows returned by a select statement, one at a time. After a cursor has been opened, it can be advanced through the result rows. When the cursor is positioned to a row, the data in the row can be transferred to host language variables and processed according to the requirements of the application. The row to which the cursor is positioned is referred to as the *current row*.

A typical cursor application uses OpenSQL statements to perform the following steps:

- Declare a cursor that will select a set of rows for processing.
- Open the cursor, thereby selecting the data.

- Fetch each row from the result table and move the data from the row into host language variables.
- Optionally update or delete the current row.
- Close the cursor and terminate processing.

An Example of Cursor Processing

This simple example of cursor processing prints the names and salaries of all the employees in the employee table and updates the salary of employees earning less than \$10,000.

```
exec sql include sqlca;

exec sql begin declare section;
name    character_string(15);
salary   float;
exec sql end declare section;

exec sql whenever sqlerror stop;

exec sql connect personnel/rdb;

exec sql declare c1 cursor for
select ename, sal
from employee
for update of sal;

exec sql open c1;

exec sql whenever not found goto closec1;

loop while more rows

/* The WHENEVER NOT FOUND statement causes the loop
** to be broken as soon as a row is not fetched.
*/
exec sql fetch c1 into :name, :salary;
print name, salary;

if salary < 10000 then
    exec sql update employee
        set salary = 10000
        where current of c1;

end if;
end loop;

closec1:
exec sql close c1;
exec sql disconnect;
```

Declaring a Cursor

Before a cursor can be used in an application, it must be declared. The syntax for declaring a cursor is:

```
exec sql declare cursor_name cursor for
    select_statement;
```

The declare cursor statement assigns a name to the cursor and associates the cursor with a select statement to use to retrieve data. A cursor is always associated with a particular select statement. The select is executed when the cursor is opened.

Updates can be performed only if the cursor's select statement does not include any of the following elements:

- Aggregates
- Union clause
- Group by clause
- Having clause
- Distinct

These elements can be present in subselects within the select statement, but must not occur in the outermost select statement.

The *cursor_name* can be specified using a string literal or a host language string variable. Cursor names can be assigned dynamically. For details, see [An Example of Dynamically Specified Cursor Names](#) in this chapter.

Opening Cursors

Opening a cursor executes the associated select statement and positions the cursor before the first row in the result table. To open a cursor, use the open statement:

```
exec sql open cursor_name [for readonly];
```

To specify that you intend to read the table without updating it, include the for readonly clause. This clause may improve the performance of the cursor retrieval. If for readonly is specified, updates cannot be performed on the data. For readonly can be specified even if the cursor was declared for update.

Open Cursors and Transaction Processing

OpenSQL treats a multi-query transaction as a single statement (logically). Cursors cannot remain open across transactions. The commit statement closes all open cursors, even if a close cursor statement was not issued.

If an error occurs while a cursor is open, the Enterprise Access product or DBMS may roll back the entire transaction and close the cursor.

Fetching the Data

The fetch statement advances the position of the cursor through the result rows returned by the select. Using the fetch statement, your application can process the rows one at a time.

The syntax of the fetch statement is:

```
exec sql fetch cursor_name  
      into variable {, variable};
```

The fetch statement advances the cursor to the first or next row in the result table and loads the values into host language variables.

To illustrate, the example of cursor processing shown previously contains the following declare cursor statement:

```
exec sql declare c1 cursor for  
select ename, sal  
from employee  
for update of sal;  
  
open c1;
```

Later in the program, the following fetch statement appears:

```
exec sql fetch c1 into :name, :salary;
```

This fetch statement puts the values from the ename and sal columns of the current row into the host language variables name and salary.

Since the fetch statement operates on a single row at a time, it is ordinarily placed inside a host language loop.

There are two ways to detect when the last row in the result table has been fetched:

- The `sqlcode` variable in the SQLCA is set to 100 if an attempt to fetch past the last row of the result table is made. (The SQL Communications Area (SQLCA) is a group of variables used by OpenSQL to provide error and status information to applications. After the last row is retrieved, succeeding fetches do not affect the contents of the host language variables specified in the `into` clause of the fetch statement.)
- The `whenever not found` statement specifies an action to be performed when the cursor moves past the last row. For details about the `whenever` statement, see [Trapping Errors Using the Whenever Statement](#) in the chapter "OpenSQL Features."

Cursors can only move forward through a set of rows. To fetch a row again, a cursor must be closed and reopened.

Fetching Rows Inserted by Other Queries

While a cursor is open, the application can append rows using non-cursor insert statements. If rows are inserted after the current cursor position, the rows may or may not be visible to the cursor, depending on the following criteria:

- **Updatable cursors** - The newly inserted rows are visible to the cursor. Updatable cursors reference a single base table or updatable view.
- **Non-updatable cursors** - If the cursor select statement retrieves rows directly from the base table, the newly inserted rows are visible to the cursor. If the select statement manipulates the retrieved rows (for example, includes an `order by` clause), the cursor retrieves rows from an intermediate buffer, and cannot detect the newly inserted rows.

Using Cursors to Update Data

To use a cursor to update data, specify the `for update` clause in the cursor's declaration:

```
exec sql declare cursor_name cursor for
  select_statement
  for update of column {, column};
```

The `for update` clause must list any columns in the selected database table that may require updating. Columns that have not been declared cannot be updated. If you are deleting rows, you do not need to declare the cursor for update.

The syntaxes for the close and fetch statements are no different for cursors opened for update. However, the update statement has an extended version for cursors:

```
exec sql update tablename
  set column = expression {, column = expression}
  where current of cursor_name;
```

The where clause of the cursor version specifies the row to which the cursor currently points, and the update affects only data in that row. Each column specified in the set clause must have been declared for updating in the declare cursor statement.

Be sure that the cursor is pointing to a row (a fetch has been executed) before performing a cursor update. The update statement does not advance the cursor. A fetch is still required to move the cursor forward one row. Two cursor updates not separated by a fetch will cause the same row to be updated twice or generate an error on the second update, depending on the underlying DBMS.

Using Cursors to Delete Data

The cursor version of the delete statement has the following syntax:

```
exec sql delete from tablename
  where current of cursor_name;
```

The delete statement deletes the current row. The cursor must be positioned on a row (as the result of a fetch statement) before a cursor delete can be performed. After the row is deleted, the cursor points to the position after the row (and before the next row) in the set. To advance the cursor to the next row, issue the fetch statement.

You do not have to declare a cursor for update to perform a cursor delete.

An Example of Updating and Deleting with Cursors

This example illustrates updating and deleting with a cursor:

```
exec sql include sqlca;

exec sql begin declare section;
  name  character_string(15);
  salary  float;
exec sql end declare section;

exec sql whenever sqlerror stop;

exec sql connect personnel/rdb;

exec sql declare c1 cursor for
  select ename, sal
  from employee
  for update of sal;

exec sql open c1;

exec sql whenever not found goto closec1;

loop while more rows

exec sql fetch c1 into :name, :salary;
  print name, salary;

/* Increase salaries of all employees earning less
than 60,000. */

if salary < 60,000 then

  print 'Updating ', name;
  exec sql update employee
    set sal = sal * 1.1
    where current of c1;

/* Fire all employees earning more than 300,000. */

else if salary > 300,000 then

  print 'Terminating ', name;
  exec sql delete from employee
    where current of c1;

end if;

end loop;

closec1:
exec sql close c1;
exec sql disconnect;
```

Closing Cursors

The final action in cursor processing is to close the cursor. Once the cursor is closed, no more processing can be performed with it unless another open statement is issued. The syntax for closing the cursor is as follows:

```
exec sql close cursor_name;
```

The same cursor can be opened and closed any number of times in a single program, but it must be closed before reopening it. If a cursor is closed and reopened, the associated select statement is executed again and the cursor is positioned before the start of the result rows.

Summary of Cursor Positioning

The following table summarizes the effects of cursor statements on cursor positioning:

Statement	Effect on Cursor Position
open	Cursor positioned before first row in set.
fetch	Cursor moves to next row in set. If it is already on the last row, the cursor moves beyond the set and its position becomes undefined.
update(cursor)	Cursor remains on current row.
delete(cursor)	Cursor moves to a position after the deleted row (but before the following row).
close	Cursor and set of rows become undefined.

For extended examples of the use of cursors in embedded OpenSQL, see the *Embedded SQL Companion Guide*.

An Example of Dynamically Specified Cursor Names

A dynamically specified cursor name (a cursor name specified using a host string variable) can be used to scan a table that contains rows that are related hierarchically, such as a table of employees and managers. In a relational database, this structure must be represented as a relationship between two columns. In an employee table, typically employees are assigned an ID number. One of the columns in the employee table contains the ID number of each employee's manager. This column establishes the relationships between employees and managers.

To use dynamically specified cursor names to scan this kind of table:

- Write a routine that uses a cursor to retrieve all the employees that work for a manager.
- Create a loop that calls this routine for each row that is retrieved and dynamically specifies the name of the cursor to be used by the routine.

The following example retrieves rows from the employee table that has the following format:

```
exec sql declare employee table
(ename  varchar(32),
 title   varchar(20),
 manager varchar(20));
```

This program scans the employee table and prints out all employees and the employees that they manage:

```
/* This program will print out, starting with
** the top manager,
** each manager and who they manage for the entire
** company. */

exec sql include sqlca;

/* main program */
exec sql begin declare section;
  topmanager character string(21)
exec sql end declare section;

exec sql connect enterprise/db2udb;

exec sql whenever not found goto closedb;
exec sql whenever sqlerror call sqlprint;

/* Retrieve top manager */
exec sql select ename into :topmanager from employee where title = 'President';

print 'President', topmanager
call printorg(1, topmanager);
/* start with top manager */

/* closedb */
closedb:
exec sql disconnect;
```

```
/* This subroutine retrieves and displays employees
** who report to a given manager. This subroutine is
** called recursively to determine if a given
** employee is also a manager and if so,
** it will display who reports to them.
*/
subroutine printorg(level, manager)
level integer

exec sql begin declare section;
  manager character string(21)
  ename character string(33)
  title character string(21);
  cname character string(4);
exec sql end declare section;

/* set cursor name to 'c1', 'c2', ... */
cname = 'c' + level

exec sql declare :cname cursor for
select ename, title, manager from employee
  where manager = :manager
  order by ename;

exec sql whenever not found goto closec;

exec sql open :cname;

loop
  exec sql fetch :cname into :ename, :title,
  :manager;

  /* Print employee's name and title */
  print title, ename
  /* Find out who (if anyone) reports to this employee*/
  printorg(level+1, ename);

end loop

closec:
exec sql close :cname;
return;
```

Data Handlers for Large Objects

To read and write long varchar and long byte columns (referred to as large objects), create routines called *data handlers*. Data handlers use get data and put data statements to read and write segments of large object data. To invoke a data handler, specify the datahandler clause in an insert, update, fetch, or select statement. When the query is executed, the data handler routine is invoked to read or write the column.

In embedded SQL programs, use the datahandler clause in place of a variable or expression. For example, you can specify a data handler in a where clause; the syntax of the datahandler clause is as follows:

datahandler(handler_routine ([handler_arg]))[:indicator_var]

The following table lists the parameters for the datahandler clause:

Parameter	Description
<i>handler_routine</i>	Pointer to the data handler routine. Must be a valid pointer. An invalid pointer results in a runtime error.
<i>handler_arg</i>	Optional pointer to an argument to be passed to the data handler routine. The argument does not have to be declared in the declare section of the program.
<i>indicator_var</i>	Optional indicator variable. For datahandler clauses in insert and update statements and where clauses, if this variable is set to a negative value, the data handler routine is not called. If the data returned by a select or fetch statement is null, the indicator variable is set to -1 and the data handler routine is not called.

For example, the following select statement returns the column, bookname, using the normal SQL method and the long varchar column, booktext, using a data handler:

```
exec sql select bookname, booktext into
  :booknamevar, datahandler(get_text())
  from booktable where bookauthor = 'Melville';
```

Separate data handler routines can be created to process different columns.

In select loops, data handlers are called once for each row returned.

Errors in Data Handlers

Errors from put data and get data statements are raised immediately, and abort the SQL statement that invoked the data handler. If an error handler is in effect (as the result of a set_sql(errorhandler) statement), the error handling routine is called.

The data handler read routines (routines that issue get data statements) must issue the enddata statement before exiting. If a data handler routine attempts to exit without issuing the enddata statement, a runtime error is issued.

To determine the name of the column for which the data handler was invoked, use the inquire_sql(columnname) statement. To determine the data type of the column, use the inquire_sql(columntype) statement. The inquire_sql(columntype) statement returns an integer code corresponding to the column data type. For a table listing the data type codes, see the table titled Data Type Codes. These inquire_sql statements are valid only within a data handler routine. Outside of a data handler, these statements return empty strings.

Restrictions on Data Handlers

Data handlers are subject to the following restrictions:

- The datahandler clause is not valid in interactive SQL.
- The datahandler clause cannot be specified in a dynamic SQL statement.
- The datahandler clause cannot be specified in an execute procedure statement.
- The datahandler clause cannot be specified in a declare section.
- A data handler routine must not issue a database query. The following statements are valid in data handlers:
 - Put data and get data
 - Enddata (for read data handlers only)
 - Inquire_sql and set_sql
 - Host language statements

Using Large Objects in Dynamic SQL

The following sections contain considerations and restrictions for using large object data in dynamic SQL programs.

Length Considerations

The sqlen field of the SQLDA is a 2-byte integer in which the DBMS server returns the length of a column. If a long varchar or long byte column that is longer than the maximum value possible for sqlen (32,768) is described, a 0 is returned in sqlen.

Long varchar and long byte columns can contain a maximum of 2 GB of data. To prevent data truncation, be sure that the receiving variable to which the SQLDA sqldata field points is large enough to accommodate the data in the large object columns your program is reading. If data is truncated to fit in the receiving variable, the sqlwarn member of the sqlca structure is set to indicate truncation.

Using Data Handlers in Dynamic SQL

To specify a data handler routine to be called by a dynamic query that reads or writes a large object column, prepare the SQLDA fields for the large object column as follows:

- Set the sqltype field to IISQL_HDLR_TYPE. This value is defined when using the include sqlda statement to define an SQLDA structure in your program.
- Declare a sqlhdlr structure in your program. For details, see the *Embedded SQL Companion Guide*. Load the sqlhdlr field of this structure with a pointer to your data handler routine. If a variable is to be passed to the data handler, load the sqlarg field with a pointer to the variable. If no argument is to be passed, set the sqlarg field to 0.

If the value of the large object column is null (sqlind field of the SQLDA set to -1) the data handler is not invoked.

Examples of Data Handlers

The following examples illustrate how data handlers are used to enter and retrieve large objects from the database. The sample table in this example stores the contents of a book, one chapter per row. The table consists of a char column (chapter_name) and a long varchar column (chapter_text).

The following create table statement shows the precise structure of the table, book.

```
exec sql create table book
  (chapter_name char(50),
   chapter_text long varchar);
```

PUT DATA Handler Example

This example illustrates the use of the put data statement; the data handler routine writes a chapter from a text file to the book table. The data handler is called when the insert statement is executed.

```
exec sql begin declare section;
      char chapter_namebuf(50);
exec sql end declare section;

int put_handler()/* not necessary to
                  declare to embedded SQL */
...
copy chapter text into chapter_namebuf

exec sql insert into book
      (chapter_name, chapter_text)
      values (:chapter_namebuf,
              datahandler(put_handler()));
...
put_handler()

exec sql begin declare section;
      charchap_segment[3000];
      int      chap_length;
      int      segment_length;
      int      error;

exec sql end declare section;

int      local_count = 0;

...
exec sql whenever sqlerror goto err;
chap_length = byte count of file
open file for reading
loop while (local_count < chap_length)
      read segment from file into chap_segment
      segment_length = number of bytes read
      exec sql put data
            (segment = :chap_segment,
             segmentlength = :segment_length)
      local_count = local_count + segment_length
end loop
exec sql put data (dataend = 1); /* required by embedded SQL */
...
err:
exec sql inquire_sql(:error = errno);
if (error <> 0)
      print error
      close file
```

GET DATA Handler Example

This example illustrates the use of the get data statement in a data handler. This routine retrieves a chapter titled, "One Dark and Stormy Night," from the book table. The data handler routine is called when the select statement is executed.

```

exec sql begin declare section;
      chapter_namebuf(50);
exec sql end declare section;
      int      get_handler()
      ...
      Copy the string "One Dark and Stormy Night" into the chapter_namebuf variable.
exec sql select chapter_name, chapter_text
      into :chapter_namebuf, datahandler(get_handler())
      from book where chapter_name = :chapter_namebuf
exec sql begin
      /* get_handler will be invoked
      once for each row */
      exec sql end;
      ...
      get_handler()
      exec sql begin declare section;
          charchap_segment[1000];
          int      segment_length;
          int      data_end;
          int      error;
      exec sql end declare section;
      ...
      exec sql whenever sqlerror goto err;
      data_end = 0
      open file for writing
      /* retrieve 1000 bytes at a time and write to text file. on last segment, less
      than 1000 bytes may be returned, so segment_length is used for actual number of
      bytes to write to file. */
      while (data_end != 1)
          exec sql get data (:chap_segment = segment,
                  :segment_length = segmentlength,
                  :data_end = dataend)
                  with maxlenlength = 1000;
          write segment_length number of bytes from
          "chap_segment" to text file
      end while
      ...
      err:
      exec sql inquire_inges(:error = error);

```

```
if (error != 0)
    print error
    close file
```

Dynamic SQL Data Handler

This example illustrates the use of data handlers in a dynamic SQL program. The sample table, `big_table`, was created with the following create table statement:

```
create table big_table
    (object_id integer, big_col long varchar);
```

The dynamic program retrieves data from `big_table`.

The data handler routine, `userdatahandler`, accepts a structure composed of a (long varchar) character string and an integer (which represents an object ID). The data handler writes the object ID followed by the text of the large object to a file. The logic for the data handler is shown in the following pseudocode:

```
userdatahandler(info)
    hd1r_param    pointer to info structure

    {exec sql begin declare section;

        charsegbuf[1000];
        int      seglen;
        int      data_end;

        exec sql end declare section;

        data_end = 0

        open file for writing

        set arg_str field of info structure to filename
        /* to pass back to main program */

        write arg_int field to file      /* id passed in
                                         from main program */

        loop while (data_end != 1)
            exec sql get data
                (:segbuf = segment, :dataend = dFataend)
                with maxlen = 1000;

            write segment to file

        end loop

        close file

    }
```

The structures required for using data handlers in dynamic SQL programs are declared in the eqsqlda.h source file, which is included in your program by an include sqlda statement. The following (C-style) definitions pertain to the use of data handlers:

```
# define IISQ_LVCH_TYPE 22
# define IISQ_HDLR_TYPE 46

typedef struct sqlhdlr_
{
    char    *sqlarg;
    int     (*sqlhdlr)();
} IISQLHDLR;
```

The following definitions must be provided by the application program. In this example the header file, mydecls.h, contains the required definitions.

```
/* Define structure hdlr_param, which will be used to pass information to and
receive information from the data handler. The data handler argument is a pointer
to a structure of this type, which is declared in the main program.*/

typedef struct hdlr_arg_struct

{
    char    arg_str[100];
    int     arg_int;

} hdlr_param;
```

The following code illustrates the main program, which uses dynamic SQL to read the long varchar data from the sample table. This sample program sets up the SQLDA to handle the retrieval of two columns, one integer column and one long varchar column. The long varchar column is processed using a user-defined data handler.

```
exec sql include 'mydecls.h';

main()
{
    /* declare the sqlda */
    exec sql include sqlda;

    declare host SQLDA: _sqlda
    declare sqlda as pointer to host SQLDA _sqlda
    exec sql begin declare section;

        character          stmt_buf[100];
        short integer      indicator1;
        short integer      indicator2;

    exec sql end declare section;
    integer      userdatahandler()
    integer      i
```

```
/* Set the iisqhldr structure; the data handler "userdatahandler" is invoked with
a pointer to "hdlr_arg" */

iisqlhdlr      data_handler;

/* Declare parameter to be passed to datahandler -- in this example a pointer to
a hdlr_param -- a struct with one character string field and one integer field as
defined in "mydecls.h". */

declare hdlr_param          hdlr_arg

set the SQLDA's sqln field to 2

copy "select object_id,big_col from big_table2" to the host language variable
stmt_buf

i = 0

exec sql connect 'mydatabase';

set the sqlhdlr field to point to the userdatahandler routine

set the sqlarg field to point to arguments (hdlr_arg)

/* Set the first sqlvar structure to retrieve column "object_id". Because this
column appears before the large object column in the target list, it IS retrieved
prior to the large object column, and can be put into the hdlr_arg that is passed
to the data handler. */

sqlvar[0].sqltype = IISQ_INT_TYPE

sqlvar[0].sqldata points to hdlr_arg.arg.int

sqlvar[0].sqlind points to indicator1

/* Set the second sqlvar structure to invoke a datahandler. the "sqltype" field
must be set to iisq_hdlr_type. the "sqldata" field must be pointer to iisqlhdlr
type. */

sqlvar[1].sqltype = IISQ_HDLR_TYPE

sqlvar[1].sqldata points to data_handler

sqlvar[1].sqlind points to indicator2

/* The data handler is called when the large object is retrieved. The data
handler writes the object_id and large object to a file and returns the file name
to the main program in the hdlr_arg struct. */

exec sql execute immediate :stmt_buf
    using descriptor sqlda;

exec sql begin;

/* process the file created in the data handler */

call processfile(hdlr_arg)

exec sql end;

}
```

Chapter 6: Dynamic OpenSQL

This chapter discusses the functionality of dynamic programming including the SQL Descriptor Area (SQLDA) and dynamic OpenSQL statements, and describes how to execute a dynamic non-select statement and a dynamic select statement.

Dynamic programming enables embedded OpenSQL programs to specify a variety of program elements (such as queries and OpenSQL statements) at runtime. In applications where table names or column names are not known until runtime, or where complete queries must be built based on the application's runtime environment, the hard-coded OpenSQL statement is not sufficient. For example, an application might include an expert mode in which the runtime user can type in select queries and browse the results at the terminal. To support applications such as these, OpenSQL provides dynamic OpenSQL.

Dynamic OpenSQL provides the ability to specify table and column names and build queries at runtime. Using dynamic OpenSQL, you can:

- Execute a statement that is stored in a buffer (execute immediate)
- Encode a statement stored in a buffer and execute it many times (prepare and execute)
- Obtain information about a table at runtime (prepare and describe)

For details about the execute immediate, prepare, execute, and describe statements, see [Dynamic OpenSQL Statements](#) in this chapter.

To support dynamic select statements, the cursor statements (for example, declare and open) have dynamic versions. For details, see [Executing a Dynamic Select Statement](#) and [Using a Cursor to Retrieve the Results](#) in this chapter.

The OpenSQL Descriptor Area (SQLDA) is an integral part of dynamic programming. The SQLDA is a host language structure used by dynamic OpenSQL as a storage space for information. When used with the describe statement, this information includes the name, data type, and length of the result columns, the form's fields, or the table field's columns. When the SQLDA is used with other dynamic forms statements, the information includes the data type, length, and addresses of the variables that either store values from the table or form or contain values to be placed in the table or form.

Depending on your host language, some of the statements discussed in this chapter may vary in syntax or may not be supported. For information about dynamic programming that is specific to your host language, see the *Embedded SQL Companion Guide*.

The SQLDA

The descriptor area, called the SQLDA (SQL Descriptor Area), is a host language structure used by both dynamic OpenSQL and dynamic Forms Runtime System (FRS). Dynamic OpenSQL uses the SQLDA to store information about each result column of the select statement. Dynamic FRS uses the SQLDA to hold descriptive information about the fields of a described form or columns of a described table field. Both dynamic OpenSQL and dynamic FRS use the SQLDA to store descriptive information about program variables. The SQLDA must be used when executing a describe statement (see the [Describe Statement](#) and [The SQLDA](#) in this chapter). The SQLDA can optionally be used when executing a fetch, open, prepare, execute, or execute immediate statement. (For details about these statements, see [Dynamic OpenSQL Statements](#) in this chapter.)

Structure of the SQLDA

Storage for the SQLDA structure is typically allocated at runtime. If a program allows several dynamically defined cursors to be opened at one time, the program can allocate several SQLDA structures, one for each select statement, and assign each structure a different name.

Each host language has different considerations for the SQLDA structure. Before writing a program that uses the SQLDA, see the *Embedded SQL Companion Guide* on dynamic OpenSQL statements.

The layout of the SQLDA is:

sqldabc	8-byte character array assigned a blank-padded value, "SQLDA."
sqldabc	4-byte integer assigned the size of the SQLDA.
sqln	2-byte integer indicating the number of allocated sqlvar elements. This value must be set by the program before describing a statement. The value must be greater than or equal to zero.

sqlid	2-byte integer indicating the number of result columns associated with the describe statement. This number specifies how many of the allocated sqlvar elements were used to describe the statement. If sqlid is greater than sqln, then the program must reallocate the SQLDA to provide more storage buffers and reissue the describe statement.
	To use the SQLDA to place values in a table or form, the program must set sqlid to the proper number before the SQLDA is used in a statement.
	When describing a dynamic OpenSQL statement, if the value in sqlid is zero, the described statement is not a select statement.
sqlvar	An sqln-size array of:
sqltype	2-byte integer containing a code number indicating the data type of the column or variable. For a list of the codes and corresponding types, see Data Type Codes in this chapter.
sqllen	2-byte integer indicating the length of the column, variable, or field.
sqldata	Pointer to the variable described by the type and length.
sqlind	Pointer to indicator variable associated with the host variable.
sqlname	String containing the result column name (if a select statement is being described). Maximum length is 32 characters.

Including the SQLDA in a Program

To define the SQLDA, your application must issue the following include statement:

```
exec sql include sqlda;
```

Do not place this statement in a declaration section.

In most languages, this statement incorporates a set of type definitions that can be used to define the SQLDA structure. In some languages, it actually declares the structure. If the structure is declared directly (instead of using the include statement), you can specify any name for the structure. For information about how your language handles this statement, see the *Embedded SQL Companion Guide*.

A program can have more than one SQLDA-type structure. A dynamic FRS describe statement and a dynamic OpenSQL statement can use the same SQLDA structure if the described fields or table field columns have the same names, lengths, and data types as the columns of the database table specified in the dynamic OpenSQL statement.

Describe Statement and the SQLDA

Dynamic OpenSQL uses the describe statement to return information about the result columns of a select statement. Describing a select tells the program the data types, lengths, and names of the columns retrieved by the select. If you describe a statement other than select, the only information returned is a 0 in the sqld field. For a complete discussion of how to use describe in a dynamic OpenSQL application, see [Preparing and Describing the Select Statement](#) in this chapter.

Data Type Codes

The describe statement returns a code indicating the data type of a field or column. This code is returned in sqltype, one of the fields in an sqlvar element. The following table lists the type codes:

Data Type Name	Data Type Code	Nullable
integer	30	No
	-30	Yes
float	31	No
	-31	Yes
decimal	10	No
	-10	Yes
character	20	No
	-20	Yes
varchar	21	No
	-21	Yes
date	3	No
	-3	Yes
money	5	No
	-5	Yes

If the column, variable, or field described by the sqlvar element is nullable, the type code is returned as a negative value.

The Using Clause

The using clause is an optional clause that provides certain OpenSQL statements with dynamic capabilities. The using clause directs OpenSQL to use the variables pointed to by the sqlvar elements of the SQLDA (or other host variables) when executing the statement.

The syntax of the using clause is shown below:

using descriptor *descriptor_name*

Note: The keyword descriptor is optional in some statements that accept the using clause.

The following statements accept the using clause:

- Describe
- Execute
- Execute immediate
- Fetch
- Open
- Prepare

For details about the execute statement, see [Executing a Dynamic Non-select Statement](#) in this chapter. For details about the execute immediate statement, see [Executing a Dynamic Select Statement](#) in this chapter.

Dynamic OpenSQL Statements

This section describes the (non-cursor) dynamic OpenSQL statements. Dynamic OpenSQL has four statements that are exclusively used in a dynamic program:

- Execute immediate
- Prepare
- Execute
- Describe

In addition, all statements that support cursors (declare, open, fetch, update, delete) have dynamic versions to support dynamically executed select statements.

Execute Immediate Statement

The execute immediate statement executes an OpenSQL statement specified as a string literal or using a host variable. The execute immediate is most useful when the program intends to execute a statement only once, or when using a select loop with a dynamic select statement.

The execute immediate statement can be used to execute all OpenSQL statements except for the following statements:

call	fetch
close	include
connect	inquire_sql
declare	open
describe	prepare
disconnect	set_sql
execute	whenever

The syntax of execute immediate is as follows:

```
exec sql execute immediate statement_string
  [into variable {, variable} | using [descriptor]
    descriptor_name
  [exec sql begin;
    program_code
  exec sql end;]];
```

The contents of the *statement_string* must not include the keywords, exec sql, or a statement terminator. The optional into/using clause and begin/end statement block can only be used when you are executing a dynamic select statement.

Prepare and Execute Statements

The prepare statement tells OpenSQL to encode the dynamically built statement and assign it the specified name. After a statement is prepared, the program can execute the statement one or more times in a transaction by issuing the execute statement and specifying the statement name.

If your program executes the same statement many times in a transaction, the prepare and execute method can improve the performance of the statement. Committing a transaction discards any statements that were prepared during the transaction.

The following OpenSQL statements cannot be prepared:

call	execute
close	fetch
connect	include
declare	inquire_sql
describe	open
disconnect	set
execute immediate	whenever

The syntax of the prepare statement is as follows:

```
exec sql prepare statement_name  
  [into descriptor_name | using descriptor descriptor_name]  
  [from host_string_variable | string_literal];
```

The *statement_name* can be a string literal or variable. The contents of the host string variable or the string literal cannot include exec sql or the statement terminator.

If the into clause is included in the prepare statement, the prepare statement also describes the statement string into the specified descriptor area and it is not necessary to describe the statement string separately.

The syntax of the execute statement is as follows:

```
exec sql execute statement_name  
  [using host_variable {, host_variable}  
  | using descriptor descriptor_name];
```

A prepared statement can be fully specified, or some portions can be specified by question marks (?). The portions specified using question marks must be filled in by the using clause when the statement is executed.

Describe Statement

The describe statement describes a prepared OpenSQL statement into a program descriptor (SQLDA) to allow the program to interact with the dynamic statement as though it was hard coded in the program. This statement is used primarily with dynamic select statements.

The syntax for the describe statement is as follows:

```
exec sql describe statement_name into|using descriptor_name;
```

For more information about the describe statement, see [Describe Statement](#), [The SQLDA](#), and [Preparing and Describing the Select Statement](#) in this chapter.

Executing a Dynamic Non-select Statement

Use either the execute immediate statement or the combination of prepare and execute to execute a dynamic non-select statement. Execute immediate is most useful if the program executes the statement only once within a transaction. If the program executes the statement many times within a transaction, for example, within a program loop, use the prepare and execute combination: prepare the statement once, then execute as many times as necessary.

If the program does not know whether the statement is a select statement, the program can prepare and describe the statement. The results returned by the describe statement will indicate whether the statement was a select. For more information and a sample of the conditional coding to handle such situations, see [Executing the Select with Execute Immediate](#) in this chapter.

Using Execute Immediate to Execute a Non-select Statement

Execute immediate executes an OpenSQL statement specified using a string literal or host variable. The execute immediate statement can be used to execute all but a few of the OpenSQL statements. For a list of statements that you cannot execute with the execute immediate statement, see [Execute Immediate Statement](#) in this chapter.

When the execute immediate statement is used to execute a statement that is not a select, its syntax is as follows:

```
exec sql execute immediate statement_string;
```

For example, the following statement executes a drop statement specified as a string literal:

```
/*
** Statement specification included
** in string literal. The string literal does
** NOT include 'exec sql' or ';'
*/
exec sql execute immediate 'drop employee';
```

As another example, the following code reads OpenSQL statements from a file into a host string variable named buffer, and executes the contents of the variable. If the variable includes a statement that cannot be executed by execute immediate, or if another error occurs, the loop is broken.

```
exec sql begin declare section;
      character buffer(100);
exec sql end declare section;
      open file;
loop while not end of file and not error

read statement from file into buffer;
exec sql execute immediate :buffer;

end loop;
close file;
```

If only a statement's parameters, such as an employee name or number, change at runtime, then you do not need to use execute immediate; you can replace a value with a host variable. For example, the following fragment increases the salaries of all employees with a specific employee number (read out of a file into variable, number):

```
loop while not end of file and not error

read number from file;
exec sql update employee
      set sal = sal * 1.1
      where eno = :number;

end loop;
```

Preparing and Executing a Non-select Statement

The prepare and execute statements can also be used to execute dynamic non-select statements. These two statements, working together, allow your program to save a statement string and execute it as many times as necessary. However, a prepared statement is discarded when the transaction in which it was prepared is rolled back or committed. Also, if a statement is prepared with the same name as an existing statement, the new statement supersedes the old statement.

The following example demonstrates how a runtime user can prepare (save) a dynamically specified OpenSQL statement and execute it a specific number of times:

```
read OpenSQL statement from terminal into buffer;
exec sql prepare s1 from :buffer;
read number in N
loop N times
  exec sql execute s1;
end loop;
```

The next example illustrates a dynamically prepared query. This example creates a table whose name is the same as the user's name, and inserts into the table a set of rows with fixed-typed parameters (the user's children):

```
get user name from terminal;
buffer = 'create table ' + user_name + '(child
character(15), age integer)';
exec sql execute immediate :buffer;

buffer = 'insert into ' + user_name + '(child, age)
values (?, ?)';
exec sql prepare s1 from :buffer;

read child's name and age from terminal;
loop until no more children
exec sql execute s1 using :child, :age;

read child's name and age from terminal;
end loop;
```

There are some statements that cannot be executed using prepare and execute. For a list of these statements, see [Dynamic OpenSQL Statements](#) in this chapter.

Executing a Dynamic Select Statement

If you know the data types of the result columns, use the execute immediate statement with the into clause. For details, see [When the Result Column Data Types are Known](#) in this chapter.

If you do not know the data types of the result columns, the select statement must be prepared and described first, then the program can either:

- Use the execute immediate statement with the using clause to execute the select.
- Declare a cursor for the prepared select statement and use the cursor to retrieve the results.

For more information, see [When the Result Column Data Types are Unknown](#) in this chapter.

The execute immediate option defines a select loop to process the results of the select. Select loops minimize disk and communications I/O but do not allow the program to issue any other OpenSQL statements in the loop. If the program must access the database while processing rows, use the cursor option.

If the program does not know whether the statement is a select, the prepare and describe statements can be used to determine whether the statement is a select. The following example demonstrates the program logic required to accept OpenSQL statements from a user, execute the statements, and print the results. If the statement is a select, the program uses a cursor to execute the query.

```
statement_buffer = ' ';
loop while reading statement_buffer from terminal

exec sql prepare s1 from :statement_buffer;
exec sql describe s1 into :result_descriptor;

if (sqlca.sqlid = 0) then
exec sql execute s1;
else
/* This is a SELECT */
exec sql declare c1 cursor for s1;
exec sql open c1;

allocate result variables using result_descriptor;

loop while there are more rows in the cursor

exec sql fetch c1 using descriptor
: result_descriptor;
if (sqlca.sqlcode not equal 100) then
print the row using result_descriptor;
end if;

end loop;

free result variables from result_descriptor;
exec sql close c1;
end if;
process sqlca for status;
end loop;
```

When the Result Column Data Types are Known

If the program knows the data types of the resulting columns and of the result variables used to store the column values, the program can execute the select statement using the execute immediate statement with the into clause.

In the following example, a database contains several password tables, each having one column and one row and containing a password value. An application connected to this database requires a user to correctly enter two passwords before continuing. The first password entered is actually the name of a password table and the second is the password value in that table.

The following code uses the execute immediate statement to execute the dynamically defined select built by the application to check these passwords:

```
...
exec frs prompt noecho ('First Password: ',
:table_password);
exec frs prompt noecho ('Second Password: ',
:value_password);

select_stmt = 'select column1 from ' +
table_password;
exec sql execute immediate :select_stmt
  into :result_password;
if (sqlcode < 0) or (value_password <>
result_password)
then
  exec frs message 'Password authorization failure';
endif
...
```

Because the application's developer knows the data type of the column in the password table (although not which password table will be selected), the developer can execute the dynamic select with the execute immediate statement and the into clause.

The syntax of execute immediate in this context is shown below:

```
exec sql execute immediate select_statement
  into variable {, variable};
[exec sql begin;
  host_code
exec sql end;]
```

This syntax retrieves the results of the select into the specified host variables. The begin and end statements define a select loop that processes each row returned by the select statement and terminates when there are no more rows to process. If a select loop is used, your program cannot issue any other OpenSQL statements for the duration of the loop.

If the select loop is not included in the statement, OpenSQL assumes that the select statement is a singleton select returning only one row and, if more than one row is returned, issues an error.

When the Result Column Data Types are Unknown

In most instances, when executing a dynamically defined select statement, the program does not know the number or types of result columns. To provide this information to the program, first prepare and then describe the select statement. The describe statement returns to the program the type description of the result columns of a prepared select statement. After the select is described, the program must dynamically allocate (or reference) the correct number of result storage areas of the correct size and type to receive the results of the select.

If the statement is not a select statement, describe returns a zero to the sqld and no sqlvar elements are used.

After the statement has been prepared and described and the result variables allocated, the program has two choices regarding the execution of the select statement:

- The program can associate the statement name with a cursor name, open the cursor, fetch the results into the allocated result storage area (one row at a time), and close the cursor.
- The program can use execute immediate, which allows you to define a select loop to process the returned rows. If the select will return only one row, then it is not necessary to define the select loop.

Preparing and Describing the Select Statement

If the program has no advance knowledge of the resulting columns, the first step in executing a dynamic select statement is to prepare and describe the statement. Preparing the statement encodes and saves the statement and assigns it a name. For information about the syntax and use of prepare, see [Prepare and Execute Statements](#) in this chapter.

The describe statement returns descriptive information about a prepared statement into a program descriptor, that is, an SQLDA structure. This statement is primarily used to return information about the result columns of a select statement to the program, but other statements can be described. When describing a non-select statement, the only information returned to the program is that the statement was not a select statement. The syntax of the describe statement is shown below:

```
exec sql describe statement_name into|using descriptor_name;
```

When a select statement is described, OpenSQL returns the information about each result column to a sqlvar element. (For information about sqlvar elements, see [Structure of the SQLDA](#) in this chapter.) This is a one-to-one correspondence: the information in one sqlvar element corresponds to one result column. Before issuing the describe statement, the program must allocate sufficient sqlvar elements and set the SQLDA sqln field to the number of allocated sqlvars. The program must set sqln before the describe statement is issued.

After issuing the describe statement, the program must check the value of sqld, which contains the number of sqlvar elements actually used to describe the statement. If sqld is zero, the prepared statement was not a select statement. If sqld is greater than sqln, the SQLDA does not have enough sqlvar elements: more storage must be allocated and the statement must be redescribed.

The following fragment shows a typical describe statement and the surrounding host program code. The program assumes that 20 sqlvar elements will be sufficient:

```
sqlda.sqln = 20;
exec sql describe s1 into sqlda;

if (sqlda.sqld = 0) then
  statement is not a select statement;

else if (sqlda.sqld > sqlda.sqln) then

  save sqld;
  free current sqlda;
  allocate new sqlda using sqld as the size;
  sqlda.sqln = sqld;
  exec sql describe s1 into sqlda;

end if;
```

Analyzing the Sqlvar Elements

After describing a statement, the program must analyze the contents of the sqlvar array. Each element of the sqlvar array describes one result column of the select statement. Together, all the sqlvar elements describe one complete row of the result table.

The describe statement sets the data type, length, and name of the result column (sqltype, sqllen and sqlname), and the program must use that information to supply the address of the result variable and result indicator variable (sqldata and sqlind).

For example, assuming the table, object, was created as follows:

```
exec sq  create table object
(o_id    integer not null,
 o_desc  character(100) not null,
 o_price float not null,
 o_sold  date);
```

and the following dynamic query was described as follows:

```
exec sql prepare s1 from 'select * from object';
exec sql describe s1 into sqlda;
```

The SQLDA descriptor results would be:

sqlid	4 (columns)
sqlvar(1)	sqltype = 30 (integer) sqllen = 4 sqlname = 'o_id'
sqlvar(2)	sqltype = 20 (character) sqllen = 100 sqlname = 'o_desc'
sqlvar(3)	sqltype = 31 (float) sqllen = 8 sqlname = 'o_price'
sqlvar(4)	sqltype = -3 (date) sqllen = 0 sqlname = 'o_sold'

The describe statement sets the value of sqllen to the length of the result column. For character data types, sqllen is set to the maximum length of the character string. For numeric data types, sqllen is set to the size of the numeric field as declared when created. For the date data type, sqllen is set to 0, but the program should use a 25-byte character string to retrieve or set date data. Note that, for nullable columns, a negative value is returned.

After the statement is described, your program must analyze the values of sqltype and sqllen in each sqlvar element. If sqltype and sqllen do not correspond exactly with the types of variables used by the program to process the select statement, then sqltype and sqllen must be modified to be consistent with the program variables. After describing a select statement, there will be one sqlvar element for each expression in the select target list.

After processing the values of `sqltype` and `sqllen`, allocate storage for the variables that will contain the values in the result columns of the select statement, by pointing `sqldata` at a host language variable that will contain the result data. If the value of `sqltype` is negative, which indicates a nullable result column data type, allocate an indicator variable for the particular result column and set `sqlind` to point to the indicator variable. If `sqltype` is positive, indicating that the result column data type is not nullable, an indicator variable is not required. In this case, set `sqlind` to zero.

To omit the null indicator for a nullable result column (`sqltype` is negative), set `sqltype` to its positive value and `sqlind` to zero. If `sqltype` is positive and an indicator variable is allocated, set `sqltype` to its negative value, and set `sqlind` to point to the indicator variable.

In the above example, after the program analyzes the results as described, the date type is changed to character and `sqlind` and `sqldata` are set to appropriate values. The values in the resulting `sqlvar` elements are:

```
sqlvar(1)  sqltype  =  30 (integer),
            sqllen   =  4,
            sqldata  =  Address of 4-byte integer,
            sqlind   =  0,
            sqlname  =  'o_id'
sqlvar(2)  sqltype  =  20 (character),
            sqllen   =  100,
            sqldata  =  Address of 100-byte character string,
            sqlind   =  0,
            sqlname  =  'o_desc'
sqlvar(3)  sqltype  =  31 (float),
            sqllen   =  8
            sqldata  =  Address of 8-byte floating point,
            sqlind   =  0,
            sqlname  =  'o_price'
sqlvar(4)  sqltype  =  -30 (Nullable character, was date),
            sqllen   =  25, (was 0)
            sqldata  =  Address of 25-byte character string,
            sqlind   =  Address of 2-byte indicator variable,
            sqlname  =  'o_sold'
```

Executing the Select with Execute Immediate

You can execute a dynamic select statement that has been prepared and described with an execute immediate statement that includes the using clause. The using clause tells OpenSQL to place the values returned by the select into the variables pointed to by the elements of the SQLDA sqlvar array. If the select will return more than one row, you can also define a select loop to process each row before another is returned.

The syntax of execute immediate in this context is shown below:

```
exec sql execute immediate select_statement
  using [descriptor] descriptor_name;
[exec sql begin;
  host_code
exec sql end;]
```

Within a select loop, no OpenSQL statements other than an endselect can be issued. For selects without select loops, OpenSQL issues an error if more than one row is returned.

To illustrate this option, the following example contains a dynamic select. The results of the select statement are used to generate a report.

```
...
allocate an sqlda
read the dynamic select from the terminal into a
stmt_buffer

exec sql prepare s1 from :stmt_buffer;
exec sql describe s1 into :sqlda;
if (sqlca.sqlcode < 0) or (sqlda.sqlid = 0) then
  print ('Error or statement is not a select');
  return;
else if (sqlda.sqlid > sqlda.sqln) then
  allocate a new sqlda;
  exec sql describe s1 into :sqlda;
endif;

analyze the results and allocate variables

exec sql execute immediate :stmt_buffer
  using descriptor :sqlda;
exec sql begin;
process results, generating report
if error occurs, then
  exec sql endselect;
endif
exec sql end;
...
```

Using a Cursor to Retrieve the Results

To give your program the ability to access the database or issue other database statements while processing rows retrieved as the result of the select, use a cursor to retrieve those rows.

To use cursors, after the SQLDA has been analyzed and result variables have been allocated and pointed at, the program must declare and open a cursor in order to fetch the result rows. The syntax of the cursor declaration for a dynamically defined select statement is as follows:

```
exec sql declare cursor_name cursor for statement_name;
```

This statement associates the select statement represented by *statement_name* with the specified cursor. *Statement_name* is the name assigned to the statement when the statement was prepared. As with non-dynamic cursor declarations, the select statement is not evaluated until the cursor is actually opened. After opening the cursor, the program retrieves the result rows using the fetch statement with the SQLDA instead of the list of output variables.

The syntax for a cursor fetch statement is as follows:

```
exec sql fetch cursor_name using descriptor descriptor_name;
```

Before the fetch statement, the program has filled the result descriptor with the addresses of the result storage areas. When executing the fetch statement, OpenSQL copies the result columns into the result areas referenced by the descriptor.

The following program fragment elaborates on an earlier example in this section. The program reads a statement from the terminal. If the statement is quit, the program ends. Otherwise, the program prepares the statement. If the statement is not a select, then it is executed. If the statement is a select statement, then it is described, a cursor is opened, and the result rows are fetched. Error handling is not shown.

```
exec sql include sqlca;
exec sql include sqlda;

allocate an sqlda with 400 sqlvar elements;
sqlda.sqln = 400;

read statement_buffer from terminal;

loop while (statement_buffer <> 'quit')

exec sql prepare s1 from :statement_buffer;
exec sql describe s1 into sqlda;

if (sqlda.sqlid = 0) then /* This is not a select */
  exec sql execute s1;
else /* This is a select */
  exec sql declare c1 cursor for s1;
  exec sql open c1;

print column headers from the sqlname fields;
analyze the SQLDA, inspecting types and lengths;
allocate result variables for a cursor result row;
set sqlvar fields sqldata and sqlind;

loop while (sqlca.sqlcode = 0)
  exec sql fetch c1 using descriptor sqlda;
  if (sqlca.sqlcode = 0) then
    print the row using sqldata and sqlind
    pointed at by the sqlvar array;
  end if;
end loop;

free result variables from the sqlvar elements;
exec sql close c1;

end if;

process sqlca and print the status;
read statement_buffer from terminal;

end loop;
```


Chapter 7: OpenSQL Features

This chapter discusses the following features of OpenSQL:

- Transactions
- Status information and error handling
- Multiple session connections
- Database procedures
- DBMS-specific extensions (using the with clause and the direct execute immediate statement)
- Database events

Transactions

A *transaction* is one or more OpenSQL statements processed as a single, indivisible database action. A transaction that consists of a single OpenSQL statement is sometimes called a single query transaction (SQT). If the transaction contains multiple statements, it is often called a multiple query transaction (MQT).

By default, all transactions are multiple query transactions. The transaction begins with the first OpenSQL statement following a connect, commit, or rollback statement, which can be issued by you, the program, or in some instances, by the DBMS. The transaction continues until there is an explicit commit or rollback statement or until the session terminates. (Terminating the session or disconnecting from the database normally issues an implicit commit statement. If the session or connection terminates abnormally, the results depend on the host DBMS.)

In Enterprise Access products, transactions are managed by the underlying DBMS. Transaction handling may vary depending on the DBMS to which your session is connected.

For example, some DBMSs begin a transaction immediately following the connect or rollback statements, rather than awaiting the next OpenSQL statement. For details, see the documentation for the host DBMS.

None of the database changes made by a transaction are visible to other sessions until the transaction is committed. In a multi-user environment, where many transactions may be executing simultaneously, this behavior maintains database consistency. For example, if two transactions are updating

the same information in a table, the DBMS must ensure that one transaction's updates are complete before allowing the other to proceed.

Controlling Transactions

The commit and rollback statements allow control of the effects of a transaction on the database:

- The commit statement makes the changes permanent.
- The rollback statement undoes the changes made by the transaction.

When a commit statement is issued, the DBMS makes all changes resulting from the transaction permanent, terminates the transaction, and drops any locks held during the transaction. When a rollback statement is issued, the DBMS undoes any database changes made by the transaction, terminates the transaction, and releases any locks held during the transaction.

Committing Transactions

Transactions are composed of one or more OpenSQL statements. In general, a transaction begins with the first statement after connection to the database or the first statement following a commit or rollback. The precise starting point of a transaction depends on the DBMS to which you are connected. Subsequent statements are part of the transaction until a commit or rollback is executed. By default, an explicit commit or rollback must be issued to close a transaction.

To direct the DBMS to commit each database statement individually, use the set autocommit on statement. (This statement cannot be issued in an open transaction.) When autocommit is set on, a commit occurs automatically after every statement, except prepare and describe.

If autocommit is on and a cursor is opened, the server or Enterprise Access product does not issue a commit until the close cursor statement is executed, because cursors are logically a single statement. A rollback statement can be issued when a cursor is open. To restore the default behavior (and enable multiquery transactions), issue the set autocommit off statement.

To determine whether you are in a transaction, use the inquire_sql statement. For information about inquire_sql, see [Retrieving Status Information](#) in this chapter and Inquire_sql in the "OpenSQL Statements" chapter. To find out if autocommit is on or off, use dbmsinfo. For information about dbmsinfo, see [The Dbmsinfo Function](#) in this chapter.

Aborting Statements and Transactions

Transactions and statements can be aborted by an application or by the DBMS. Applications can abort transactions or statements as a result of:

- Rollback statement
- Timeout (if available and set)

The DBMS aborts statements and transactions as a result of these conditions:

- Deadlock
- Error while executing a database statement

Effects of Aborting Transactions

When a statement or transaction is aborted:

- Rolling back a single statement does not cause the DBMS to release any locks held by the transaction. Locks are released when the transaction ends.
- If cursors are open, the entire transaction is always aborted.
- When an entire transaction is aborted, all open cursors are closed, and all prepared statements are invalidated.

Interrupting Transactions

The effect of a keyboard interrupt (Ctrl+C or Ctrl+Y) on a transaction depends on the Enterprise Access product and underlying DBMS. For details, see the DBMS documentation.

Retrieving Status Information

The following features enable your application program to obtain status information:

- **Dbmsinfo** - Returns information about the current session
- **Inquire_sql** - Returns information about the last database statement that was executed
- **Inquire_frs** - Returns information about the forms system
- **SQLCA** (SQL Communications Area) - Returns status and error information about the last OpenSQL statement that was executed

These statements are described in the following sections.

The Dbmsinfo Function

Dbmsinfo is a function that returns a string containing information about the current session. This statement can be used in the Terminal Monitor or in an embedded OpenSQL application. The dbmsinfo statement has the following syntax:

```
select dbmsinfo ('request_name') [as result_column]
```

For example, to determine which version of the Enterprise Access product or server you are using, enter:

```
select dbmsinfo('_version');
```

In OpenSQL, only one dbmsinfo request is allowed per select statement. In addition, when issuing a select dbmsinfo statement, you cannot specify other select statement clauses (such as from or where).

The following table lists valid *request_names*:

Request Name	Response Description
autocommit_state	Returns 1 if autocommit is on; 0 if autocommit is off.
_bintim	Returns the current time and date in an internal format, represented as the number of seconds since January 1, 1970 00:00:00 GMT.
database	Returns the name of the database to which the session is connected.
dba	Returns the DBMS username of the database owner.
_et_sec	Returns the elapsed time for session, in seconds.
query_language	Returns query language in use ("SQL").
server_class	Returns the class of DBMS server, for example "db2".
terminal	Returns the terminal address for local connections.
transaction_state	Returns 1 if presently in a transaction, 0 if not.
username	Returns the DBMS user name of the current session's user (like user).
_version	Returns the DBMS version number.

The Inquire_sql Statement

The inquire_sql statement returns information about the results of the last OpenSQL database statement issued by a session. Using inquire_sql you can obtain a variety of information, including:

- Error number and text (if the last statement resulted in an error)
- Type of error being returned (for details, see [Local and Generic Errors](#) in this chapter)
- Whether a transaction is open
- Session identifier (in multiple-session applications)

Note: The inquire_sql statement does not return status information about forms statements. Use the inquire_frs statement, described in the *Forms-based Application Development Tools User Guide*, to obtain information about forms statements.

The SQL Communications Area (SQLCA)

The SQL Communications Area (SQLCA) consists of a number of variables that contain error and status information accessible by the program. This information reflects only the status of executed embedded OpenSQL database statements. Forms statements do not affect these variables. Because each embedded OpenSQL statement has the potential to change values in the SQLCA, the application must perform any checking and consequent processing required to deal with a status condition immediately after the statement in question. Otherwise, the next executed OpenSQL statement might change the status information in the variables.

Each host language implements the SQLCA structure differently. For instructions on how to include the SQLCA in your applications, see the *Embedded SQL Companion Guide*.

The following list describes the variables that compose the SQLCA (not all of the variables are currently used):

sqlcaid	An 8-byte character string variable initialized to "SQLCA." This value does not change.
sqlcabc	A 4-byte integer variable initialized to the length in bytes of the SQLCA, 136. This value also does not change.
sqlcode	A 4-byte integer variable indicating the OpenSQL return code. Its value falls into one of three categories: = 0 The statement executed successfully (though there may have been warning messages - see sqlwarn0).

< 0	An error occurred. The value of sqlcode is the negative value of the error number returned to errno. (For a discussion of errno, see Error Handling in this chapter.) A negative value sets the sqlerror condition of the whenever statement.
>0	The statement executed successfully but an exceptional condition occurred. The value +100 indicates that no rows were processed by a delete, fetch, insert, select, update, modify, copy, create index, or create...as select statement. This value (+100) sets the not found condition of the whenever statement.
sqlerrm	A varying-length character string variable composed of an initial 2-byte count and a 70-byte long buffer. This variable is used for error messages. When an error occurs for a database statement, the leading 70 characters of the error message are assigned to this variable. If the message contained within the variable is less than 70 characters, the variable contains the complete error message. Otherwise, the variable contains a truncated error message. To retrieve the full error message, use the inquire_sql statement with the errortext object. If no errors occur, sqlerrm will contain blanks. For some languages, this variable is divided into two other variables: sqlerrml, a 2-byte integer count indicating how many characters are in the buffer, and sqlerrmc, a 70-byte fixed-length character string buffer.
sqlerrp	An 8-byte character string variable, currently unused.
sqlerrd	An array of six 4-byte integers. Currently only sqlerrd(1) and sqlerrd(3) are in use. sqlerrd(1) is used to store error numbers returned by the server. For more information about sqlerrd(1), see Local and Generic Errors in this chapter. sqlerrd (3) indicates the number of rows processed by a delete, fetch, insert, select, update, copy, modify, create index, or create...as select statement. All other database statements reset this variable to zero. Some host languages start array subscripts at 0. In these languages (C, BASIC), use the subscript 2 to select the third array variable.
qlwarn0 through sqlwarn7	A set of eight 1-byte character variables that denote warnings when set to "W." The default values are blanks. sqlwarn0 If set to "W," at least one other sqlwarn contains a "W." When "W" is set, the sqlwarning condition of the whenever statement is set.

sqlwarn1	Set to "W" on truncation of a character string assignment from the database into a host variable. If an indicator variable is associated with the host variable, the indicator variable is set to the original length of the character string.
sqlwarn2	Set to "W" on elimination of nulls from aggregates.
sqlwarn3	Set to "W" when mismatching number of result columns and result host variables in a fetch or select statement.
sqlwarn4	Set to "W" when preparing (prepare) an update or delete statement without a where clause.
sqlwarn5	Currently unused.
sqlwarn6	Set to "W" when the error returned in sqlcode caused the abnormal termination of an open transaction.
sqlwarn7	Currently unused.
sqlext	An 8-byte character string variable not currently in use.

Error Handling

The following section describes the types of errors returned to OpenSQL sessions, and the methods used to handle errors.

The SQLSTATE Variable

The SQLSTATE variable is a 5-character string in which OpenSQL returns the status of the last SQL statement executed. The values returned in SQLSTATE are specified in the ANSI/ISO Entry SQL-92 standard. For details about the requirements for declaring the SQLSTATE variable in embedded programs, see the *Embedded SQL Companion Guide*.

If queries are executed while connected to a DBMS that does not support SQLSTATE, SQLSTATE is set to '5000K' (meaning "SQLSTATE not available"). This result does not necessarily mean that an error occurred. To check the results of the query, one of the other error-checking methods must be used. SQLSTATE is not available within database procedures. However, a routine that directly executes a database procedure can check SQLSTATE to determine the result of the procedure call.

The following is a brief example illustrating the use of SQLSTATE in an embedded program:

```
exec sql begin declare section;
      character      SQLSTATE(5)
exec sql end declare section;
exec sql connect mydatabase;
if SQLSTATE <> "00000" print 'Error on connection!'
```

Local and Generic Errors

A local error is a specific error issued by a specific server, such as Ingres or the Enterprise Access to IBM DB2 UDB product. All server-specific local errors are also mapped into generic errors, enabling applications to handle errors returned from a variety of servers in a consistent way.

For example, the Ingres DBMS returns the local error number 4702 for a timeout error, but other database management systems may return different error numbers for a timeout error. To handle errors consistently, OpenSQL maps the different local timeout error numbers to the same generic error number.

By default, Enterprise Access servers return errors as follows:

- Generic errors
 - Returned to `sqlcode` (an SQLCA variable) as a negative value
 - Returned when your application issues the `inquire_sql(errno)` statement
- Local errors
 - Returned in `sqlerrd(1)`, the first element of the SQLCA's `sqlerrd` array
 - Returned when your application issues the `inquire_sql(dbmserror)` statement

To reverse this arrangement (so that local error numbers are returned to `errno` and `sqlcode` and generic errors to `dbmserror` and `sqlerrd(1)`), use the `set_sql(errortype)` statement. To obtain the text of error messages, use the `inquire_sql(errortext)` statement or check the SQLCA variable `sqlerrm`.

Reading an OpenSQL Error Message

Every generic error message consists of an error code and the accompanying error message text.

All generic error codes begin with E_, followed by one or two letters plus a 4-digit hexadecimal number, and, optionally, descriptive text or the decimal equivalent of the hex error code. For example:

E_GEC2EC_SERIALIZATION

indicates a serialization failure (deadlock).

The content and format of local error messages are determined by the local DBMS.

Displaying an Error Message

If you are working in one of the forms-based user interfaces, such as the Terminal Monitor, error messages display on a single line across the bottom of the terminal screen. The text appears first, followed by the error code. If the text is longer than one line, press the Help key to display the rest of the message. To clear the error message from the screen, press the Return key.

If you are not working in a forms-based user interface, OpenSQL displays the error code followed by the entire message text.

If you have included an SQLCA, embedded OpenSQL applications do not automatically display error messages. You must provide program code to do so.

Handling Errors in Embedded Applications

OpenSQL provides a variety of tools for trapping and handling errors in embedded applications, including:

- The SQLCA
- The whenever statement
- Handler routines
- Inquire statements
- The IIseterr function

Obtaining Error Information from the SQLCA

The SQL Communications Area (SQLCA) is a collection of host language variables whose values provide status and error information about embedded OpenSQL database statements. (The status of forms statements is not reflected in SQLCA variables.) If your application does not have an SQLCA, the default is to display errors and continue with the next statement if possible.

Two variables in the SQLCA contain error information: sqlcode and sqlerrm. The value in sqlcode indicates one of three conditions:

- **Success** - Sqlcode contains zero.
- **Error** - Sqlcode contains the error number as a negative value.
- **Warning** - (Set when the statement executed successfully but an exceptional condition occurred.) Sqlcode contains +100, indicating that no rows were processed by a delete, fetch, insert, update, modify, copy, or create table...as statement.

The sqlerrm variable is a varying length character string variable that contains the text of the error message. The maximum length of sqlerrm is 70 bytes. If the error message exceeds that length, OpenSQL truncates the message when it assigns it to sqlerrm. To retrieve the full message, use the inquire_sql statement (see [The Inquire sql Statement](#) in this chapter). In some host languages, this variable has two parts: sqlerrml, a 2-byte integer indicating how many characters are in the buffer, and sqlerrmc, a 70-byte fixed length character string buffer.

The SQLCA also contains eight 1-byte character variables, sqlwarn0 - sqlwarn7, that are used to indicate warnings. For a complete listing of these, see [The SQL Communications Area \(SQLCA\)](#) in this chapter.

The SQLCA is often used in conjunction with the whenever statement, which defines a condition and an action to take whenever that condition is true. The conditions are set to true by values in the sqlcode variable. For example, if sqlcode contains a negative error number, then the sqlerror condition of the whenever statement is true, and any action specified for that condition is performed.

You can also access the SQLCA variables directly. For information about implementing the SQLCA in an application and using its variables, see the *Embedded SQL Companion Guide*.

Trapping Errors Using the Whenever Statement

The whenever statement specifies a particular action to be performed whenever a particular condition is true. Since conditions are set to true by values in the SQLCA sqlcode, the whenever statement responds only to errors generated by embedded OpenSQL database statements. Forms statements do not set sqlcode.

The conditions that indicate errors or warnings are listed in the following table:

Condition	Description
sqlwarning	Indicates that the executed OpenSQL database statement produced a warning condition. Sqlwarning becomes true when the SQLCA sqlwarn0 variable is set to "W."
sqlerror	Indicates that an error occurred in the execution of the database statement. Sqlerror becomes true when the SQLCA sqlcode variable contains a negative number.

There are two other conditions that are more closely related to status conditions rather than error conditions. For a complete list of the conditions, see [Whenever](#) in the chapter "OpenSQL Statements."

The actions that can be specified for these conditions are listed in the following table:

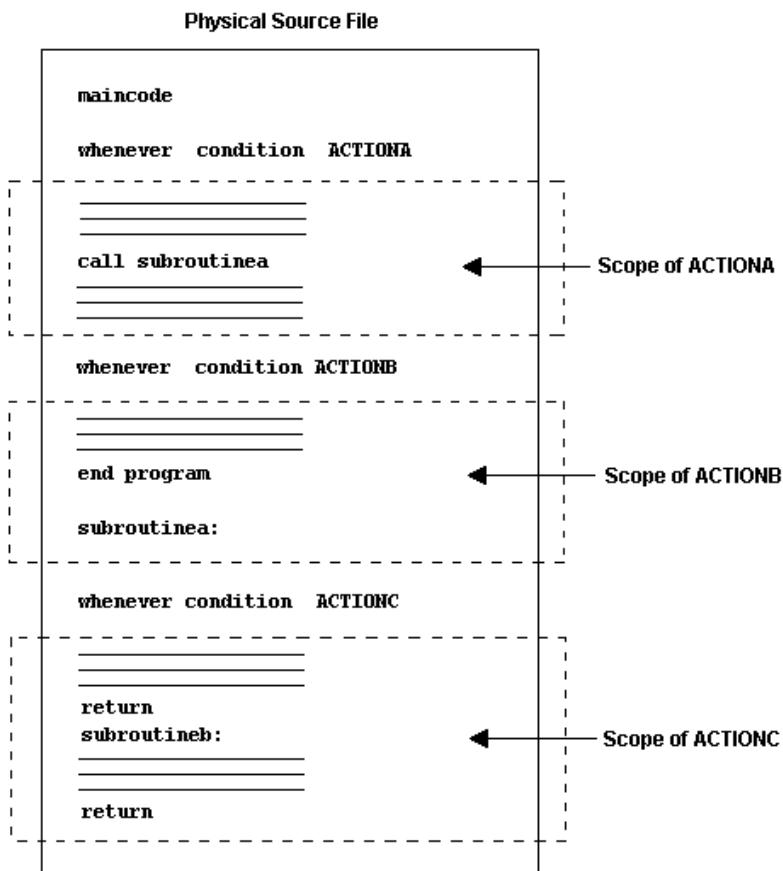
Action	Description
continue	Execution continues with the next statement.
stop	Prints an error message and terminates the program's execution. Pending updates are not committed.
goto <i>label</i>	Performs a host language "go to."
call <i>procedure</i>	Calls the specified host language procedure. If call sqlprint is specified, the sqlprint procedure prints the error or warning message and continues with the next statement.

In an application program, a whenever statement is in effect until the next whenever statement (or the end of the program). For example, if you put the following statement in your program:

```
exec sql whenever sqlerror call myhandler;
```

OpenSQL traps errors for all database statements in your program that physically follow the whenever statement to the procedure, myhandler. A whenever statement does not affect the statements that physically precede it.

The following diagram illustrates the scope of the whenever statement:



If your program includes an SQLCA, OpenSQL will not display error messages unless your application issues a whenever ... sqlprint statement, or you set II_EMBED_SET to sqlprint.

Defining an Error Handler

An error handling function can be defined to be called when OpenSQL errors occur. To do this, you must:

- Write the error handling routine and link it into your embedded OpenSQL application.
- In the application, issue the following set statement:
`exec sql set_sql(errorhandler = error_routine)`

... where *error_routine* is the name of the error-handling routine you created. Do not declare *error_routine* in an OpenSQL declare section, and do not precede *error_routine* with a colon (:). The *error_routine* argument must be a function pointer.

When this form of error-trapping is enabled, all OpenSQL errors are trapped to your routine until you disable error-trapping (or until the application terminates). Forms errors are not trapped.

To disable the trapping of errors to your routine, your application must issue the following set statement:

```
exec sql set_sql(errorhandler = 0 | :error_var)
```

where *error_var* is a host integer variable having a value of 0.

Your error-handling routine must not issue any database statements in the same session in which the error occurred. If it is necessary to issue database statements in an error handler, open a session or switch to another session.

To obtain error information, your error-handling routine should issue the inquire_sql statement.

Obtaining Error Information Using Inquire Statements

There are two inquire statements that can perform error checking: inquire_sql and inquire_frs. Both statements return error numbers and the associated error text using the constants errno and errortext. Inquire_sql returns the error number and text for the last executed OpenSQL database statement. Inquire_frs returns information about the last executed forms statement.

Unlike the whenever statement, an inquire statement must be executed immediately after the database or forms statement in question. The inquire_sql returns a generic error number in errno by default. OpenSQL can be directed to return a local error number in errno. For more information, see [Local and Generic Errors](#) in this chapter.

Neither of the inquire statements suppress the display of error messages. Both of the inquire statements return a wide variety of information in addition to error numbers and text. For a complete list of the information returned by inquire_sql, see "[Chapter 8: OpenSQL Statements](#)." For details about inquire_frs, see the *Forms-based Application Development Tools User Guide*.

Suppressing Error Messages

The IIseterr function is a feature that allows the display of error messages to be suppressed. Although IIseterr is intended for use in Ingres 4GL applications, it can also be used to suppress error messages generated by forms statements. For details, see the *4GL Reference Guide*.

If IIseterr is used in an embedded OpenSQL program that makes use of the SQLCA, errors returned by embedded OpenSQL database statements do not interact with IIseterr. If your program does not use the SQLCA, errors resulting from both forms statements and embedded OpenSQL database statements are passed through IIseterr, if it is present. For ease of use and implementation, it is recommended that you use the SQLCA and whenever statements to handle embedded OpenSQL database statement errors.

Specifying Program Termination on Errors

The `set_sql(programquit)` statement specifies how an embedded OpenSQL application handles the following types of errors:

- Attempting to execute a query when not connected to a database
- Enterprise Access product or DBMS server failure
- Communications service failure

By default, when these types of errors occur, OpenSQL issues an error but lets the program continue. To force an application to abort when one of these errors occur, issue the following `set_sql` statement:

```
exec sql set_sql (programquit = 1);
```

If an application aborts as the result of one of the previously listed errors, OpenSQL issues an error, then rolls back open transactions and disconnects all open sessions. (To disable aborting and restore the OpenSQL default behavior, specify `programquit = 0`.)

Errors affected by the `programquit` setting belong to the generic error class `GE_COMM_ERROR`, which is returned to `errno` as 37000, and to `sqlcode` (in the SQLCA) as -37000. An application can check for these errors and, when detected, must disconnect from the current session. After disconnecting from the current session, the application can attempt another connection, switch to another session (if using multiple sessions), or perform clean-up operations and quit.

You can also specify `programquit` using `II_EMBED_SET`.

To determine the current setting for this behavior, use the `inquire_sql` statement:

```
exec sql inquire_sql (int_variable = programquit);
```

This returns a 0 if `programquit` is not set (OpenSQL continues on any of the errors) or 1 if `programquit` is set (OpenSQL exits the application on these errors).

Handling Deadlock

Deadlock occurs when two transactions are each waiting for the other to release a part of the database to enable it to complete its update. Transactions that handle deadlocks in conjunction with other errors can be difficult to code and test, especially if cursors are involved.

To facilitate the proper coding and testing for these situations, you can use the following three template programs as guides in your resolution of similar error situations. Deadlock conditions are identified by the generic error code value of E_GEC2EC_SERIALIZATION.

The following templates assume the default OpenSQL transaction behavior (set autocommit is off).

Non-cursor Template

This template assumes your transactions do not contain a cursor.

```
exec sql whenever not found continue;
exec sql whenever sqlwarning continue;
exec sql whenever sqlerror goto err;
/* branch on error */

start:
exec sql insert into ...
exec sql update ...
exec sql select ...

exec sql commit;
goto end;
err:
exec sql whenever sqlerror call sqlprint;
  if (sqlca.sqlcode = E_GEC2EC_SERIALIZATION) then
    goto start;
  else if (sqlca.sqlcode < 0) then
    exec sql inquire_sql (:err_msg = errortext);
    exec sql rollback;
    print 'Error', err_msg;
  end if;
end:
```

Single Cursor Template

This template is similar to the first, but with a single cursor added.

```
exec sql whenever not found continue;
exec sql whenever sqlwarning continue;
exec sql whenever sqlerror goto err;
/* branch on error */

exec sql declare c1 cursor for ...

start:
exec sql open c1;
while more rows loop
```

```
exec sql fetch c1 into ...
if (sqlca.sqlcode = E_GE0064_NO_MORE_DATA) then
  exec sql close c1;
  exec sql commit;
  goto end;
end if;

exec sql insert into ...
exec sql update ...
exec sql select ...

end loop;
goto end

err:
exec sql whenever sqlerror call sqlprint;
if (sqlca.sqlcode = E_GEC2EC_SERIALIZATION) then
  goto start;
else if (sqlca.sqlcode != 0) then
  exec sql inquire_sql (:err_msg = errortext);
  exec sql rollback;
  print 'Error', err_msg;
end if;

end:
```

Master/Detail Template

This template is like the previous one, but includes two cursors with a master/detail relationship.

```
exec sql whenever not found continue;
exec sql whenever sqlwarning continue;
exec sql whenever sqlerror goto err;
/* branch on error */

exec sql declare master cursor for ...
exec sql declare detail cursor for ...

start:
exec sql open master;
while more master rows loop
  exec sql fetch master into ...
  if (sqlca.sqlcode = E_GE0064_NO_MORE_DATA) then
    exec sql close master;
    exec sql commit;
    goto end;
  end if;

/* ...queries using master data... */
  exec sql insert into ...
  exec sql update ...
  exec sql select ...

  exec sql open detail;
  while more detail rows loop
    exec sql fetch detail into ...
    if (sqlca.sqlcode = E_GE0064_NO_MORE_DATA) then
      exec sql close detail;
      end loop; /* drops out of detail fetch loop */
    end if;

/* ...queries using detail & master data... */
```

```

exec sql insert into ...
exec sql update ...
exec sql select ...

end loop; /* end of detail fetch loop */

/* ...more queries using master data... */
exec sql insert into ...
exec sql update ...
exec sql select ...

end loop; /* end of master fetch loop */
goto end

err:
exec sql whenever sqlerror call sqlprint;
if (sqlca.sqlcode = E_GEC2EC_SERIALIZATION) then
  goto start;
else if (sqlca.sqlcode < 0) then
  exec sql inquire_sql (:err_msg = errortext);
  exec sql rollback;
  print 'Error', err_msg;
end if;
end:

```

Multiple Session Connections

OpenSQL provides embedded applications with the ability to maintain multiple sessions. An application can open an initial session and, with subsequent connect statements, open additional sessions with the same or different types of servers or Enterprise Access products.

Connecting to Multiple Sessions

Individual sessions in a multiple session application are identified by a session identifier that is specified when the connect statement for each session is issued. Each connect statement in a multiple session application, including the first connect statement, must specify a session identifier.

It is possible to open new sessions with previously unconnected databases or with databases already associated with an open session. New sessions can be opened under different user names (for Enterprise Access products that support the connect statement's identified by clause) and can be entered using different option flags. For a description of syntax and optional flags for connect, see the *SQL Reference Guide*.

Once an application issues a connect statement, the session initiated by the statement is the current session and all subsequent embedded OpenSQL statements apply to the database associated with that statement until another connect statement or a set_sql statement (to switch sessions) is issued.

If an error occurs during a connection attempt, the program is no longer connected to any session after the failure, whether or not it was connected before the attempted connection. After the failure of an attempt to connect, the program must either attempt to connect again or switch to a previously established session before continuing.

Switching Sessions

To switch from one open session to another, use the `set_sql` statement. To open a new session, issue the `connect` statement. To determine the session identifier for the current session, use the `inquire_sql` statement.

Applications can switch sessions freely. Note that session switching is supported under the following circumstances:

- In a transaction.
- While cursors are open.
- In OpenSQL statement blocks (such as select loops).
The code for the nested session must be inside a host language subroutine. If it is not, the SQL preprocessor will issue an error.
- In subroutines called by a `whenever` statement.

After an application switches sessions, the error information obtained from the `SQLCA` or the `inquire_sql` statement is not updated until an OpenSQL statement has completed in the new session.

Terminating a Session

To terminate the current session, the application issues the `disconnect` statement. An optional session identifier parameter exists to identify the current session specifically if desired.

When an application terminates one of many open sessions, it is not automatically placed in another session. The application must issue either a `connect` or `set_sql` statement to establish the current session. If the application fails to do this, OpenSQL returns an error when the next OpenSQL statement is issued.

To terminate a specific session, specify the session identifier. To obtain the session identifier for the current session, issue the `inquire_sql(:session_id=session)` statement. To disconnect all sessions, issue the `disconnect all` statement.

Multiple Sessions and the SQLCA

The SQL Communications Area (SQLCA) is a data area in which OpenSQL passes query status information to your application program. Although an application can sustain multiple sessions, there is only one SQLCA per application. By contrast, the values returned by `inquire_sql(errorcode)` and `inquire_sql(errortext)` are specific to a session.

If you switch sessions in a select loop (for example, by calling a routine that switches sessions) and execute database statements in the alternate session, the values in the SQLCA will be reset. When you return to the original session, the SQLCA will not reflect the results of the select loop.

When switching between sessions, the values in the SQLCA fields are not updated until after the first OpenSQL statement in the current session has completed. If you switch sessions, the values in the SQLCA will apply to the previous session until an OpenSQL statement in the current session resets them. In contrast, the error information returned by `inquire_sql` (`errortext` and `errno`) always apply to the current session.

When an application switches sessions within a select loop or other block statement, the SQLCA field values are updated to reflect the status of the statements executed inside the nested session. After the application switches back to the session with the loop, the SQLCA field values reflect the status of the last statement in the nested session. `Sqlcode` and `sqlwarn` are not updated until the statement immediately following the loop completes. (The information obtained by `inquire_sql` is not valid until the statement following a loop completes.) For this reason, the application should reset the `sqlcode` and `sqlwarn` fields before continuing the loop.

Multiple Sessions and the DBMS

Each session in a multiple-session application requires an independent connection to the Enterprise Access products or DBMS server. When creating multiple-session applications, keep the following points in mind:

- In a multi-session application, an application can encounter deadlock against itself. For example, one session may attempt to update a table that was locked by another session.
- An application can also lock itself out in an undetectable manner. For example, if a table is updated in a transaction in one session and then selected from in another transaction in a second session, the second session waits indefinitely.
- For sessions connected to Ingres databases, be sure that the server parameter `connect_limit` is large enough to accommodate the number of sessions required by the application.

Multiple Session Examples

This section presents two examples of multiple sessions. The first example, illustrates session switching using two open sessions in a forms-based application. These sessions gather project information for updating the projects database using the personnel database to verify employee identification numbers.

```
exec sql begin declare section;
  empid integer;
  found integer;
  ...
exec sql end declare section;

/* Set up two database connections */
exec sql connect 'projects/rdb' session 1;
exec sql connect 'unixbox::personnel/db2udb' session 2;

/* Set 'projects' database to be current session */
exec sql set_sql (session = 1);

exec frs display projectform;
exec frs activate field empid;
exec frs begin;

/* Validate user-entered employee id against master
** list of employees in personnel database. */

found = 0;
exec sql getform (:empid = empid);

/* Switch to 'personnel' database session */
exec sql set_sql (session = 2);
exec sql repeated select 1 into :found from employee
  where empid = :empid;

/* Switch back to 'project' database session */
exec sql set_sql (session = 1);
if (found !=1) then
  exec frs message 'Invalid employee identification';
  exec frs sleep 2;
else
  exec frs resume next;
endif;

exec frs end;
program code to validate other fields in
  'projectform'
exec frs activate menuitem 'Save';
exec frs begin;
get project information and update 'projectinfo'
  table
exec frs end;
...

exec sql disconnect;
exec sql set_sql (session = 2);
exec sql disconnect;
```

The second example illustrates session switching inside a select loop and the resetting of status fields. The main program processes sales orders and calls the subroutine, `new_customer`, for every new customer.

The main program:

```
...
exec sql include sqlca;
exec sql begin declare section;

/* Include output of DCLGEN for declaration
** of record order_rec
*/
exec sql include 'decls';
exec sql end declare section;
exec sql connect 'customers/alb' session 1;
exec sql connect sales session 2;
...

exec sql select * into :order_rec from orders;
exec sql begin;
if (order_rec.new_customer = 1) then
  call new_customer(order_rec);
endif
process order;
exec sql end;
...

exec sql disconnect;

exec sql set_sql(session = 1);
exec sql disconnect;
```

The subroutine, `new_customer`, from the select loop, containing the session switch:

```
subroutine new_customer(record order_rec)
begin;

exec sql set_sql(session = 1);
exec sql insert into accounts values (:order_rec);

process any errors;
exec sql set_sql(session = 2);

sqlca.sqlcode = 0;
sqlca.sqlwarn.sqlwarn0 = ' ';
end subroutine;
```

Database Procedures

A *database procedure* is a named routine that is stored in the host DBMS or linked to an Enterprise Access or EDBC product. The following sections describe how to create, declare, and execute database procedures.

Creating Database Procedures

Database procedures can be created using the following methods:

- **Ingres Database Procedures** - The Ingres DBMS (and some Enterprise Access and EDBC products) allows you to create database procedures using the create procedure statement. For details about the create procedure statement, see the *SQL Reference Guide*.
- **Host DBMS Procedures** – Enterprise Access and EDBC provide access to procedures located in the host DBMS. (These procedures are created and maintained in the host DBMS.) The procedure must be declared to Enterprise Access or EDBC by issuing the register procedure statement. For details regarding support of host DBMS procedures, see your Enterprise Access or EDBC product guide. For details about creating and managing the host DBMS procedures, see your host DBMS documentation.
- **Enterprise Access and EDBC Procedures** – Enterprise Access and EDBC to host DBMSs that do not support database procedures provide an alternate mechanism for database procedures: object code modules for the routine are linked into the Enterprise Access or EDBC executable program. These routines must be declared to Enterprise Access or EDBC by issuing the register procedure statement. For details on the creating and registering this kind of procedure, see your Enterprise Access or EDBC product guide.
- **Ingres Distributed Option** – Using the Distributed Option, you can execute database procedures that are located in a remote database, Enterprise Access, or EDBC.

Note: OpenSQL does not control the transaction behavior that occurs when executing a database procedure. Transaction behavior is determined by the host DBMS.

Registering Database Procedures

The register procedure statement defines the interface between an application and a database procedure when support for the create procedure statement is not available. Creation and maintenance of the database procedure is dependent on the host DBMS, Enterprise Access, or EDBC. The register procedure statement defines the procedure name, its parameters and their types, and the host DBMS, Enterprise Access, or EDBC information required to access the procedure.

Non-row returning register procedure syntax:

```
register procedure procedure_name
  [(parameter_definition {,parameter_definition})]
  as import from '...'
  with [with_clause]
```

Note: The byref keyword can be used for parameters.

Row-returning register procedure syntax:

```
register procedure procedure_name
  [(parameter_definition {,parameter_definition})]
  as import from '...'
  result row (return_type_list);
```

Note: The byref keyword cannot be used for parameters.

The *procedure_name* specifies the procedure name to be used in the OpenSQL execute procedure or remove procedure statements. The from clause specifies host DBMS, Enterprise Access, or EDBC information required to identify the procedure being registered. Additional information may be required by an Enterprise Access or EDBC product, and is specified using the optional with clause. The *return_type_list* is a list of data types.

The *parameter_definition* is specified as:

```
parameter_name datatype [not|with null]
  [not default | [with] default [default_value]]
  [byref]
  [is host_info]
```

Parameters are nullable unless you specify not null. The *default_value* can be a numeric or character literal or one of the following constants: null, user, current_date, or current_time. If the default value is omitted, a system-generated default is assigned. If the default clause is omitted, default null is assumed. The byref keyword specifies that the parameter is passed by reference, enabling the procedure to return a value in the parameter. The byref keyword must also be used in the execute procedure statement to obtain the returned value. Byref cannot be used if the procedure returns rows. The is clause specifies additional information about the parameter, as required by the host DBMS, Enterprise Access, or EDBC product. The host information must be enclosed in single quotes.

Deleting a Procedure Registration

To delete a procedure registration, use the remove procedure statement. After deleting the registration, the procedure cannot be executed (unless you register the procedure again).

The remove procedure syntax is:

remove procedure *procedure_name*

For details about using the register procedure or remove procedure statements, see your Enterprise Access or EDBC product guide.

Executing Database Procedures

To execute a database procedure, issue the execute procedure statement.

To ensure portability of your application code and consistency of the transactions in your application, observe the following guidelines for executing database procedures:

- Do not issue commit or rollback statements within a database procedure, because these statements or their equivalents may not be supported in all host database management systems.
- Issue a commit or rollback statement before and after executing a database procedure.
- If an error occurs while a database procedure is being executed, the current transaction may be rolled back by the host DBMS. While this is permitted by OpenSQL, it is not required. After executing a database procedure, your application should check for errors and, if necessary, roll back the transaction.

DBMS Extensions

OpenSQL statements work with all Enterprise Access, EDBC, and DBMS servers. However, the underlying DBMS typically supports additional SQL statements and extensions. (For example, Ingres SQL includes statements that support rules and database events, and the DB2 UDB SQL create table statement includes extensions governing "editprocs.")

OpenSQL provides the following methods for issuing DBMS-specific statements from an OpenSQL application:

- **Ingres SQL extensions** - These can be coded directly in an application. The embedded SQL or 4GL preprocessors recognize the extension and execute it properly. However, extended statements will fail if issued against a non-Ingres DBMS.

- **Direct execute immediate** - The direct execute immediate statement passes a statement to the underlying DBMS. OpenSQL does not attempt to process or translate the statement. The direct execute immediate statement can be used with any SQL statement that can be executed dynamically (statements that can be issued with a DBMS execute immediate). Statements that return rows (for example, select or fetch) cannot be issued.
- **Enterprise Access and EDBC with clause** – Many Enterprise Access and EDBC products support with clauses that provide the ability to access DBMS extensions to database connection and Data Definition Language (DDL) SQL statements. The following section describes the EDBC and Enterprise Access with clause in detail.

The With Clause

The Enterprise Access and EDBC with clause enables DBMS-specific options to be specified in an OpenSQL statement. EDBC and Enterprise Access servers process only the options directed at them, and ignore the rest. Valid options depend on the specific Enterprise Access or EDBC product, and DBMS. For information on valid with clause parameters, see your Enterprise Access or EDBC product guide. The DBMS, Enterprise Access, or EDBC is responsible for performing the specified action or translating the with clause to the syntax required by the underlying DBMS.

The following OpenSQL statements support the Enterprise Access and EDBC with clause:

- Connect
- Create index
- Create table
- Create view
- Drop index
- Drop table
- Drop view

Syntax of the With Clause

The with clause must be specified using the following syntax:

```
with [db_id_]option_name [= option_value]
      {, [db_id_]option_name [= option_value]}
```

The with clause can contain options intended for different Enterprise Access or EDBC products. Enterprise Access, EDBC, and Ingres options can be specified in a with clause.

The following table describes the parameters of the with clause:

Parameter	Description
<i>db_id_</i>	<p>Specifies the server class of the Enterprise Access or EDBC product for which the option is specified. The trailing underscore is required, and the <i>option_name</i> parameter must be appended with no intervening space.</p> <p>If this parameter is specified, only the specified Enterprise Access or EDBC product will process the option. If this parameter is omitted, all Enterprise Access, EDBC, or database management systems will attempt to process the option. Enterprise Access and EDBC will ignore options they cannot process. Valid values are:</p> <ul style="list-style-type: none"> DB2_ DB2 or DB2 UDB IMS_ IMS RDB_ Rdb/VMS RMS_ RMS SQL_ All Ingres relational or SQL-based Enterprise Access or EDBC products
<i>option_name</i>	Name of the option. If this is an Enterprise Access-specific or EDBC-specific option, <i>option_name</i> must be preceded by the <i>db_id</i> . For details about the product-specific options, see your Enterprise Access or EDBC product guide.
<i>option_value</i>	<p>Value (if required by the option). This value can be specified using a quoted or unquoted character string, numeric literal, or variable.</p> <p>All values must be specified using simple data formats, such as integers, numerics, names, or strings. If a complex value is required, it must be encoded in a quoted string.</p> <p>To specify a list of values, use a comma-separated list enclosed in parentheses. For example:</p> <pre>with myoption=(value1, value2, value3)</pre>

If an option is specified using a string variable, (for example with `:stringvar`), and no value is to be provided, the variable must contain the string "NULL." Enterprise Access or EDBC will ignore the option.

Examples

- Connect to a DB2 subsystem DB2T and set the default database for table creation to mydb.

```
connect 'mvs1::db2t/db2' with db2_ct_option =  
'mydb';
```

EDBC for DB2 receiving the preceding connect request will issue the DB2 statements required to connect to the DB2T DB2 subsystem with the indicated default database.

- Create a database table and specify DBMS-specific extensions for DB2.

```
create table newtab (col1 integer, col2 integer not null)  
with db2_ct_option = 'audit all', alb_type = private;
```

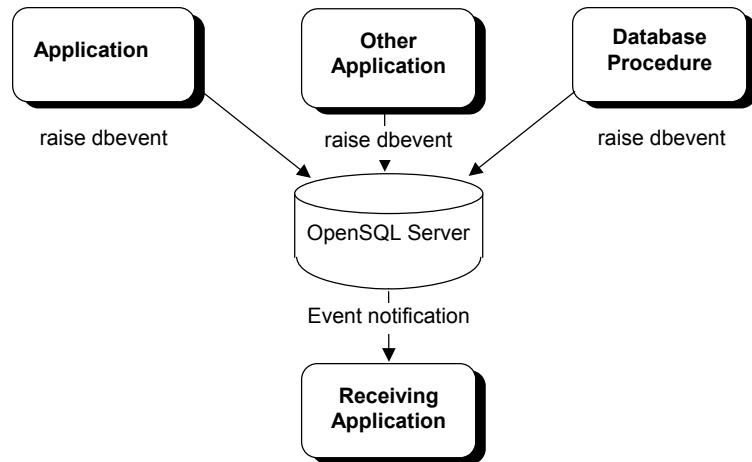
Database Events

Database events are an extended feature of OpenSQL. This means that not all OpenSQL servers support database events. If an OpenSQL server supports database events, there will be a row in iidbcapabilites with a cap_capability of DBEVENTS and a cap_value of Y. To see if a particular OpenSQL server supports database events or for any restrictions, refer to the documentation for that server.

Database events enable an application or the DBMS to notify other applications that a specific event has occurred. An *event* is any occurrence that your application program is designed to handle. Note that support for database events is optional for OpenSQL servers.

The following diagram illustrates a typical use of database events: various applications raise database events, and the DBMS notifies a monitor (receiving) application that is registered to receive the database events.

The monitor application responds to the database events by performing the actions the application designer specified when writing the monitor application.



Note: In the diagram above, OpenSQL Server refers only to OpenSQL servers that support database events.

Database events can be raised by an application that issues the `raise dbevent` statement.

Database Event Statements

The following sections describe the SQL statements required to define and use database events. The statements are:

- `create dbevent`
- `raise dbevent`
- `register dbevent`
- `get dbevent`
- `remove dbevent`
- `drop dbevent`
- `inquire_sql`
- `set_sql`

Creating a Database Event

To create a database event, use the `create dbevent` statement:

`create dbevent` *event_name*

where *event_name* is a unique database event name and a valid object name.

Database events can be raised by all applications connected to the database, and received by all applications connected to the database and registered to receive the database event.

Raising a Database Event

To raise a database event, use the `raisedbevent` statement:

`raisedbevent` *event_name* [*event_text*]

The `raisedbevent` statement can be issued from interactive or embedded SQL applications. When the `raisedbevent` statement is issued, the DBMS sends a database event message to all applications that are registered to receive *event_name*. If no applications are registered to receive a database event, raising the database event has no effect.

The optional *event_text* parameter is a string (maximum 256 characters) that can be used to pass information to receiving applications. For example, you can use *event_text* to pass the name of the application that raised the database event, or to pass diagnostic information.

Registering to Receive a Database Event

To register an application to receive database events, use the `registerdbevent` statement:

`registerdbevent` *event_name*

where *event_name* is an existing database event. Sessions must register for each database event to be received. For each database event, the registration is in effect until the session issues the `removedbevent` statement or disconnects from the database.

The DBMS issues an error if a session attempts to register for a database event for which the session does not have `register` privilege.

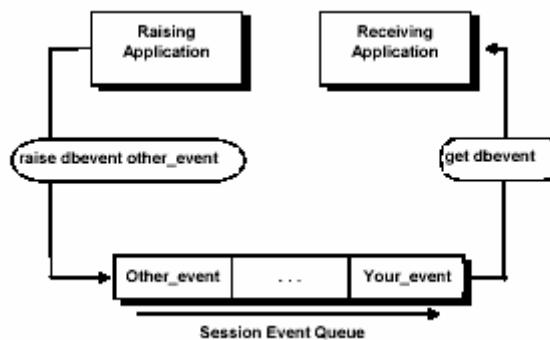
The `registerdbevent` statement can be issued from interactive or embedded SQL program.

Receiving a Database Event

To receive a database event and its associated information, an application must perform two steps:

1. Remove the next database event from the session's database event queue (using `getdbevent` or, implicitly, using `wheneverdbevent` or `set_sqldbeventhandler`).

2. Inquire for database event information (using inquire_sql). The get dbevent statement gets the next database event, if any, from the queue of database events that have been raised and for which the application session has registered, as shown in the following illustration:



Get dbevent returns database events for the current session only; if an application runs multiple sessions, each session must register to receive the desired database events, and the application must switch sessions to receive database events queued for each session.

The optional with clause specifies whether your application waits for a database event to arrive in the queue. If get dbevent with wait is specified, the application will wait indefinitely for a database event to arrive. If get dbevent with *wait=wait_value* is specified, the application waits the specified number of seconds for a database event to arrive. If no database event arrives in the specified time, the get dbevent statement times out, and no database event is returned. If get dbevent with nowait is specified, the DBMS checks for a database event and returns immediately. The default is nowait.

The with wait clause cannot be specified if the GET dbevent statement is issued in a select loop or user-defined error handler.

To obtain database event information, your application must issue the inquire_sql statement, and specify one or more of the following parameters:

dbeventname

The name of the database event (in lowercase letters). If there are no database events in the database event queue, the DBMS returns an empty string (or a string containing blanks, if your host language uses blank padded strings).

dbeventowner

The username of the user that created the database event.

dbeventdatabase

The database in which the database event was raised; returned in lowercase letters.

dbeventtime

The date and time the database event was raised, in date format. The receiving host variable must be a string (minimum length of 25 characters).

dbeventtext

The text, if any, specified in the optional *event_text* parameter by the application that raised the database event. The receiving variable must be a 256-character string. If the receiving variable is too small, the text is truncated.

Processing Database Events

Three methods can be used to process database events:

- Use the GET dbevent statement to explicitly consume each database event from the database event queue of the session. Typically, a loop will be constructed that polls for database events and calls routines that appropriately handle different database events. *Get dbevent* is a low overhead statement: it polls the application's database event queue and not the server.
- Trap database events using the whenever dbevent statement. To display database events and remove them from the database event queue, specify whenever dbevent sqlprint. To continue program execution without removing database events from the database event queue, specify whenever dbevent continue. To transfer control to a database event handling routine, specify whenever dbevent goto or whenever dbevent call. To obtain the database event information, the routine must issue the inquire_sql statement.
- Trap database events to a handler routine, using set_sql dbeventhandler. To obtain the database event information, the routine must issue the inquire_sql statement.

Note: If your application terminates a select loop using the endselect statement, unread database events may be purged. Note that dbevents are received only during communication between the application and the DBMS server while performing SQL query statements. When notification is received, the application programmer should ensure that all database events in the database events queue are processed by using the get dbevent loop, which is described below.

Using GET DBEVENT

To get a database event registration, use the get dbevent statement:

```
exec sql get dbevent [with nowait | wait [=wait_value]];
```

To specify whether the GET dbevent statement waits for database events or checks the queue and returns immediately, specify the with [no]wait clause. By default, GET dbevent checks and returns immediately.

If with wait is specified, GET dbevent waits indefinitely for the next database event to arrive. If with wait = *wait_value* is specified, GET dbevent returns when a database event arrives or when *wait_value* seconds have passed, whichever occurs first.

The following example shows a loop that processes all database events in the database event queue. The loop terminates when there are no more database events in the queue.

```
loop
  exec sql get dbevent;
  exec sql inquire_sql (:event_name =
    dbeventname);
  if event_name = 'event_1'
    process event 1
  else
    if event_name = 'event_2'
      process event 2
    else
      ...
    endif
  until event_name = ''
```

Using WHENEVER DBEVENT

To specify an action to occur whenever a DBEvent is raised, use the WHENEVER statement:

```
exec sql whenever DBEvent action;
```

The *action* can be one of the following: Continue, Stop, or Go to label.

To use the whenever dbevent statement, your application must include an SQLCA. When a database event is added to the database event queue, the sqlcode variable in the SQLCA is set to 710 (as will the standalone SQLCODE variable; SQLSTATE is not affected). However, if a query results in an error that resets sqlcode, the whenever statement will not trap the database event. The database event will still be queued, and your error-handling code can use the GET dbevent statement to check for queued database events.

To avoid inadvertently (and recursively) triggering the whenever mechanism from within a routine called as the result of a whenever dbevent statement, your database event-handling routine should turn off trapping:

```
main program:  
exec sql whenever dbevent call event_handler;  
...  
event_handler:  
/* turn off the whenever event trapping */  
exec sql whenever dbevent continue;  
exec sql inquire_sql(:evname=dbeventname...);  
process events  
return
```

Using User-defined Database Event Handlers

To define your own database event-handling routine, use the exec sql set_sql(dbeventhandler) statement. This method traps database events as soon as they are added to the database event queue; the whenever method must wait for queries to complete before it can trap database events. For more information, see the Set_sql section in the chapter "SQL Statements."

Removing a Database Event Registration

To remove a database event registration, use the remove dbevent statement:

remove dbevent *event_name*

where *event_name* specifies a database event for which the application has previously registered. After a database event registration is removed, the DBMS will not notify the application when the specified database event is raised. (Pending database event messages are not removed from the database event queue.)

When attempting to remove a registration for a database event that was not registered, the DBMS issues an error.

Dropping a Database Event

To drop a database event, use the drop dbevent statement:

```
drop dbevent event_name
```

where *event_name* is a valid and existing database event name. Only the user that created a database event can drop it. After a database event is dropped, it cannot be raised, and applications cannot register to receive the database event. (Pending database event messages are not removed from the database event queue.) If a database event is dropped while applications are registered to receive it, the database event registrations are not dropped from the DBMS until the application disconnects from the database or removes its registration for the dropped database event. If the database event is recreated (with the same name), it can again be received by registered applications.

To enable or disable the display of database events as they are received by an application, use the following statement:

```
exec sql set_sql(dbeventdisplay = 1 | 0)
```

Specify a value of 1 to enable the display of received database events, or 0 to disable the display of received database events. This feature can also be enabled by using II_EMBED_SET. For details about II_EMBED_SET, see the *System Administrator Guide*.

A routine can be created that will trap all database events returned to an embedded SQL application. To enable or disable a database event-handling routine or function, your embedded SQL application must issue the following set_sql statement:

```
exec sql set_sql(dbeventhandler = event_routine | 0)
```

To trap database events to your database event-handling routine, specify *event_routine* as a pointer to your error-handling function. For information about specifying pointers to functions, see your host language companion guide. Before using the set_sql statement to redirect database event handling, create the database event-handling routine, declare it, and link it with your application.

Chapter 8: OpenSQL Statements

This chapter presents OpenSQL statements individually, describing the purpose, syntax, and use of each statement.

SQL Version

This chapter describes the version of OpenSQL indicated by the following values in the iidbcapabilities catalog:

CAP_CAPABILITIES	CAP_VALUE
OPEN/SQL_LEVEL	00602

SQL Statements Context

At the beginning of each statement description, you will see the following table:

SQL	ESQL
*	*

The columns in this table have the following meanings:

- An asterisk (*) under SQL indicates you can use the statement in an interactive session.
- An asterisk (*) under ESQL indicates that you can use the statement in embedded programs.

Forms Statements

This chapter does not describe Ingres Forms statements. For information about these statements, see the *Forms-based Application Development Tools User Guide*.

Extended Statements

If the iidbcapabilities catalog contains the following row:

CAP_CAPABILITIES	CAP_VALUE
SQL92_COMPLIANCE	ENTRY

These additional statements and features can be used:

- grant
- revoke
- create schema
- create table constraints and defaults enhancements

If these statements and extensions are not supported, the iidbcapabilities catalog contains the following row:

CAP_CAPABILITIES	CAP_VALUE
SQL92_COMPLIANCE	NONE

Begin Declare Section

SQL	ESQL
*	

Begins a program section that declares host language variables to embedded OpenSQL.

Syntax

```
exec sql begin declare section;
```

Description

The begin declare section statement signals the start of a declaration section that declares host language variables for use in embedded OpenSQL. (All variables used in embedded OpenSQL or forms statements must be declared.) A single program can have multiple declaration sections.

The statements that can appear inside a declaration section are:

- Legal host language variable declarations.
- An include statement that includes a file that contains host language variable declarations. (This must be an SQL include statement, not a host language include statement.)
- A declare table statement (normally generated by dclgen in an included file).

The end declare section statement marks the end of the declaration section.

For more information about declaring and using host language variables, see the Host Language Variables section in the *Embedded SQL Companion Guide*.

Example

The example below shows the typical structure of a declaration section.

```
exec sql begin declare section;
      buffer      character_string(2000);
      number      integer;
      precision   float;
exec sql end declare section;
```

Call

SQL	ESQL
	*

Calls the operating system or an Ingres tool.

Syntax

To call the operating system:

```
exec sql call system (command = command_string)
```

To call an Ingres tool:

```
exec sql call subsystem (database = dbname
      {, parameter = value})
```

Description

The call statement allows an embedded SQL application to call the operating system or an Ingres tool (such as Query-By-Forms or Report-Writer).

When used to call the operating system, this statement executes the specified *command_string* as if the user typed it at the operating system command line. After the *command_string* is executed, control returns to the application at the statement following the call statement.

If *command_string* is a null, empty, or blank string, the statement transfers the user to the operating system. The user can then execute any operating system command. Exiting or logging out of the operating system returns the user to the application.

The *command_string* can invoke an Ingres tool. For example:

```
exec sql call system (command =
  'qbf personnel/alb');
```

However, it is more efficient to call the Ingres tool directly:

```
exec sql call qbf (database = 'personnel/alb');
```

When an Ingres tool is called directly, the database argument must identify the database to which the session is connected.

The call statement is not sent to the database. Therefore, it cannot appear in a dynamic SQL statement string. When calling an Ingres tool, an application cannot rely on the dynamic scope of open transactions, open cursors, or queries that have been defined, prepared, or specified as repeated queries. The application programmer must treat each subsystem call as an individual DBMS session. The Ingres tool commits any open transaction when it starts. For this reason, it is a good practice to commit before calling the Ingres tool.

When the user exits from the Ingres tool, control passes to the statement following the call.

The following table lists the valid parameters for this command. All parameters can be specified using a quoted or unquoted string literal or a string variable.

Parameter	Description
<i>subsystem</i>	The name of the tool to be called
<i>dbname</i>	The name of the current database
<i>parameter</i>	A list of one or more parameters specific to the called tool
<i>value</i>	The value assigned to the specified parameter
<i>command_string</i>	Specifies the command to be executed at the operating system level when the operating system is called

Performance

If this statement is being used to call an Ingres tool, it is most efficient to call the tool directly, rather than calling the operating system and, from there, calling the tool. For details, see the Text description.

Examples

- a. Run a default report on the employee table in the column mode.

```
exec sql commit;
exec sql call report (database='personnel/alb',
                      name='employee', mode='column');
```

- b. Run QBF in the append mode with the QBF name, expenses, suppressing verbose messages.

```
exec sql commit;
exec sql call qbf (database='personnel/alb',
                     qbfname='expenses',
                     flags='‐mappend -s');
```

Close

SQL	ESQL
*	

Closes an open cursor.

Syntax

```
exec sql close cursor_name
```

Description

The close statement closes an open cursor. The *cursor_name* must have been previously defined in your source file by a declare cursor statement. Once closed, the cursor cannot be used for further processing unless reopened with a second open statement. A commit, rollback, or disconnect statement closes all open cursors.

A string constant or host language variable can be used to specify the cursor name.

Permissions

This statement is available to all users.

Example

This example illustrates cursor processing from cursor declaration to closing.

```
exec sql declare c1 cursor for
    select ename, jobid
        from employee
            where jobid = 1000;
...
exec sql open c1;
loop until no more rows;
    exec sql fetch c1
        into :name, :jobid;
    print name, jobid;
end loop;
exec sql close c1;
```

Commit

SQL	ESQL
*	*

Commits the current transaction.

Syntax

```
[exec sql] commit [work]
```

Description

This statement terminates the current transaction. Once committed, the transaction cannot be aborted, and all changes it made become visible to all users through any statement that manipulates that data.

The optional keyword work is included for compatibility with other versions of SQL.

Embedded Usage

In addition to committing the current transaction, an embedded commit statement also:

- Closes all open cursors
- Discards all statements prepared (with the prepare statement) during the current transaction

When a program issues the disconnect statement, an implicit commit is also issued. Any pending updates are submitted. To roll back pending updates before terminating the program, a rollback statement must be issued.

Permissions

This statement is available to all users.

Example

This embedded example issues two updates, each in its own transaction.

```
exec sql connect 'mvs1::personnel/db2';
exec sql update employee set salary = salary * 1.1
  where rating = 'Good';
exec sql commit;
exec sql update employee set salary = salary * 0.9
  where rating = 'Bad';
exec sql disconnect;
/* Implicit commit issued on disconnect */
```

Create Dbevent

SQL	ESQL	DB Proc
*	*	

Defines a database event.

Syntax

```
[exec sql] create dbevent [schema.]event_name
```

Description

The createdbevent statement creates the specified database event. Database events enable an application to pass status information to other applications.

Event_name must be a valid object name.

Database events can be registered or raised by any session.

For a full description of database events, see [Database Events](#) in the chapter “OpenSQL Features.”

Embedded Usage

The *event_name* cannot be specified using a host language variable.

Event_name can be specified as the target of a dynamic SQL statement string.

Connect

SQL	ESQL
*	

Connects the application to a database and, optionally, to a specified transaction.

Syntax

```
exec sql connect dbname
      [session session_identifier]
      [identified by username]
      [options = flag {, flag}]
      [with_clause]
```

The *with_clause* parameter consists of the word with followed by a comma-separated list of valid options. For an overview of this parameter, see the With Clause topic of the Enterprise Access product. For a list of the valid with clause options for a specific Enterprise Access product, see your Enterprise Access product guide.

Description

The embedded SQL connect statement connects an application to a database, similar to the operating-system-level sql command. The connect statement must precede all statements that access the database. The connect statement cannot be issued in a dynamic OpenSQL statement.

Use the session clause if your application includes multiple open sessions. The session clause uniquely identifies each session, by associating each session with the specified *session_identifier*. The session identifier must be a positive integer.

Multiple-session applications require the session clause on each connect statement including the first. If this clause is not present on the first connect in the application, OpenSQL assumes that the application does not use multiple open sessions, and subsequent attempts to open other sessions generate an error.

To switch from one existing session to another existing session, use the set_sql statement. The connect statement with the session clause is used only to establish new sessions. You can, however, open more than one session with the same database.

For a discussion of multiple sessions and examples of their use, see [Multiple Session Connections](#) in the chapter “OpenSQL Features.”

The identified by clause allows the session to run as the specified user, like the -u flag of the sql command. To determine whether your Enterprise Access product supports the -u flag (and, therefore, the identified by clause), see your Enterprise Access product guide.

The options clause allows up to 12 flags to be specified that control session behavior. For details about these flags, see the description of the sql command in the *Command Reference Guide*. Not all flags are supported by all Enterprise Access products.

The with clause enables Enterprise Access product-specific connection parameters to be specified. For an overview of the Enterprise Access product with clause, see [The With Clause](#) in the chapter “OpenSQL Features.” To determine the options supported by a specific Enterprise Access product, see your Enterprise Access product guide.

The following table lists valid parameters for this command:

Parameters	Description
<i>dbname</i>	Specifies the database to which the session will connect. Dbname can be a quoted or unquoted string literal or a host string variable. If the name includes any name extensions, such as a virtual node name or server class, string literals must be quoted.
<i>server_class</i>	Specifies the Enterprise Access product or type of server to which the session is connecting. Examples include:
<u>Server class codes</u>	<u>Product</u>
DB2	DB2
DB2UDB	DB2 UDB
RDB	Rdb/VMS
RMS	RMS
IMS	IMS
DBD	Star
INGRES	Ingres (default)
<i>session_identifier</i>	A positive integer literal or variable whose value must be unique among existing session identifiers in the application. A value of 0 is equivalent to omitting the session clause.
<i>username</i>	Specifies the user identifier under which this session will run. Username can be a quoted or unquoted character string literal or string variable. Valid only if the Enterprise Access product supports the identified by clause.
<i>flag</i>	Any flag that is accepted by the sql command and is not specific to the Terminal Monitor can be specified in the options clause. The flags can be expressed as quoted or unquoted character string literals or as string variables. See your Enterprise Access product guide for supported flags.
<i>with_clause</i>	Specifies Enterprise Access product specific connection parameters. The command line +c flag provides access to the connect statement's Enterprise Access product with clause. For a discussion of the Enterprise Access product with clause, see DBMS Extensions in the chapter "OpenSQL Feature."

Permissions

This statement is available to any user. Some Enterprise Access products do not support the identified by clause. For details, see your Enterprise Access product guide.

Examples

1. Connect to the DB2UDB database mydb on virtual node UNIXBOX.

```
exec sql connect 'unixbox::master/db2'  
with db2udb = 'audit all';
```

2. Connect to two databases: the Ingres database named personnel, which is located in London, and the local Rdb/VMS database called sales. Set the current session to the personnel database.

```
exec sql connect 'london::personnel' session 1;  
exec sql connect 'sales/rdb' session 2;  
exec sql set_sql (session = 1);
```

Create Index

SQL	ESQL
*	*

Creates an index on an existing base table.

Syntax

```
[exec sql] create [unique] index indexname on tablename  
  (columnname [, columnname])  
  [with with_clause]
```

The *with_clause* parameter consists of a comma-separated list of valid Enterprise Access product with clause options. For an overview of the Enterprise Access product with clause, see "[Chapter 7: OpenSQL Features](#)." For a list of the valid with clause options for a specific Enterprise Access product, see your Enterprise Access product guide.

Description

The create index statement creates an index on an existing base table. The index contains the columns specified and is keyed on those columns, in the order they are specified.

Indexes can improve query processing. If data is retrieved from a table based on an indexed column, the DBMS uses indexes, if available, to accelerate query processing. To obtain the greatest benefit, create indexes that contain all of the columns that are generally queried and keyed on some subset of those columns.

Any number of indexes can be created for a table, but, for portability, each index can contain no more than 16 columns.

To prevent the index from accepting duplicate values in key fields, specify the unique option. If the base table on which the index is being created has duplicate values for the index's key fields, then the create index statement will fail. Similarly, if you attempt an insert or update that violates the uniqueness constraint of an index created on the table, then the insert or update will fail. This is true for an update statement that updates multiple rows: the update statement will fail as soon as it attempts to write a row that update violates the uniqueness constraint.

Particular Enterprise Access products may support extensions to the create index statement (using the with clause). For a discussion of the Enterprise Access product with clause, see "[Chapter 7: OpenSQL Features](#)."

To ensure application portability, follow each create index statement with a commit statement.

An index cannot be updated directly. When a table is changed, the DBMS updates indexes as required. To destroy an index, use the drop statement. All indexes on a table are destroyed when the table is dropped.

The following table lists valid parameters for this statement:

Parameter	Description
<i>indexname</i>	Specifies the name of the index. This must be a valid object name.
<i>tablename</i>	Specifies the table on which the index is to be created.
<i>columnname {, columnname}</i>	A list of columns from the specified table to be included in the index.
<i>with_clause</i>	Specifies Enterprise Access product-specific options. For details, see your Enterprise Access product guide.

Embedded Usage

The preprocessor does not validate the syntax of the with clause.

Example

Create an index called, x, for the columns, ename and age, on employee table.

```
create index x on employee (ename, age);
```

Create Table

SQL	ESQL
*	*

Creates a new base table.

Syntax

```
[exec sql] create table tablename
  (columnname format {, columnname format})
  [with_clause]
```

To create a table and load from another table:

```
[exec sql] create table tablename
  [(columnname {, columnname})] as subselect {union [all] subselect}
  [with with_clause]
```

The *with_clause* parameter consists of a comma-separated list of valid Enterprise Access product with clause options. For an overview of the Enterprise Access product with clause, see "[Chapter 7: OpenSQL Features](#)." For a list of the valid with clause options for a specific Enterprise Access product, see the documentation for that product.

For the syntax of *subselect*, see [Select \(interactive\)](#) in this chapter. For details about ISO Entry SQL92 extensions to this statement, see [Create Table \(extended\)](#) in the chapter "Extended Statements."

Description

The create table statement creates a new base table owned by the user who issues the statement. If you use the create table...as syntax, then the table that you create is some subset of the columns and values in an existing table(s) defined by the *subselect*.

Tablename specifies the name of the new table. This must be a valid OpenSQL name. For the rules for naming database objects, see [Object Names](#) in the chapter "Overview of OpenSQL."

The `as` clause causes the table that you create to be defined and populated by the `subselect` specified in the statement.

To ensure application portability, follow every `create table` statement with a `commit` statement.

Embedded Usage

- Host variables can be used to specify constant expressions in the `subselect` of a `create table...as` statement.
- The preprocessor does not validate the syntax of the `with_clause`.

Specifying the Column Names, Data Types, and Lengths

The name and data type of each column in the new table are specified by the `columnname` and `format` arguments. If you specify `create table...as select`, the new table takes its column names and formats from the results of the `select` clause of the `subselect` in the `as` clause (unless you specify column names following the table name). For more information, see [Create Table](#) in this chapter.

`Columnname` can be any valid OpenSQL name. `Format` specifies the data type and length of the column using the following syntax:

`datatype [not null | with null]`

`Datatype` can be any valid OpenSQL data type and length.

The `with|not null` clause determines whether or not a column will accept null or default values, or neither, during an `insert`, `update`, or `copy` operation. The options for the `with|not null` clause are:

- **with null** - The column accepts nulls. The DBMS inserts null as the default value if no value is supplied by the user.
- **not null** - The column does not accept nulls, and the DBMS does not supply a default value. The user must supply a non-null value. (The column is mandatory.)

If the `with|not null` clause is omitted, `with null` is assumed.

Using the `Create Table...As` Syntax

The `create table...as` syntax allows a table to be created from another table or tables. The new table is populated with the set of rows resulting from execution of the specified `subselect`.

When the create table statement includes an as clause, specifying column names is optional unless two or more columns of the table would otherwise have the same name. If that is the case, specify the column names.

The column format cannot be specified when using create table ...as; the formats are copied from the source table columns specified in the *subselect* clause. The nullability attribute of a column in the new table is the same as the corresponding column in the source table.

Examples

1. Create the employee table with columns eno, ename, age, job, salary, and dept.

```
create table employee
  (eno      smallint,
   ename    varchar(20) not null,
   age      integer,
   job      smallint,
   salary   float,
   dept     smallint
   started date);
```

2. Create a table listing employee numbers for employees who make more than the average salary.

```
create table highincome as
  select eno
  from employee
  where salary
    > (select avg (salary)
        from employee);
```

Create View

SQL	ESQL
*	*

Defines a virtual table.

Syntax

```
[exec sql] create view view_name [(columnname {, columnname})]
  as subselect {
  union [all] subselect}
  [with_clause]
```

For the syntax of the *subselect*, see [Select \(interactive\)](#) in this chapter.

The *with_clause* parameter consists of the word with followed by a comma-separated list of valid Enterprise Access product with clause options (including, for this statement, check option). For an overview of the Enterprise Access product with clause, see "[Chapter 7: OpenSQL Features](#)." For a list of the valid with clause options for a specific Enterprise Access product, see the product guide. The check option is not supported by all Enterprise Access products. Enterprise Access products that do not support check option will ignore it when creating the specified view.

Description

The syntax of the create view statement is very similar to that of the as form of create table. However, data is not retrieved when a view is created. Instead, the view definition is stored and, when the *view_name* is later used in an SQL statement, the statement operates on the tables that are used to define the view. (The tables or views used to define a view are called its base tables.)

All selects on views are fully supported. Simply use a *view_name* in place of a *tablename* in any SQL retrieval. However, updates, inserts, and deletes on views are subject to several rules:

- The view was created from more than one table.
 - The view was created from a non-updateable view.
 - Any columns in the view are derived from an expression or aggregate (set) function.
- Additionally, inserts are not allowed if:
 - The view definition contains a where clause and specifies the with check option (if supported by the Enterprise Access product).
 - If any column in the underlying table that was declared as not null not default is not present in the view.
- The ability to update a view depends in part on whether the with check option is specified.

When a view is created with check option, columns that are part of the view's qualification cannot be updated.

If the with check option is not specified, any row in the view can be updated, even if the update results in a row that is no longer a part of the view.

For example, consider the following two statements:

```
create view v
as select *
from t
where c = 10;
update v
set c = 5;
```

Because the with check option is not specified in the view's definition, you are allowed to update column c. If the view had been created with check option, the update would not be allowed.

By default, with check option is not set.

When a table used in the definition of a view is dropped, the view is also dropped.

Note: Particular Enterprise Access products may support extensions to the create view statement, using the with clause.

To ensure application portability, follow every create view statement with a commit statement.

Embedded Usage

When used in an embedded program, constant expressions can be specified in the *select_stmt* with host language string variables. If the *select_stmt* includes a where clause, a host language string variable can be used to represent the entire where clause qualification.

Example

Define a view of employee data including names, salaries, and managers' names.

```
create view empdpt (ename, sal, dname)
as select employee.name, employee.salary,
dept.name
from employee, dept
where employee.mgr = dept.mgr;
```

Declare Cursor

SQL	ESQL
*	

Declares a cursor for use in data manipulation.

Syntax

```
exec sql declare cursor_name cursor
  for select [all | distinct]
  result_expression {, result_expression}
  from table {, table}
  [where search_condition]
  [group by column {, column}]
  [having search_condition]
  [union [all] full_select]
  [order by result_column [asc | desc]
  {, result_column [asc | desc]}]
  [for update of column {, column}]
```

Dynamic SQL form:

```
exec sql declare cursor_name cursor
  for statement_name;
```

Description

The declare cursor statement associates a specified cursor with a select statement. For information about using the select statement with cursors, see [Cursor Select](#) in this chapter.

Declare cursor is a compile-time statement and must appear before the first statement that references the cursor. Despite its declarative nature, a declare cursor statement must not be located in a host language variable declaration section.

Cursor_name can be specified using a quoted or unquoted string literal or a host language string variable. If *cursor_name* is a reserved word, it must be specified in quotes. *Cursor_name* can contain a maximum of 24 alphanumeric characters.

The typical order of events in cursor processing is:

1. Issue a declare cursor statement to associate a cursor with a select statement.
2. Open the cursor. When the cursor is opened, the DBMS executes the select statement that was specified in the declare cursor statement.

3. Process rows one at a time. The fetch statement returns one row from the results of the select statement that was executed when the cursor was opened.
4. Close the cursor by issuing the close statement.

A source file can have multiple cursors, but the same cursor cannot be declared twice. If you want to declare several cursors using the same host language variable to represent *cursor_name*, it is only necessary to declare the cursor once, since declare cursor is a compile-time statement. Multiple declarations of the same *cursor_name* will cause a preprocessor error, even if its actual value is to be changed between declarations. For example, the following statements cause a preprocessor error:

```
exec sql declare :cname[i] cursor for s1;  
i = i + 1  
/* The following statement causes preprocessor error */  
exec sql declare :cname[i] cursor for s2;
```

Instead, declare the cursor once. The value assigned to the host language variable *cursor_name* is not determined until the open cursor statement is executed. For example:

```
exec sql declare :cname[i] cursor for :sname[i];  
loop incrementing i  
exec sql open :cname[i];  
end loop;
```

If a cursor is declared using a host language variable, all subsequent references to that cursor must use the same host language variable. At runtime, a dynamically specified cursor name, that is, a cursor declared using a variable, must be unique among all dynamically specified cursor names in an application. In a similar manner, any cursors referenced in a dynamic statement, for example a dynamic update or delete cursor statement, must be unique among all open cursors within the current transaction.

A cursor name declared in one source file cannot be referred to in another file, since the scope of a cursor declaration is the source file. If the cursor is redeclared in another file with the same associated query, it will *still* not identify the same cursor, not even at runtime. For example, if a cursor c1 is declared in source file, file1, then all references to c1 must be made within file1. Failure to follow this rule results in runtime errors. For example, if you declare cursor c1 in an include file, open it in one file and fetch from it in another file, at runtime the DBMS returns an error indicating that the cursor c1 is not open on the fetch.

This rule applies equally to dynamically specified cursor names. If a dynamic update or delete cursor statement is executed, the cursor referenced in the statement must be declared in the same file in which the update or delete statement appears.

The embedded SQL preprocessor does not generate any code for the declare cursor statement. Therefore, in a language that does not allow empty control blocks, (for example, COBOL, which does not allow empty IF blocks), the declare cursor statement should not be the only statement in the block.

The for update clause must be included if there is any possibility that the cursor will be used to update rows. List any column that might be updated. If you only intend to delete rows, then the for update clause is not required. The actual updating or deleting takes place with the cursor version of the update or delete statement, respectively (see [Update](#) and [Delete](#) in this chapter).

A cursor cannot be declared for updating if its select statement:

- Refers to more than one table.

For example, the following cursor declaration causes a compile-time error:

```
exec sql declare c1 cursor for
  select employee.id, accounts.sal
  from employee, accounts
  where employee.salno = accounts.accno
  for update of sal;
  /* illegal join on different tables for
  update */
```

This declaration is illegal because two tables were used in the select statement.

- Refers to a non-updateable view.

For example, assume that empdept is a read-only view, not a table, then the following example generates a runtime error at the time the open statement is executed. No preprocessor error is generated, because the preprocessor does not know that empdept is a view.

```
exec sql declare c2 cursor for
  select name, deptinfo
  from empdept /* empdept is a read-only view */
  for update of deptinfo;

  ...
exec sql open c2;
```

- Includes a distinct, group by, having, order by, or union clause.

It is also illegal to update a column that is a constant or is based on a calculation. For example, the following cursor declaration generates an error when you attempt to update the column named constant:

```
exec sql declare c3 cursor for
  select 123 as constant, ename
  from employee
  for update of constant;
  /* "constant" cannot be declared for update */
```

If an updateable column has been given a result column name by using this syntax:

```
columnname as resultname
```

then the column referred to in the for update list must name the table column name, and not the result column name.

Updates associated with a cursor take effect on the underlying table when the statement is executed. The effects of the updates can be seen by the program before the cursor is closed. The actual committal of the changes does not override or interfere with commit or rollback statements that may be executed subsequently in the program. Because changes take effect immediately, avoid updating keys that cause the current row to move “forward” with respect to the current position of the cursor, because this may result in fetching the same row more than once.

If the for update clause is specified, the cursor can still be opened for reading only. The open statement accepts the optional for readonly clause, which specifies that, though the cursor may have been declared for update, the cursor is not being opened for update. By including this clause in the open statement, the performance of the cursor retrieval can be improved.

Not all database management systems allow the use of a cursor to update a row more than once. For details, see your Enterprise Access product and DBMS-specific documentation for details.

The union form of the select statement can be used in a cursor declaration. To select all columns, use select *. Each column does not need to be listed individually.

When the order by clause is specified, the ordering is performed according to SQL comparison rules. Each column specified in the ordering must specify either a column name, which identifies a column of the result table, or an integer, which identifies a numbered column of the result table. A named result column can be identified by an ordering name or a number. An unnamed result column must be identified by an ordering number.

Host language variables can be used in the select statement of a declare cursor to substitute for expressions in the select clause or in the search condition (see [Select \(interactive\)](#) in this chapter). When the search condition is specified within a single string variable (as when the query is constructed using the form system query mode) then all the following clauses, such as the order by or update clause, can be included within the variable. These variables must be valid at the time of the cursor’s open statement, because that is when the select is actually evaluated—they need not have defined values at the time of the declare cursor statement. Host language variables cannot substitute for any table or column names.

You can also use the dynamic OpenSQL syntax and specify a prepared statement name instead of a select statement. The statement name must identify a select statement that has been prepared previously. The statement name must not be the same as another prepared statement name that is associated with a currently open cursor.

Examples

1. Declare a cursor for a retrieval of employees from the shoe department, ordered by name (ascending) and salary (descending). (This could also be specified as a select loop.)

```
exec sql declare cursor1 cursor for
  select ename, sal
  from employee
  where dept = 'shoes'
  order by 1 asc, 2 desc;
```

2. Declare a cursor for updating the salaries and departments of employees currently in the shoe department.

```
exec sql declare cursor2 cursor for
  select ename, sal
  from employee
  where dept = 'shoes'
  for update of sal, dept;
```

3. Declare a cursor for updating the salaries of employees whose last names are alphabetically like a given pattern.

```
searchpattern = 'a%';
exec sql declare cursor3 cursor for
  select ename, sal
  from employee
  where ename like :searchpattern
  for update of sal;

...
exec sql open cursor3;
```

In the above example, the variable, searchpattern, must be a valid declaration in the host language at the time the statement, open cursor3, is executed. It also must be a valid embedded OpenSQL declaration at the point where the cursor is declared.

4. Declare a cursor in order to print the results of a retrieval for runtime viewing and salary changes.

```
exec sql declare cursor4 cursor for
  select ename, age, eno, sal
  from employee
  for update of sal;

exec sql whenever sqlerror stop;
exec sql whenever not found goto close_cursor;
exec sql open cursor4;

loop /* loop is broken when NOT FOUND becomes
       true. */
  exec sql fetch cursor4
    into :name, :age, :idno, :salary;
  print name, age, idno, salary;
  print 'New salary';
  read newsal;
  if (newsal > 0 and newsal <> salary) then
    exec sql update employee
    set sal = :newsal
    where current of cursor4;
  end if;
end loop;
```

```
close_cursor:  
  exec sql close cursor4;
```

5. Declare a cursor for retrieval of specific data. The for update clause refers to column name sal and not res.

```
exec sql declare cursor5 cursor for  
  select ename, sal as res  
  from employee  
  where eno between :eno_low and :eno_high  
  for update of sal;  
  
loop while more input  
  read eno_low, eno_high;  
  exec sql open cursor5;  
  print and process rows;  
end loop;
```

6. Declare two cursors for the department and employee tables and open them in a master-detail fashion.

```
exec sql declare master_cursor cursor for  
  select * from dept  
  order by dno;  
  
exec sql declare detail_cursor cursor for  
  select * from employee  
  where edept = :dno  
  order by ename;  
  
exec sql open master_cursor;  
  
loop while more departments  
  exec sql fetch master_cursor  
    into :dname, :dno, :dfloor, :dsales;  
  if not found break loop;  
  
  /* For each department retrieve all the employees  
  and display the department and employee data.*/  
  exec sql open detail_cursor;  
  loop while more employees  
    exec sql fetch detail_cursor  
      into :name, :age, :idno, :salary, :edept;  
  
    /*For each department retrieve all the employees  
    and display the department and employee data.*/  
    process and display data;  
  end loop;  
  exec sql close detail_cursor;  
end loop;  
  
exec sql close master_cursor;
```

7. Declare a cursor that is a union of three tables with identical typed columns (the columns have different names). As each row returns, record the information and add it to a new table. Ignore all errors.

```
exec sql declare shapes cursor for
  select boxname, boxnum from boxes
  where boxid > 100
  union
  select toolname, toolnum from tools
  union
  select nailname, nailnum from nails
  where nailweight > 4;

  exec sql open shapes;
  exec sql whenever not found goto done;

  loop while more shapes
    exec sql fetch shapes into :name, :number;
    record name and number;
    exec sql insert into hardware (:name, :number);

  end loop;
  done:
  exec sql close shapes;
```

Declare Global Temporary Table

SQL	ESQL	DB Proc
*	*	

Creates a temporary table.

Syntax

```
[exec sql] declare global temporary table [session.]table_name
  (column_name format {, column_name format})
  on commit preserve rows
  [with norecovery]
```

To create a temporary table by selecting data from another table:

```
[exec sql] declare global temporary table [session.]table_name
  (column_name {, column_name})
  as sub-select
  on commit preserve rows
  [with norecovery]
```

For details about sub-selects, see [Select \(interactive\)](#) in the chapter “OpenSQL Statements.”

The `on commit preserve rows` and `with norecovery` are required for the `declare global temporary table` session statement; these keywords cannot be omitted. The `on commit preserve rows` clause directs the DBMS to retain the contents of a temporary table when a `commit` statement is issued.

Description

The `declare global temporary table` statement creates a temporary table, also referred to as a *session-scope* table. Temporary tables are useful in applications that need to manipulate intermediate results and want to minimize the processing overhead associated with creating tables. Depending on the target DBMS, temporary tables may reduce overhead in the following ways:

- No logging is performed on temporary tables.
- No page locking is performed on temporary tables.
- Disk space requirements are minimized. If possible, the temporary table is created in memory and never written to disk.
- No system catalog entries are made for temporary tables.

Embedded Usage

In embedded programs, do not specify the `declare global temporary table` session statement within the `declare` section of an embedded program; place the statement in the body of the embedded program.

Restrictions

Temporary tables may be subject to the following restrictions:

- Temporary tables may not be used within database procedures.
- Temporary tables may not be used in view definitions.
- The following SQL statements may not be used on temporary tables:
 - Create index
 - Create view
 - Grant
 - Help
 - Revoke
 - Set lockmode

Note: Repeat queries referencing temporary tables cannot be shared between sessions.

The following commands cannot be issued with a temporary table name:

- auditdb
- copydb
- optimizedb
- statdump
- verifydb

Related Statements

For more information, see the following statement descriptions in this chapter:

- Create Table
- Delete
- Drop
- Insert
- Select
- Update

Examples

1. Create a temporary table.

```
exec sql declare global temporary table
  session.emps
    (name char(20) , empno char(5))
    on commit preserve rows
    with norecovery;
```

2. Use a sub-select to create a temporary table containing the names and

```
employee numbers of the highest-rated employees.
exec sql declare global temporary table
  session.emps_to_promote
    as select name, empno from employees
    where rating >= 9
    on commit preserve rows
    with norecovery;
```

Declare Statement

SQL	ESQL
	*

Declares names to identify one or more dynamic OpenSQL prepared statement names.

Syntax

```
exec sql declare statement_name {, statement_name} statement
```

Description

Declare statement lists one or more names that are used in a program to identify prepared OpenSQL statements. Declare statement is provided for purposes of program documentation. The declaration of prepared statement names is not required. No syntactic elements can be specified using host language variables.

The embedded SQL preprocessor does not generate any code for declare statement. Therefore, in a language that does not allow empty control blocks (for example, COBOL, which does not allow empty IF blocks), this statement must not be the only statement in the block.

Example

This example declares one statement name for a dynamic statement that will be executed 10 times.

```
exec sql declare ten_times statement;
loop while more input
  print 'Type in statement to be executed 10 times?';
  read statement_buffer;
exec sql prepare ten_times from :statement_buffer;
loop 10 times
  exec sql execute ten_times;
end loop;
end loop;
```

Declare Table

SQL	ESQL
	*

Describes the structure of a database table.

Syntax

```
exec sql declare tablename table
  (columnname type [with null | not null]
  {, columnname type})
```

Description

The declare table statement is a comment statement inside a variable declaration section that lists the columns and data types of a table, for the purpose of program documentation. The dclgen utility includes this statement in the file it generates. Dclgen creates a structure corresponding to a database table. For details, see the *Embedded SQL Companion Guide*.

Any elements of the syntax cannot be replaced with host language variables.

The embedded SQL preprocessor does not generate any code for the declare table statement. Therefore, in a language that does not allow empty control blocks (for example, COBOL, which does not allow empty IF blocks), the declare table statement must not be the only statement in the block.

Example

Declare a database table.

```
exec sql declare employee table
  (eno  integer2 not null,
  ename character(20) not null,
  age   integer,
  job   integer2,
  sal   float,
  dept  integer2 not null);
```

Delete

SQL	ESQL
*	*

Deletes rows from a table.

Syntax

Interactive version:

```
delete from tablename [where search_condition]
```

Embedded versions:

- Non-cursor version:

```
exec sql [repeated] delete from tablename  
[where search_condition]
```

- Cursor version:

```
exec sql delete from tablename  
where current of cursor_name;
```

Description

The delete statement removes rows from the specified table that satisfy the *search_condition* in the where clause. If the where clause is omitted, the statement deletes all rows in the table. The result is a valid but empty table.

If the where clause includes a subselect, the tables specified in the subselect cannot include the table from which you are deleting rows.

Embedded Usage

There are two embedded versions of the delete statement: one deletes rows according to the search criteria specified in its where clause, and the second deletes the row to which the specified cursor is positioned.

Non-cursor Delete

The non-cursor version of the embedded OpenSQL delete statement is virtually identical to the interactive delete. Host language variables can be used to represent constant expressions in the *search_condition* but they cannot represent names of database columns or include any operators. A host string variable can also replace the complete search condition.

The non-cursor delete can be formulated as a repeated query by using the keyword `repeated`. Doing so reduces the overhead required to run the same delete repeatedly within your program. The `repeated` keyword directs the OpenSQL to encode the delete and save its execution plan when it is first executed. This encoding can account for significant performance improvements on subsequent executions of the same delete. The `repeated` keyword is valid only for non-cursor deletes, and it is ignored if used with the cursor version. The repeated delete cannot be specified using a dynamic OpenSQL statement.

If the *search_condition* is dynamically constructed, that is, if the `complete` clause is specified in a host string variable, do not use the `repeated` option if you intend to change the *search_condition* after the statement's initial execution. The saved execution plan is based on the initial values in the *search_condition* and any changes would be ignored. This rule does not apply to simple variables used in *search_conditions*.

Cursor Delete

The cursor version immediately deletes the row to which the specified cursor is pointing. If the cursor is not currently pointing at a row when the delete is executed, then the DBMS generates an error indicating the need to issue a `fetch` statement to position the cursor on a row. (After a deletion, the cursor points to a position after the deleted row, but before the next row, if any.)

The `commit` and `rollback` statements close all open cursors. A common programming error is to delete the current row of a cursor, commit the change, then loop to repeat the process. This process fails because the first `commit` closes the cursor.

In performing a cursor delete, certain conditions must be met:

- A cursor must be declared in the same file in which any delete statements referencing that cursor appear. This applies also to any cursors referenced in dynamic delete statement strings.
- A cursor name in a dynamic delete statement must be unique among all open cursors in the current transaction.
- The cursor stipulated in the delete must be open before the statement is executed.
- The cursor's select statement must not contain a `distinct`, `group by`, `having`, `order by`, or `union` clause.

-
- The from clause of the delete and the from clause in the cursor's declaration must refer to the same database table.

The cursor name can be specified with a string constant or a host language variable.

If the statement does not delete any rows, the sqlcode variable in the SQLCA structure is set to 100.

The sqlerrd(3) variable in the SQLCA structure contains the number of rows deleted.

Example

Remove all employees who make over \$35,000.

```
delete from employee where salary >35000;
```

Describe

SQL	ESQL
*	

Retrieves information about a prepared dynamic OpenSQL statement.

Syntax

```
exec sql describe statement_name
    into|using descriptor_name [using names]
```

Description

The describe statement returns information about a prepared dynamic OpenSQL statement. Describe is intended primarily for use with dynamic select statements. Describe returns the data type, length, and name of the select's result columns. If the prepared statement is not a select, describe returns a zero to the SQLDA sqld field. For a complete discussion of the SQLDA (SQL Descriptor Area), see "[Chapter 6: Dynamic OpenSQL](#)."

The *statement_name* can be specified as either a string literal or using a host language string variable. In either case, *statement_name* must identify a valid prepared statement. (An invalid prepared statement results whenever an error occurs when the specified statement is prepared or if a commit or rollback statement is executed after the statement is prepared and before it is executed.)

Descriptor_name identifies an SQLDA (SQL Descriptor Area). The actual name can be "SQLDA" or any other valid OpenSQL name defined by the program when the structure is allocated. Because the SQLDA is not declared in a declaration section, the preprocessor does not verify that *descriptor_name* represents an SQLDA structure. If *descriptor_name* does not represent an SQLDA structure, undefined errors will occur at runtime.

Descriptor_name can be preceded by a colon (:).

The optional using names clause directs the OpenSQL Enterprise Access product or server to return the names of result columns in the descriptor if the described statement is a select statement.

The describe statement cannot be issued until after the program allocates the SQLDA and sets the value of the SQLDA sqln field to the number of elements in the SQLDA sqlvar array. The results of the describe statement are complete and valid only if the number of the result columns (from the select) is less than or equal to the number of allocated sqlvar elements. For more information about describing a select statement and analyzing the results, see ["Chapter 6: Dynamic OpenSQL."](#)

The prepare statement can also be used with the into clause to retrieve the same descriptive information provided by describe.

Direct Execute Immediate

SQL	ESQL
	*

Sends DBMS-specific commands to the DBMS without translation.

Syntax

```
exec sql direct execute immediate string | string_variable
```

Description

The direct execute immediate statement allows statements to be sent to the Enterprise Access product or DBMS to which a session is connected. The Enterprise Access product does not translate the statement. If the statement is not supported by the DBMS or Enterprise Access product, an error is returned. The direct execute immediate statement cannot be used to return rows to a session.

A host language variable or string literal can be used to specify the statement. If you use a string literal, avoid embedding quotes in the literal. If you specify the statement using a host language variable, the OpenSQL string-delimiting conventions must be observed.

Disconnect

SQL	ESQL
	*

Terminates access to the database.

Syntax

```
exec sql disconnect [session session_identifier | all]
```

Description

The disconnect statement terminates access to the database, closes any open cursors, and commits any open transactions.

To disconnect the current session, issue the disconnect statement, omitting the session identifier. Other sessions (if any) will remain connected. To switch sessions, use the set_sql statement. To disconnect all open sessions, specify disconnect all.

To disconnect a specific session in a multi-session application, use the session *session_identifier* clause to identify the session you want to disconnect. The *session_identifier* must be a positive integer constant or variable containing the session identifier. To determine the *session_identifier* for the current session, use the inquire_sql(:session_id = session) statement. If an invalid session is specified, OpenSQL issues an error and does not disconnect the session.

Examples

1. Disconnect from the current database.

```
exec sql disconnect;
```

2. On an error, roll back pending updates, then disconnect the database session.

```
exec sql whenever sqlerror goto err;  
...  
err:  
  exec sql rollback;  
  exec sql disconnect;
```

Drop

SQL	ESQL
*	*

Destroys one or more tables, indexes, or views.

Syntax

```
[exec sql] drop table tablename [with with_clause]  
[exec sql] drop index indexname [with with_clause]  
[exec sql] drop view viewname [with with_clause]
```

The *with_clause* parameter consists of a comma-separated list of valid Enterprise Access product with clause options. For an overview of the Enterprise Access product with clause, see "[Chapter 7: OpenSQL Features](#)." For a list of the valid with clause options for a specific Enterprise Access product, see the product guide.

Description

The drop statement removes the specified tables, indexes, and views from the database. When a table is dropped, any indexes, views, or privileges defined on that table are automatically dropped also. When a view is dropped, all associated privileges and dependent views are dropped.

To ensure application portability, follow every drop statement with a commit statement.

Embedded Usage

You cannot replace any portions of the statement with host language variables.

Examples

1. Drop an index named, tindex.

```
drop index tindex;  
commit;
```

2. Drop a base table and all related views, indexes, and permissions.

```
drop table employee;  
commit;
```

3. In an embedded program, drop a view.

```
exec sql drop view tempview;  
exec sql commit;
```

Drop Dbevent

SQL	ESQL	DB Proc
*	*	

Drops a database event.

Syntax

```
[exec sql] dropdbevent [schema.]event_name;
```

Description

The DROPdbevent statement drops the specified database event. If applications are currently registered to receive the database event, the registrations are not dropped. If the database event was raised prior to being dropped, the database event notifications remain queued, and applications can receive them using the getdbevent statement.

For a full description of database events, see [Database Events](#) in the chapter “OpenSQL Features.”

Embedded Usage

The *event_name* cannot be specified using a host language variable.
Event_name can be specified as the target of a dynamic SQL statement string.

End Declare Section

SQL	ESQL
	*

Ends declaration of host language variables.

Syntax

```
exec sql end declare section
```

Description

The end declare section statement marks the end of a host language variable declaration section.

A host language variable declaration section contains declarations of host language variables for use in an embedded OpenSQL program. The begin declare section statement starts each variable declaration section. For more information about declaration sections and host language variables, see [Begin Declare Section](#) in this chapter, and “[Chapter 5: Embedded OpenSQL](#).”

Endselect

SQL	ESQL
	*

Terminates a select loop.

Syntax

```
exec sql endselect;
```

Description

The endselect statement terminates embedded OpenSQL select loops. A select loop is a block of code delimited by begin and end statements and associated with a select statement. As the select statement retrieves rows from the database, each row is processed by the code in the select loop. (For more information about select loops, see [Select \(interactive\)](#) in this chapter.) When the endselect statement is executed, the program stops retrieving rows from the database and program control is transferred to the first statement following the select loop.

The endselect statement must be inside the select loop that it is intended to terminate. If an endselect statement is placed inside a forms statement code block that is syntactically nested within a select loop, the statement ends the nested construct as well as the select loop.

The statement must be terminated according to the rules of the host language.

To find out how many rows were retrieved before the endselect statement was issued, check the sqlerrd(3) variable of the SQLCA.

Example

Break out of a select loop on a data loading error.

```
exec sql select ename, eno into :ename, :eno
  from employee;
exec sql begin;
  load ename, eno into data set;
  if error then
    print 'Error loading ', ename, eno;
    exec sql endselect;
  end if
exec sql end;
/* endselect transfers control to here */
```

Execute

SQL	ESQL
*	

Executes a previously prepared dynamic OpenSQL statement.

Syntax

```
exec sql execute statement_name
  [using variable {, variable} | 
  using descriptor descriptor_name]
```

Description

The execute statement executes the prepared OpenSQL statement specified by *statement_name*. Execute can be used to execute any statement that can be prepared, with the exception of the select statement. (The execute statement cannot be used to execute a prepared select statement. For more information, see [Prepare and Execute Statements](#) and the [Execute Immediate Statement](#) in the chapter "Dynamic OpenSQL.")

The *statement_name* can be specified using a string literal or a host language variable. *Statement_name* must identify a valid prepared statement. If the statement identified by *statement_name* is invalid, the Enterprise Access product or server issues an error and aborts the execute statement. (A prepared statement is invalid if a transaction was committed or rolled back after the statement was prepared or if an error occurred while preparing the statement.)

If the prepared statement refers to a cursor update or delete and the associated cursor is not open, the Enterprise Access product or server issues an error. For more information, see [Update](#) and [Delete](#) in this chapter.

If the prepared statement uses a question mark (?) to specify one or more constant expressions, the using clause must be specified in the statement. If you know the number and data types of the expressions specified by question marks in the prepared statement, use the using *variable* {, *variable*} option. The number of the variables listed must correspond to the number of question marks in the prepared statement, and each variable's data type must be compatible with its usage in the prepared statement.

The following example prepares a statement containing one question mark from a buffer and executes it using a host language variable:

```
statement_buffer =
'delete from ' + table_name + ' where code = ?';
exec sql prepare del_stmt from :statement_buffer;
...
exec sql execute del_stmt using :code;
```

The value in the variable, code, replaces the ? in the where clause of the prepared delete statement.

If the number and data types of the prepared statement parameters are not known until runtime, use the using descriptor option. In this alternative, the *descriptor_name* identifies an SQLDA, a host language structure that must be allocated prior to its use. The SQLDA includes the sqlvar array. Each element of sqlvar is used to describe and point to a host language variable. The execute statement uses the values placed in the variables pointed to by the sqlvar elements to execute the prepared statement.

When the SQLDA is used for input, the program must set the sqlvar array element type, length, and data area for each portion of the prepared statement specified by question marks, prior to executing the statement.

Here are some of the ways the program can supply that information:

- When preparing the statement, the program can request all type and length information from the interactive user.
- Before preparing the statement, the program can scan the statement string, and build a select statement out of the clauses that include parameters. The program can then prepare and describe this select statement to collect data type information to be used on input.
- If another application development tool is being used to build the dynamic statements (such as a Vision frame or a VIFRED form), the data type information included in those objects can be used to build the descriptor. An example of this method is shown in the Examples section.

In addition, the program must correctly set the sqld field in the SQLDA structure. For a complete description of the structure of the SQLDA and how to use it, see ["Chapter 6: Dynamic OpenSQL."](#)

The variables used by the using clause can be associated with indicator variables if indicator variables are permitted with the same statement in the non-dynamic case. For example, because indicator variables are permitted in the insert statement values clause, then the following dynamically defined insert statement can include indicator variables (name_ind and age_ind) in the execute statement:

```
statement_buffer = 'insert into employee (name, age)      values (?, ?)';
exec sql prepare s1 from :statement_buffer;
exec sql execute s1 using :name:name_ind,
                           :age:age_ind;
```

However, a host structure variable cannot be used in the using clause, even if the named statement refers to a statement which allows a host structure variable when issued non-dynamically.

This statement must be terminated according to the rules of the host language.

Examples

1. Although the commit statement can be prepared, once the statement is executed, the prepared statement becomes invalid. For example, the following code will cause an error on the second execute statement:

```
statement_buffer = 'commit';
exec sql prepare s1 from :statement_buffer;
process and update data;
exec sql execute s1; /* Once committed, 's1' is lost */
process and update more data;
exec sql execute s1;
/* 's1' is NOT a valid statement name */
```

2. When leaving an application, each user deletes all their rows from a working table. User rows are identified by their different access codes. One user may have more than one access code.

```
read group id from terminal;
statement_buffer = 'delete from ' + group_id + '
where access_code =    ?';
exec sql prepare s2 from :statement_buffer;
read access_code from terminal;
loop while (access_code <> 0)
  exec sql execute s2 using :access_code;
  read access_code from terminal;
end loop;
exec sql commit;
```

3. This example uses the OpenSQL forms system and Dynamic OpenSQL. The program reads the forms descriptions using the formdata statement and then uses that information to fill an input SQLDA for a variety of statements. For details about forms programming, see the *Forms-based Application Development Tools User Guide*.

In preparation, the program must allocate a large local SQLDA, called local_sqlda. At the start of form display, the program must retrieve descriptive information into the local SQLDA. The form name is only known at runtime through a command line flag.

```
exec frs formdata :form_name;
exec frs begin;
Using inquire_frs statements, retrieve the type
and length information from the form and fill the
corresponding element in the sqlvar. For each
field on the form set the sqltype, sqllen and
sqldata fields. If the type is negative (nullable)
set the sqlind field too.
Build 3 dynamic statements into 3 statement
buffers to execute the insert, update and delete
operations, using the field names returned by inquire_frs.
exec frs end;
```

At this point, the program has built a SQLDA that it will use for input, and three statement buffers, each with a full list of field names and parameter markers. The insert statement buffer, `insert_buffer`, may look like:

```
'insert into table1 (field1, field2) values (?, ?)'
```

while the delete statement buffer, `delete_buffer`, may look like:

```
'delete from table1 where field1 = ? and field2 = ?'
```

Now prepare the statements:

```
exec sql prepare insert_stmt from :insert_buffer;
exec sql prepare update_stmt from :update_buffer;
exec sql prepare delete_stmt from :delete_buffer;
```

Run the form allowing the user to enter data and execute an operation.

Supply the menu items, Insert, Update, and Delete, as well as others. For example:

```
...
exec frs activate menuitem 'Insert';
exec frs begin;
Get values from the form and point the sqldata and
sqlind fields of local_sqlda to those values;
exec sql execute insert_stmt
using descriptor :local_sqlda;
exec frs end;
...
```

Execute Immediate

SQL	ESQL
	*

Executes an SQL statement specified as a string literal or in a host language variable.

Syntax

```
exec sql execute immediate statement_string
[into variable {, variable} | using [descriptor]
descriptor_name
[exec sql begin;
program_code
exec sql end;]]
```

Description

The execute immediate statement executes a dynamically built statement string. Unlike the prepare and execute sequence, this statement does not name or encode the statement and cannot supply parameters. The execute immediate statement is equivalent to:

```
exec sql prepare statement_name from
      :statement_buffer;
exec sql execute statement_name;
'Forget' the statement_name;
```

Execute immediate can be used:

- To execute a dynamic statement once in your program
- To execute a dynamic select statement and process the result rows with a select loop

If you intend to execute the statement string repeatedly and it is not a select statement, use the prepare and execute statements instead. For more information about the alternatives available for executing dynamic statements, see ["Chapter 6: Dynamic OpenSQL."](#) If the statement string is blank or empty, OpenSQL returns a runtime syntax error.

The execute immediate statement must be terminated according to the rules of the host language.

The following OpenSQL statements cannot be executed using execute immediate:

call	disconnect	inquire_sql
close	endselect	open
connect	execute	prepare
declare	fetch	set
describe	help	set_sql
direct execute immediate	include	whenever

The statement string must not include exec sql, any host language terminators, or references to variable names. If your statement string includes embedded quotes, it is easiest to specify the string in a host language variable. If you choose to specify a string that includes quotes as a string constant, remember that quoted characters *within* the statement string must follow the OpenSQL string delimiting rules. Even if your host language delimits strings with double quotes, the quoted characters within the statement string must be delimited by single quotes. For complete information about embedding quotes within a string literal, see the *Embedded SQL Companion Guide*.

If the statement string is a cursor update or cursor delete, the declaration of the named cursor must appear in the same file as the execute immediate statement executing the statement string.

The into or using clause can only be used when the statement string is a select statement.

The into clause specifies variables to store the values returned by a select. This option can be used if the program knows the data types and lengths of the result columns before the select executes. The *variables* must be type compatible with the associated result columns. For information about the compatibility of host language variables and OpenSQL data types, see the *Embedded SQL Companion Guide*.

Include the using clause if the program does not know the types and lengths of the result columns until runtime. The using clause specifies an SQL Descriptor Area (SQLDA), a host language structure having, among other fields, an array of sqlvar elements. Each sqlvar element describes and points to a host language variable. When the using clause is specified, OpenSQL places the result column values in the variables pointed at by the sqlvar elements.

If you intend to use the using clause, the program can first prepare and describe the select statement. This process returns data type, name, and length information about the result columns to the SQLDA. Your program can then use that information to allocate the necessary variables before executing the select. For more information and about executing dynamic select statements and some examples of executing a dynamic select, see "[Chapter 6: Dynamic OpenSQL](#)."

If the select statement will return more than one row, include the begin/end statement block. This block defines a select loop. OpenSQL processes each row that the select returns using the program code that you supply in the select loop. The program code inside the loop must not include any other database statements, except the endselect statement. If the select returns multiple rows and you do not supply a select loop, the application receives only the first row and an error to indicate that others were returned but unseen.

Example

This example reads an SQL statement from the terminal into a host string variable, statement_buffer. If the user enters quit, the program ends. If an error occurs, the program informs the user.

```
exec sql include sqlca;
read statement_buffer from terminal;
loop while (statement_buffer <> 'QUIT')
exec sql execute immediate :statement_buffer;
  if (sqlcode = 0) then
```

```
exec sql commit;
else if (sqlcode = 100) then
  print 'No qualifying rows for statement:';
  print statement_buffer;
else
  print 'Error :', sqlcode;
  print 'Statement :', statement_buffer;
end if;

read statement_buffer from terminal;
end loop;
```

Execute Procedure

SQL	ESQL
*	*

Invokes a database procedure.

Syntax

Non-dynamic version:

```
[exec sql] execute procedure [schema.]proc_name
  [(param_name=param_spec {, param_name=param_spec})]
  [result row (variable [:indicator_var] {, variable[:indicator_var]})]
  [into return_status]
  [exec sql begin;program code;
  exec sql end;]
```

where *param_spec* is a literal value, a host variable containing the value to be passed (*:hostvar*), or a host variable passed by reference (**byref(:host_variable)**).

Dynamic version:

```
[exec sql] execute procedure [schema.]proc_name
  [using [descriptor] descriptor_name]
  [into return_status]
```

Description

The `execute procedure` statement executes the database procedure identified by *proc_name*. *Proc_name* can be specified using a literal or a host string variable. Database procedures can be executed from interactive SQL (the Terminal Monitor), an embedded OpenSQL program, or from another database procedure. For details about database procedures, see “[Chapter 7: OpenSQL Features](#).”

This statement can be executed dynamically or non-dynamically. When executing a database procedure, you generally provide values for the formal parameters specified in the procedure's definition.

Passing Parameters - Non-Dynamic Version

In the non-dynamic version, parameters can be passed by value or by reference. Each *param_name* must match one of the parameter names in the parameter list of the procedure's definition. *Param_name* must be a valid identifier specified using a quoted or unquoted string or a host variable.

Data can be passed to a database procedure by:

- **Value** - To pass a parameter by value, specify *param_name* = *value*. When passing parameters by value, the database procedure receives a copy of the value. *Values* can be specified using:
 - Numeric or string literals
 - OpenSQL constants (such as today or user)
 - Host variables
 - Arithmetic expressions
- The *value* assigned to a *param_name* must be compatible in type with the formal parameter represented by *param_name*. You can specify date data using quoted character string values. If the data types are not compatible, OpenSQL issues an error and does not execute the procedure.
- **Reference** - To pass a parameter by reference, specify the parameter as *param_name* = byref(:*host_variable*). When passing parameters by reference, the database procedure can change the contents of the variable. Any changes made by the database procedure are visible to the calling program. You cannot pass parameters by reference in interactive SQL.

Passing Parameters - Dynamic Version

In the dynamic version, the *descriptor_name* specified in the using clause identifies an SQL Descriptor Area (SQLDA), a host language structure allocated at runtime. Prior to issuing the execute procedure statement, the program must place the parameter names in the *sqlname* fields of the SQLDA's *sqlvar* elements and the values assigned to the parameters must be placed in the host variables pointed to by the *sqldata* fields. When the statement is executed, the using clause directs OpenSQL to use those parameter names and values.

Parameter names and values follow the same rules for use and behavior when specified dynamically as those specified non-dynamically. For example, because positional referencing is not allowed when you issue the statement non-dynamically, when you use the dynamic version, any sqlvar element representing a parameter must have entries for both its sqlname and sqldata fields. The names must match those in the procedure's definition and the data types of the values must be compatible with the parameter to which they are assigned.

OpenSQL assigns a null or a default value to any parameter in the procedure's definition that is not assigned an explicit value when the procedure is executed. If the parameter is not nullable and does not have a default, an error is issued.

For example, for the create statement:

```
create procedure p (i integer not null,  
d date, c varchar(100)) as ...
```

the following associated execute statement implicitly assigns a null to parameter d.

```
exec sql execute procedure p (i = 123,  
c = 'String');
```

When executing a procedure dynamically, set the SQLDA sqld field to the number of parameters that you are passing to the procedure. The sqld value tells OpenSQL how many sqlvar elements the statement is using, indicating the number of parameters specified. If the sqld element of the SQLDA is set to 0 when you dynamically execute a procedure, it indicates that no parameters are being specified, and if there are parameters in the formal definition of the procedure, these are assigned null or default values when the procedure executes. If the procedure parameter is not nullable and does not have a default, an error is issued.

A parameter cannot be specified in the execute procedure statement that was not specified in the create procedure or register procedure statement.

Return_status is an integer variable that receives the return status from the procedure. If a *return_status* is not specified in the database procedure, or the return statement is not executed in the procedure, then 0 is returned to the calling application.

Note: The into clause cannot be used in interactive SQL.

The statement must be terminated according to the rules of the host language.

Execute Procedure Loops

Use an execute procedure loop to retrieve and process rows returned by a row producing procedure using the result row clause. The result row clause identifies the host variables into which the values produced by the procedure return row statement are loaded. The entries in the result row clause must match in both number and type the corresponding entries in the result row declaration of the procedure.

The begin-end statements delimit the statements in the execute procedure loop. The code is executed once for each row as it is returned from the row producing procedure. Statements cannot be placed between the execute procedure statement and the begin statement.

During the execution of the execute procedure loop, no other statements that access the database can be issued - this causes a runtime error. However, if your program is connected to multiple database sessions, you can issue queries from within the execute procedure loop by switching to another session. To return to the outer execute procedure loop, switch back to the session in which the execute procedure statement was issued. To avoid preprocessor errors, the nested queries cannot be within the syntactic scope of the loop but must be referenced by a subroutine call or some form of a goto statement.

There are two ways to terminate an execute procedure loop: run it to completion or issue the endexecute statement. A host language goto statement cannot be used to exit or return to the execute procedure loop.

To terminate an execute procedure loop before all rows are retrieved the application must issue the endexecute statement. The endexecute statement must be syntactically within the begin-end block that delimits the endexecute procedure loop. For more information, see Endexecute.

The following example retrieves a set of rows from a row producing procedure:

```
exec sql execute procedure deptsal_proc (deptid = :deptno)
      result row (:deptname, :avgsal, :empcount);
exec sql begin;
  browse data;
  if error condition then
    exec sql endexecute;
  end if;
exec sql end;"
```

Permissions

You must have permission to execute the specified procedure.

Locking

The locks taken by the procedure depend on the statements that are executed inside the procedure. All locks are taken immediately when the procedure is executed.

Performance

The first execution of the database procedure may take slightly longer than subsequent executions. For the first execution, the host DBMS may need to create a query execution plan.

Examples

These examples assume the following create procedure statement has been successfully executed:

```
exec sql create procedure p
  (i integer not null,
  d date,
  c varchar(100)) as ...
```

1. This example uses a host variable, a null constant, and an empty string.

```
exec sql execute procedure p
  (i=:ivar, d=null, c='')
  into :retstat;
```

2. This example assumes parameter "c" is null and uses a null indicator for parameter "d".

```
exec sql execute procedure p
  (i=:ivar, d=:dvar:ind)
  into :retstat;
```

3. This example demonstrates the use of the whenever statement for intercepting errors and messages from a database procedure.

```
exec sql whenever sqlerror goto err_exit;
exec sql whenever sqlmessage call sqlprint;
exec sql execute procedure p into :retstat;
...
err_exit:
  exec sql inquire_sql (:errbug = errortext);
```

4. This example demonstrates a dynamically executed execute procedure statement. The example creates and executes the dynamic equivalent of the following statement:

```
exec sql execute procedure enter_person
  (age = :i4_var, comment = :c100_var:indicator);
```

Dynamic version:

```

exec sql include sqlda;
allocate an SQLDA with 10 elements;
sqlda.sqln = 10;
sqlda.sqld = 2;

/* 20-byte character for procedure name */
proc_name = 'enter_person';

/* 4-byte integer to put into parameter 'age' */
sqlda.sqlvar(1).sqltype = int;
sqlda.sqlvar(1).sqllen = 4;
sqlda.sqlvar(1).sqldata = address(i4_var);
sqlda.sqlvar(1).sqlind = null;
sqlda.sqlvar(1).sqlname = 'age';

/* 100-byte nullable character to put into the
** parameter "comment" */
sqlda.sqlvar(2).sqltype = char;
sqlda.sqlvar(2).sqllen = 100;
sqlda.sqlvar(2).sqldata = address(c100_var);
sqlda.sqlvar(2).sqlind = address(indicator);
sqlda.sqlvar(2).sqlname = 'comment';

exec sql execute procedure :proc_name
      using descriptor sqlda;

```

5. Call a database procedure, passing parameters by reference. This enables the procedure to return the number of employees that received bonuses and the total amount of bonuses conferred.

```

exec sql execute procedure grant_bonuses
  (ecount = byref(:number_processed),
  btotal = byref (:bonus_total));

```

Fetch

SQL	ESQL
*	

Fetches data from a database cursor into host language variables.

Syntax

Non-dynamic version:

```

exec sql fetch cursor_name
  into variable[:indicator_var] {, variable[:indicator_var]}

```

Dynamic version:

```

exec sql fetch cursor_name using descriptor descriptor_name

```

Description

The fetch statement retrieves the results of the select statement that is executed when a cursor is opened. When a cursor is opened, the cursor is positioned immediately before the first result row. The fetch statement advances the cursor to the first (or next) row and loads the values in that row into the specified variables. Each fetch statement advances the cursor one row.

There must be a one-to-one correspondence between variables specified in the into or using clause of fetch and expressions in the select clause of the declare cursor statement. If the number of variables does not match the number of expressions, the preprocessor will generate a warning and, at runtime, the SQLCA variable sqlwarn3 will be set to "W."

The variables listed in the into clause can include structures that substitute for some or all of the variables. The structure is expanded by the preprocessor into the names of its individual variables. Therefore, placing a structure name in the into clause is equivalent to enumerating all members of the structure in the order in which they were declared.

The descriptor associated with the using descriptor clause must identify an SQLDA that contains type descriptions of one or more host language variables. Each element of the SQLDA is assigned the corresponding value in the current row of the cursor. For more details, see "[Chapter 6: Dynamic OpenSQL](#)," and [Describe](#) in this chapter.

The variables listed in the into clause or within the descriptor must be type-compatible with the values being retrieved. If a result expression is nullable, then the host language variable that will receive that value must have an associated null indicator.

If the statement does not fetch a row—a condition that occurs after all rows in the set have been processed—the sqlcode of the SQLCA is set to 100 (condition not found) and no values are assigned to the variables.

The cursor identified by *cursor_name* must be an open cursor. *Cursor_name* can be either a string constant or a host language variable.

The statement must be terminated according to the rules of the host language.

Examples

1. Typical fetch, with associated cursor statements.

```

exec sql begin declare section;
  name  character_string(20);
  age   integer;
exec sql end declare section;

exec sql declare cursor1 cursor for
  select ename, age
  from employee
  order by ename;
  ...
exec sql open cursor1;

loop until no more rows
  exec sql fetch cursor1
    into :name, :age;
    print name, age;
  end loop;
  exec sql close cursor1;

```

Assuming the structure:

```

emprec
  name  character_string(20),
  age   integer;

```

the **fetch** in the above example could have been written

```

exec sql fetch cursor1
  into :emprec;

```

The preprocessor would then interpret that statement as though it had been written

```

exec sql fetch cursor1
  into :emprec.name, :emprec.age;

```

2. Fetch using an indicator variable.

```

exec sql fetch cursor2 into :name,
  :salary:indicator_var;

```

Get Dbevent

SQL	ESQL	DB Proc
*		

Gets an event previously defined by the create dbevent statement.

Syntax

```
exec sql get dbevent [with nowait |wait [=wait_value]];
```

Description

The GET dbevent statement receives database events for which an application is registered. The GET dbevent statement returns the next database event from the database event queue. To obtain database event information, issue the inquire_sql statement. For a full description of database events, see [Database Events](#) in the chapter "OpenSQL Features."

To specify whether the GET dbevent statement waits for database events or checks the queue and returns immediately, specify the with [no]wait clause. By default, GET dbevent checks and returns immediately.

If with wait is specified, GET dbevent waits indefinitely for the next database event to arrive. If with wait = *wait_value* is specified, GET dbevent returns when a database event arrives or when *wait_value* seconds have passed, whichever occurs first. If GET dbevent times out before a database event arrives, no database event is returned. *Wait_value* can be specified using an integer constant or integer host language variable.

The with wait option cannot be used within a select loop.

Help

SQL	ESQL
*	

Gets information about SQL and a variety of database objects.

Syntax

```
help [*]
help tablename | viewname | indexname
      {, tablename | viewname | indexname}
help table tablename {, tablename}
help view viewname {, viewname}
help index indexname {, indexname}
help help
help sql
help sql_statement
```

Description

The help statement displays information about the contents of the database or specific tables. In addition, help can be used at the terminal monitor to obtain information regarding OpenSQL, including such features as the syntax of OpenSQL statements and valid data types.

The following table lists help parameters:

Parameter	Description
help	Lists all user tables, views, and indexes that exist in the current database. (System catalogs are not listed.)
help *	Gives information about the makeup of all user-defined (not system) tables, views, and indexes in the database.
help <i>tablename</i> {, <i>tablename</i> }	Provides the name, owner, creation date and time, and the dbms version under which the table was created. Displays the name, data type, length, nullability, default, and key sequence for each column in the table.
help <i>viewname</i> {, <i>viewname</i> }	Displays information similar to that displayed by help <i>tablename</i> .
help <i>indexname</i> {, <i>indexname</i> }	Displays information similar to that displayed by help <i>tablename</i> .
help table <i>tablename</i> {, <i>tablename</i> }	Displays the same information as help <i>tablename</i> plus additional table information, depending on the particular Enterprise Access product or server.
help view <i>viewname</i> {, <i>viewname</i> }	Displays the text of the view, the view name, owner and the state of the check option.
help index <i>indexname</i> {, <i>indexname</i> }	Displays the name, owner, creation date and time, dbms version under which it was created, and, for each column, its name, data type, length, nullability, default attribute, and key sequence.
help help	Displays a list of OpenSQL features for which help is available.
help sql	Displays general information about OpenSQL.
help <i>sql_statement</i>	Displays information on the specified <i>sql_statement</i> .

The asterisk (*) can be used as a pattern matching character when specifying an object name. For example, if you type help table emp*, you receive help on all tables in the database whose names begin with emp. If you type, help table *emp, you receive help on all the tables whose names end with emp.

When the asterisk is used by itself with help, as in help *, OpenSQL provides information about all tables, views, and indexes in the database.

Examples

1. Retrieve a list of all tables, views, and indexes in the database.

```
help;
```

2. Retrieve help about the employee table.

```
help employee;
```

3. Retrieve help about the employee and dept tables.

```
help employee, dept;
```

4. Retrieve the definition of the view highpay.

```
help view highpay;
```

5. List information on the select statement.

```
help select;
```

Include

SQL	ESQL
*	

Includes an external file in source code.

Syntax

```
exec sql include filename | sqlca | sqlda
```

Description

The include statement provides a way to include external files in your program source code. This statement is normally used to include variable declarations, although it is not restricted to such use. When used to include variable declarations, it must be inside an embedded OpenSQL declaration section. The file generated by dclgen should be specified by means of the include statement.

Unlike the “include” facilities of most programming languages, the file specified by the OpenSQL include statement must comprise complete, not partial, statements or declarations. For example, it is illegal to use include in the following manner, where the file, predicate, contains a common predicate for select statements.

Incorrect:

```
exec sql select ename
from employee
where
exec sql include 'predicate';
```

Filename must be a quoted string constant specifying a file name or a logical system symbol that contains a file name. If the specified file has no extension, OpenSQL assumes the default extension of your host language.

The specified file can contain declarations, host language statements, embedded OpenSQL statements and nested includes. When the original source file is preprocessed, the include statement is replaced by a host language include directive, and the included file is also preprocessed.

There are two special instances of the include statement:

- **include sqlca**—Include the SQL Communications Area
- **include sqlda**—Include the definitions associated with the SQL Descriptor Area

Both these statements must be placed outside all declaration sections, preferably at the start of the program.

The statement must be terminated as required by the rules of your host language.

Examples

1. Include the SQLCA in the program.

```
exec sql include sqlca;
```

2. Include global variables.

```
exec sql begin declare section;
      exec sql include 'global.var';
      exec sql end declare section;
```

3. Include a file that contains header files that list variable declarations.

```
exec sql begin declare section;
      exec sql include 'mypath:global.var';
      exec sql end declare section;
```

Inquire_sql

SQL	ESQL
*	

Provides an application program with a variety of runtime information.

Syntax

```
exec sql inquire_sql {variable = object [, variable = object]}
```

Description

The inquire_sql statement enables an embedded OpenSQL program to retrieve a variety of runtime information, such as:

- Information about the last executed database statement
- Status information, such as the current session ID, the type of error (local or generic) being returned to the application, and whether a transaction is currently open

The inquire_sql statement does not execute queries. The information inquire_sql returns to the program reflects the results of the last query that was executed. For this reason, the inquire_sql statement must be issued after the database statement about which you want information, and before another database statement is executed (and resets the values returned by inquire_sql).

Some of the information returned by inquire_sql is also available in the SQLCA. For example, the error number returned by the object errno is also available in the SQLCA sqlcode field.

Similarly, when an error occurs, you can retrieve the error text using inquire_sql with the errortext object or you can retrieve it from the SQLCA sqlerrm variable. Errortext provides the complete text of the error message, which is often truncated in sqlerrm.

This statement must be terminated according to the rules of your host language.

Inquiring About Database Events

The following table lists the inquire_sql parameters that return information about a database event. For information about database events, see Database Events in the chapter “OpenSQL Features.” All character values are returned in lower case. If no event is queued, an empty or blank string is returned (depending on your host language conventions).

Object	Data Type	Description
Dbeventname	Character	The name of the event (assigned using the createdbevent statement). The receiving variable must be large enough for the full event name; if the receiving variable is too small, the event name is truncated to fit.
Dbeventowner	Character	The creator of the event.
Dbeventdatabase	Character	The database in which the event was raised.
Dbeventtime	Date	The date and time at which the event was raised.
Dbeventtext	Character	The text (if any) specified as the <i>event_text</i> parameter when the event was raised. The receiving value must be a 256-character string; if the receiving variable is too small, the text is truncated to fit.

Types of Inquiries

The following table lists the valid inquiries that can be performed using the inquire_sql statement:

Object	Data Type	Comment
dbmserror	integer	The number of the error caused by the last query. This number corresponds to the value of <i>sqlerrd</i> (1), the first element of the <i>sqlerrd</i> array in the SQLCA. You can specify whether a local or generic error is returned using <i>set_sql(errortype)</i> .

Object	Data Type	Comment
endquery	integer	If the previous fetch statement was issued after the last row of the cursor, endquery returns the value "1." If the last fetch statement returns a valid row, the value returned is "0." This is identical to the NOT FOUND condition (value 100) of the SQLCA variable sqlcode, which can be checked after a fetch statement is issued. Like the NOT FOUND condition, when endquery returns "1," the variables assigned values from the fetch remain unchanged.
errno	integer	<p>A positive integer, representing the error number of the last query. The error number is cleared before each embedded OpenSQL statement, so that this object is only valid immediately after the statement in question. This error number is the same as the positive value of the SQLCA variable sqlcode, except in two cases:</p> <ol style="list-style-type: none"> 1. A single query generates multiple different errors, in which case the sqlcode identifies the first error number, and the errno object identifies the last error. 2. After switching sessions. In this case, sqlcode reflects the results of the last statement executed before switching sessions, while errno will reflect the results of the last statement executed in the current session. <p>If a statement executes with no errors or sqlcode is set to a positive number (for example, +100 to indicate no rows affected), then the error number is set to 0.</p>
errortext	character	The error text of the last query. The error text is only valid immediately after the database statement in question. The text that is returned is the complete error message of the last error. This message may have been truncated when it was deposited into the SQLCA variable sqlerrm. A character string result variable of size 512 should be sufficient to retrieve all OpenSQL error messages. If the result variable is shorter than the error message, the message is truncated. If there is no error message, a blank message is returned.
errortype	character	Returns genericerror if OpenSQL returns generic

Object	Data Type	Comment
		error numbers to errno and sqlcode, or dbmserror if OpenSQL returns local DBMS error numbers to errno and sqlcode. For information about generic and local errors, see “ Chapter 7: OpenSQL Features .”
programquit	integer	<p>Returns 1 if applications quit:</p> <ol style="list-style-type: none"> 1. After issuing a query when not connected to a database. 2. If the Enterprise Access product or server fails. 3. If communications services fail. <p>Returns 0 if applications continue after encountering such errors.</p>
querytext	character	<p>Returns the text of the last query issued. Valid only if this feature is enabled. To enable or disable the saving of query text, use set_sql(savequery). A maximum of 1024 characters is returned. If the query is longer, it is truncated to 1024 characters. If the receiving variable is smaller than the query text being returned, the text is truncated to fit.</p> <p>If a null indicator variable is specified together with the receiving host language variable, the indicator variable is set to -1 if query text cannot be returned, 0 if query text is returned successfully. Query text cannot be returned if (1) savequery is disabled, (2) no query has been issued in the current session, or (3) the inquire_sql statement is issued outside of a connected session.</p>
rowcount	integer	The number of rows affected by the last query. “Affected” means subject to any of the following statements: insert, delete, update, select, fetch, create index, or create table as select. If any of these statements run successfully, the value of rowcount is the same as the value of the SQLCA variable sqlerrd(3). If these statements generate errors, or if statements other than these are run, then the value of rowcount is negative and the value of sqlerrd(3) is 0.
savequery	integer	Returns 1 if query text saving is enabled, 0 if disabled.

Object	Data Type	Comment
session	integer	Returns the session identifier of the current database session. If the application is not using multiple sessions or there is no current session, 0 is returned.
transaction	integer	Returns a value of 1 if there is a transaction open. Returns 0 if no transaction is open.

Example

Execute some database statements, and handle errors by displaying the message and aborting the transaction.

```

exec sql whenever sqlerror goto err_handle;
exec sql select name, sal
  into :name, :sal
  from employee
  where eno = :eno;
if name = 'Badman' then
  exec sql delete from employee where eno = :eno;
else if name = 'Goodman' then
  exec sql update employee set sal = sal + 3000
    where eno = :eno;
end if;
exec sql commit;
...
err_handle:
exec sql whenever sqlerror continue;
exec sql inquire_sql (:err_msg = errortext);
print 'Enterprise Access product error: ',
sqlca.sqlcode;
print err_msg;
exec sql rollback;
end if;

```

Insert

SQL	ESQL
*	*

Inserts rows into a table.

Syntax

```
[exec sql [repeated]] insert into tablename [(column {, column})]
[values (value{, value})] | [subselect]
```

Description

The insert statement inserts new rows into the specified table. Use either the values list or specify a *subselect*. When using the values list, only a single row can be inserted with each execution of the statement. If you specify a *subselect*, then the statement inserts all the rows that result from the evaluation of the *subselect*. The subselect must not select rows from the table into which you are inserting rows; specifically, you cannot specify the same table in the into clause of the insert statement and the from clause of the subselect.

The *column* list identifies the columns of the specified table into which the values are placed. When the column list is included, OpenSQL places the first value in the values list or *subselect* into the first column named, the second value into the second column named, and so on. The data types of the values must be compatible with the data types of the columns in which they are placed.

The list of column names can be omitted only if:

- You specify a subselect that retrieves a value for each column in *tablename*. The values must be of an appropriate data type for each column and must be retrieved in an order corresponding to the order of the columns in *tablename*.
- There is a one-to-one correspondence between the values in the values list and the columns in the table. That is, the values list must have a value of the appropriate data type for each column and the values must be listed in an order corresponding to the order of the columns in the table.

Values in the values list must be string or numeric literals or one of the OpenSQL constants. When the column list is included, any columns in the table that are not specified in the column list are assigned their default value. A value must be specified for mandatory columns. (Mandatory columns are columns defined as not default or not null with no default specified.)

Embedded Usage

Host language variables can be used within expressions in the values clause or in the search condition of the *subselect*. Variables used in search conditions must denote constant values, and cannot represent names of database columns or include any operators. A host string variable can also replace the complete search condition of the subselect, as when it is used in the forms system query mode. Host language variables that correspond to column expressions can include null indicator variables.

The keyword `repeated` directs the Enterprise Access product or server to encode the insert and save its execution plan when it is first executed. This encoding can improve the performance of subsequent executions of the same insert.

Do not specify the `repeated` option for insert statement that is constructed using dynamic OpenSQL. A dynamic where clause cannot be used in a `repeated` insert: the query plan is saved when the query is first executed, and subsequent changes to the where clause will be ignored.

The `values` clause can include structure variables that substitute for some or all of the expressions. The structure is expanded by the preprocessor into the names of its individual members. Therefore, placing a structure name in the `values` clause is equivalent to enumerating all members of the structure in the order in which they were declared.

The `sqlerrd(3)` of the SQLCA indicates the number of rows inserted by the statement. If no rows are inserted, for example, if no rows satisfied the `subselect` search condition, then the `sqlcode` variable of the SQLCA is set to 100.

Examples

1. Add a row to an existing table.

```
insert into emp (name, sal, bdate)
values ('Jones', Bill', 10000, 1944);
```

2. Insert into the jobtable all rows from the newjob table where the job title is not Janitor.

```
insert into job (jid, jtitle, lowsal, highsal)
select job_no, title, lowsal, highsal
from newjob
where title <> 'Janitor';
```

3. Add a row to an existing table, using the default columns.

```
insert into emp
values ('Jones', Bill', 10000, 1944);
```

4. Use a structure to insert a row.

```
/* Description of table employees from
database deptdb */

exec sql declare employees table
(eno      smallint not null,
ename    character(20) not null,
age      smallint,
jobcode  smallint,
sal      float not null,
deptno   smallint);

exec sql begin declare section;
```

```

emprec
  int    eno;
  char   ename[21];
  int    age;
  int    job;
  float  sal;
  int    deptno;

exec sql end declare section;
/* Assign values to fields in structure */
eno = 99;
ename = "Arnold K. Arol";
age = 42;
jobcode = 100;
sal = 100000;
deptno=47;

exec sql connect deptdb;
exec sql insert into employees values (:emprec);
exec sql disconnect;

```

Open

SQL	ESQL
	*

Opens a cursor for processing.

Syntax

Non-dynamic version:

```
exec sql open cursor_name [for readonly]
```

Dynamic version:

```
exec sql open cursor_name [for readonly]
  [using variable {, variable} | 
  using descriptor descriptor_name]
```

Description

The open statement executes the select statement specified when the cursor was declared and positions the cursor immediately before the first row returned. (To actually retrieve the rows, the fetch statement must be used.) A cursor must be opened before it can be used in any data manipulation statements such as fetch, update, or delete and you must declare a cursor before it can be opened.

The `for readonly` clause indicates that, though the cursor may have been declared for update, the cursor is being opened for reading only. The `for readonly` clause may improve the performance of data retrieval, and should be used whenever appropriate.

When a cursor that was declared for a dynamically prepared select statement is opened, the `using` clause must be used if the prepared select statement contains constants specified with question marks. For information about using question marks to specify constants in prepared statements, see [Prepare](#) in this chapter.

The `using` clause provides the values for these “unspecified” constants in the prepared select so that the open statement can execute the select. For example, assume that your application contains the following dynamically prepared select statement:

```
statement_buffer =  
'select * from' + tablename + 'where low < ? and'  
    'high > ?';  
exec sql prepare sel_stmt from :statement_buffer;
```

When the cursor is opened for this prepared select statement, values must be provided for the question marks in the `where` clause. The `using` clause performs this task.

```
Declare the cursor for sel_stmt;  
assign values to variables named "low" and "high";  
exec sql open cursor1  
using :low, :high;
```

The values represented by `low` and `high` replace the question marks in the `where` clause and the DBMS can evaluate the select. If Descriptor Area (SQLDA) is used, then the values that replace the question marks are taken from variables pointed to by the `sqlvar` elements of the descriptor. Allocate the SQLDA and the variables to which the `sqlvar` elements point and place values in the variables before using the descriptor in an open cursor statement.

The same cursor can be opened and closed (with the `close` statement) any number of times in a single program. It must be closed, however, before it can be reopened.

A string constant or a host language variable can be used to represent `cursor_name`. This statement must be terminated according to the rules of your host language.

Examples

1. Declare and open a cursor.

```
Exec sql declare cursor1 cursor for
  select :one + 1, ename, age
  from employee
  where age >= :minage;
  ...
  exec sql open cursor1;
```

When the open statement is encountered, the variables, one and minage, are evaluated. The first statement that follows the opening of a cursor should be a fetch statement to define the cursor position and retrieve data into the indicated variables:

```
exec sql fetch cursor1
  into :two, :name, :age;
```

The value of the expression, :one + 1, is assigned to the variable, two, by the fetch.

2. The following example demonstrates the dynamic OpenSQL syntax. In a typical application, the prepared statement and its parameters would be constructed dynamically.

```
Select_buffer = 'select * from employee
  where eno = ?';
exec sql prepare select1 from :select_buffer;
exec sql declare cursor2 cursor for select1;
eno = 1234;
exec sql open cursor2 using :eno;
```

Prepare

SQL	ESQL
*	

Prepares and names a dynamically constructed OpenSQL statement for execution.

Syntax

```
exec sql prepare statement_name
  [into descriptor_name [using names]]
  from string_constant | string_variable
```

Description

The `prepare` statement encodes the dynamically constructed OpenSQL statement string in the `from` clause and assigns it the specified `statement_name`. When the program subsequently executes the prepared statement, it uses the name to identify the statement, rather than the full statement string. Both the name and statement string can be represented by either a string constant or a host language variable.

Within the statement string, replace constant expressions in `where` clauses, `insert values` clauses, and `update set` clauses with question marks. When the statement executes, these question marks are replaced with specified values. Question marks cannot be used in place of table or column names or reserved words.

To illustrate, the following example prepares and executes a `delete` statement on a dynamically defined table:

```
statement_buffer =  
'delete from ' + table_name + ' where code = ?';  
exec sql prepare del_stmt from :statement_buffer;  
...  
exec sql execute del_stmt using :code;
```

The value in the variable, `code`, replaces the `?` in the `where` clause of the prepared `delete` statement.

Illustrating incorrect usage, the following example is wrong because it includes a parameter specification in place of the table name:

```
exec sql prepare bad_stmt  
from 'delete from ? where code = ?';
```

Whenever an application executes a prepared statement that contains parameters specified with question marks, the program must supply values for each question mark. If the statement string is blank or empty, OpenSQL returns a runtime syntax error.

If the statement name identifies an existing prepared statement, the existing statement is destroyed and the new statement takes effect. This rule holds across the dynamic scope of the application. The statement name must not identify an existing statement name that is associated with an open cursor. The cursor must be closed before its statement name can be destroyed. Once prepared, the statement can be executed any number of times.

However, if a transaction is rolled back or committed, the prepared statement becomes invalid. If the prepared statement is to be executed only once, `execute immediate` should be used on the statement string. If the prepared statement is to be executed repeatedly, the `prepare` and `execute` sequence should be used.

The following statements cannot be prepared and executed dynamically:

call	disconnect	inquire_sql
close	endselect	open
connect	execute immediate	set
declare	execute	set_sql
describe	fetch help	whenever
direct execute immediate	include	

In addition, you cannot prepare and dynamically execute OpenSQL statements that include the keyword repeated.

If the statement string is a select statement, the select must not include an into clause. The select statement string can include the different clauses of the cursor select statement, such as the for update and order by clauses.

As with execute immediate, the statement string must not include exec sql, any host language terminators, or references to variable names. If your statement string includes embedded quotes, it is easiest to specify the string in a host language variable. If you specify a string that includes quotes as a string constant, remember that quoted characters *within* the statement string must follow the OpenSQL string delimiting rules. Consequently, even if your host language delimits strings with double quotes, the quoted characters within the statement string must be delimited by single quotes. For complete information about embedding quotes within a string literal, see the *Embedded SQL Companion Guide*.

The into *descriptor_name* clause is equivalent to issuing the describe statement after the statement is successfully prepared. For example, the prepare statement

```
exec sql prepare prep_stmt  
    into sqlda from :statement_buffer;
```

is equivalent to

```
exec sql prepare prep_stmt from :statement_buffer;  
exec sql describe prep_stmt into sqlda;
```

The into clause returns the same information as does the describe statement. If the prepared statement is a select, the descriptor will contain the data types, lengths, and names of the result columns. If the statement was not a select, the descriptor's sqld field will contain a zero. For more information about the results of describing a statement, see "[Chapter 6: Dynamic OpenSQL](#)," and [Describe](#) in this chapter.

This statement must be terminated according to the rules of your host language.

Example

A two-column table, whose name is defined dynamically but whose columns are called, high and low, is manipulated within an application, and statements to delete, update and select the values are prepared.

```
get tablename from a set of names;  
  
statement_buffer =  
  'delete from ' + tablename + '  
  where high = ? and low = ?';  
exec sql prepare del_stmt from :statement_buffer;  
  
statement_buffer =  
  'insert into ' + tablename + ' values (?, ?)';  
exec sql prepare ins_stmt from :statement_buffer;  
  
statement_buffer =  
  'select * from ' + tablename + ' where low ?';  
exec sql prepare sel_stmt from :statement_buffer;  
  
...  
exec sql execute del_stmt using :high, :low;  
...  
exec sql execute ins_stmt using :high, :low;  
...  
exec sql declare sel_csr for sel_stmt;  
exec sql open sel_csr using :high, :low;  
loop while more rows  
  exec sql fetch sel_csr into :high1, :low1;  
  ...  
end loop;
```

Raise Dbevent

SQL	ESQL	DB Proc
*	*	

Enables an application to notify other applications of its status.

Syntax

```
[exec sql] raisedbevent [schema.]event_name [event_text];
```

Description

The raise dbevent statement enables a session to communicate status information to other sessions that are registered to receive *event_name*. For a full description of database events, see [Database Events](#) in the chapter “OpenSQL Features.” Use the optional *event_text* parameter to pass a (maximum 256 character) string to receiving applications; to obtain the text, receiving applications must use the inquire_sql(dbeventtext) statement.

Embedded Usage

Event_name cannot be specified using a host language variable, though *event_text* can be specified using a host string variable.

Register Dbevent

SQL	ESQL	DB Proc
*	*	

Specifies that an application is to be notified when an event is raised.

Syntax

```
[exec sql] register dbevent [schema.] event_name;
```

Description

The register dbevent statement enables a session to specify the database events it intends to receive. For a full description of database events, see [Database Events](#) in the chapter “OpenSQL Features.”

A session receives only the database events for which it has registered. To remove a registration, use the remove statement. After registering for a database event, the session receives the database event using the GET dbevent statement.

Embedded Usage

Event_name cannot be specified using a host language variable.

Remove Dbevent

SQL	ESQL	DB Proc
*	*	

Removes a database event for which an application has previously registered.

Syntax

```
[exec sql] removedbevent [schema.]event_name;
```

Description

The remove dbevent statement specifies that an application no longer intends to receive the specified database event. For a full description of database events, see [Database Events](#) in the chapter "OpenSQL Features."

If the database event has been raised before the application removes the registration, the database event remains queued to the application and will be received when the application issues the GET dbevent statement.

Rollback

SQL	ESQL
*	*

Rolls back the current transaction.

Syntax

```
[exec sql] rollback [work]
```

Description

The rollback statement backs out the changes made during the current transaction. The optional keyword work has no effect. It is included for compatibility with other versions of SQL.

Embedded Usage

In addition to aborting the current transaction, an embedded rollback:

- Closes all open cursors
- Discards all statements that were prepared in the current transaction

Performance

Executing a rollback undoes the work done by a transaction. The time required to do this is generally the same amount of time as it took to perform the work originally.

Select (interactive)

SQL	ESQL
*	

Retrieves values from one or more tables or views.

Syntax

```
select [first rowCount][all|distinct] * | result_expression {, result_expression}
  from from_source {, from_source}
  [where search_condition]
  [group by column {, column}]
  [having search_condition]
  {union [all]          (select)}
  [order by result_column [asc | desc]
  {, result_column [asc | desc]}];
```

where *result_expression* is one of the following:

- *[schema.]tablename.** (to select all columns)
- *[[schema.]tablename.]columnname [[as] result_column]* (to select one column)
- *expression [as] result_column*

Description

The select statement returns values from one or more tables or views in the form of a single result table. Using the various clauses of the select statement, you can specify:

- Qualifications for the values in the result table

- Sorting and grouping of the values in the result table

This statement description presents details of the select statement in interactive OpenSQL (ISQL). In ISQL the results of a query are displayed on your terminal. In embedded OpenSQL (ESQL), results are returned in host language variables. For details about using the select statement in ESQL, see [Select \(embedded\)](#) in this chapter.

The following sections describe the clauses of the select statement, explain how to create simple queries, and explain how the results of a query are obtained.

Select Statement Clauses

The select statement has the following clauses:

- select
- from
- where
- group by
- having
- order by

The following sections describe how the clauses are processed and explain each clause in detail.

Query Evaluation

This section describes the logic applied to the evaluation of select statements. This logic does not precisely reflect how OpenSQL evaluates your query to figure out the fastest and most efficient way to return results. However, by applying the logic presented here to your queries and data, you can anticipate the results of your query.

1. **Evaluate the from clause.** Combine all the sources specified in the from clause to create a *Cartesian product* (a table composed of all the rows and columns of the sources). If joins are specified, evaluate each join to obtain its results table, then combine it with the other sources in the from clause. If select distinct is specified, discard duplicate rows.
2. **Apply the where clause.** Discard rows in the result table that do not fulfill the restrictions specified in the where clause.
3. **Apply the group by clause.** Group results according to the columns specified in the group by clause.

4. **Apply the having clause.** Discard rows in the result table that do not fulfill the restrictions specified in the having clause.
5. ***Evaluate the select clause.** Discard columns that are not specified in the select clause.
6. ***Perform any unions.** Combine result tables as specified in the union clause.
7. **Apply the order by clause.** Sort the result rows as specified.

* In case of Select first n... union select, the first n rows of the result from union are chosen.

The Select Clause

The select clause specifies which values are to be returned. To display all the columns of a table, use the asterisk wildcard character (*). For example, the following query displays all rows and columns from the employees table:

```
select * from employees;
```

To select specific columns, specify the column names. For example, the following query displays all rows, but only two columns from the employees table:

```
select ename, enumber from employees;
```

To specify the table from which the column is to be selected, use the *[schema.]table.columnname* syntax. For example:

```
select personnel.managers.name,  
      personnel.employees.name
```

In the preceding example, both source tables contain a column called, name. The column names are preceded by the name of the source table. The first column of the result table contains the values from the name column of the managers table, and the second column contains the values from the name column of the employees table. If a column name is used in more than one of the source tables, you must qualify the column name with the table to which it belongs, or with a correlation name. For details, see [The From Clause](#) in this chapter.

The number of rows in the result table can be limited using the **first** clause. *RowCount* is a positive integer value that indicates the maximum rows in the result table. The query is effectively evaluated without concern for the **first** clause, but only the first "n" rows (as defined by *rowCount*) are returned. Note that this clause may not be used in a where clause subselect and it may only be used in the first of a series of union'ed selects. However, it may be used in the create table, as select and insert into, select statements. When used with create table...as select and insert into...select statements, first n should not be used along with the order by clause.

To eliminate duplicate rows from the result table, specify the keyword **distinct**. To preserve duplicate rows, specify the keyword **all**. By default, duplicate rows are preserved.

For example, the following table contains order information. The **partno** column contains duplicate values, because different customers have placed orders for the same part.

partno	customerno	qty	unit_price
123-45	101	10	10.00
123-45	202	100	10.00
543-21	987	2	99.99
543-21	654	33	99.99
987-65	321	20	29.99

The following query displays the part numbers for which there are orders on file:

```
select distinct partno from orders
```

The result table looks like this:

partno
123-45
543-21
987-65

A constant value can be included in the result table. For example:

```
select 'Name: ', ename, date('today'),  
       edept from employees;
```

The preceding query selects all rows from the employees table. The result table is composed of the string constant 'Name:', the employee's name, today's date (specified using the constant today), and the employee's department, or if there is no department assigned, the string constant 'Unassigned'.

The result table looks like this (depending, of course, on the data in the employees table):

COL1	ename	COL3	COL4
Name:	Mike Sannicandro	Aug 8, 1999	Micrography
Name:	Dave Murtagh	Aug 8, 1999	Percussive arts
Name:	Benny Barth	Aug 8, 1999	Unassigned
Name:	Dean Reilly	Aug 8, 1999	Lumber
Name:	Al Obidinski	Aug 8, 1999	Unassigned

The select clause can be used to obtain values calculated from the contents of a table. For example:

```
select ename, annual_salary/52 from employees;
```

The preceding query calculates each employee's weekly salary based on their annual salary.

Aggregate functions can be used to calculate values based on the contents of column. For example:

```
select max(salary), min(salary), avg(salary)
  from employees;
```

The preceding query returns the highest, lowest, and average salary from the employees table. These values are based on the amounts stored in the salary column. For details about aggregate functions, see "[Chapter 4: Elements of OpenSQL Statements](#)."

To specify a name for a column in the result table, use the *as result_column* clause. For example:

```
select ename, annual_salary/52 as weekly_salary
  from employees;
```

In the preceding example, the name, weekly_salary, is assigned to the second result column. If you omit a result column name for columns that are not drawn directly from a table (for example, calculated values or constants), the result columns are assigned the default name COL n , where n is the column number. Result columns are numbered from left to right. Column names cannot be assigned in select clauses that use the asterisk wildcard (*) to select all the columns in a table.

The From Clause

The from clause specifies the source tables and views from which data is to be read. The specified tables and views must exist at the time the query is issued. The tables or views must be specified using the following syntax:

`[schema.]table [corr_name]`

where *table* is the name of a table or view. To ensure program portability, specify no more than 15 tables in a query, including the tables in the from list and tables in subqueries. (Individual host database management systems may allow more than 15 tables.)

The following sections explain these sources in detail.

Specifying Tables and Views

This section describes how to specify table names in queries. The same rules apply to views.

To select data from a table you own, specify the name of the table. To select data from a table you do not own, specify *schema.table*, where *schema* is the name of the user that owns the table. However, if the table is owned by the database DBA, the schema qualifier is not required. You must have the appropriate permissions to access the table (or view) granted by the owner.

A *correlation name* can be specified for any table in the from clause. A correlation name is an alias (or alternate name) for the table. For example:

```
select... from employees e, managers m...
```

The preceding example assigns the correlation name "e" to the employees table and "m" to the managers table. Correlation names are useful for abbreviating long table names and for joining a table to itself.

If you assign a correlation name to a table, you must refer to the table using the correlation name. For example:

Correct:

```
select e.name, m.name  
from employees e, managers m...
```

Incorrect:

```
select employees.name, managers.name  
from employees e, managers m...
```

The Where Clause

The where clause specifies criteria that restrict the contents of the results table. You can test for simple relationships or, using subqueries, relationships between a column and a set of columns.

Simple Where Clauses

Using a simple where clause, you can restrict the contents of the results table as follows:

- Comparisons

```
select ename from employees
  where manager = 'Jones';
```

```
select ename from employees
  where salary > 50000;
```

- Ranges

```
select ordnum from orders
  where odate between date('jan-01-1993') and
        date('today');
```

- Set membership

```
select * from orders
  where partno in ('123-45', '678-90');
```

- Pattern matching

```
select * from employees
  where ename like 'A%';
```

- Nulls

```
select ename from employees
  where edept is null;
```

- Combined restrictions using logical operators

```
select ename from employees
  where edept is null and
        hiredate = date('today');
```

For details about query restriction operators, see [Predicates](#) in the chapter "Elements of OpenSQL Statements."

Joins

Joins combine information from multiple tables and views into a single result table, according to column relationships specified in the where clause.

For example, given the following two tables:

Employee Table

ename	edepthno
Benny Barth	10
Dean Reilly	11
Rudy Salvini	99
Tom Hart	123

Department Table

ddeptno	dname
10	Lumber
11	Sales
99	Accounting
123	Finance

The following query joins the two tables on the relationship of equality between values in the edeptno and ddeptno columns. The result is a list of employees and the names of the departments in which they work:

```
select ename, dname from employees, departments  
where edeptno = ddeptno;
```

A table can be joined to itself using correlation names—this is useful when listing hierarchical information. For example, the following query displays each employee's name and the name of the employee's manager.

```
select e.ename, m.ename  
  from employees e, employees m  
 where e.eno = m.eno
```

Tables can be joined on any number of related columns. The data types of the join columns must be comparable.

Outer Joins

Data can be combined from two or more tables to produce an intermediate results table using an outer join.

Note: Outer join functionality is available **only** if OUTER_JOIN is set to "Y" in the iidbcapabilities table.

Note: Outer joins specified in the from clause are not the same as joins specified in the where clause: the from clause specifies sources of data, while the where clause specifies restrictions to be applied to the sources of data to produce the results table.

Outer joins are specified in the from clause, using the following syntax:

```
source join_type join source  
      on search_condition
```

where:

- The *source* parameter is the table, view, or outer join where the data for the left or right side of the join originates.
- The *join_type* parameter specifies inner, left, right, or full outer join. The default join type is inner.
- The *search_condition* is a valid restriction, subject to the rules for the where clause. The search condition must not include aggregate functions or subselects.

Think of an outer join as the union of two select statements: the first query returns rows that fulfill the join condition, and the second returns nulls for rows that do not.

There are three types of outer joins:

- **Left outer join** - Returns all values from the left source
- **Right outer join** - Returns all values from the right source
- **Full outer join** - Returns all values from both sources

Note: Right and left joins are symmetrical: (table1 right-join table2) returns the same results as (table2 left-join table1).

By default, joins are evaluated left to right. To override the default order of evaluation, use parentheses.

A source can itself be an outer join, and the results of joins can be joined with the results of other joins, as illustrated in the following pseudocode:

```
(A join B) join (C join D)
```

The placement of restrictions is important in obtaining correct results. For example:

```
A join B on cond1 and cond2
```

does not return the same results as:

```
A join B on cond1 where cond2
```

In the first example, the restriction determines which rows in the join result table will be assigned null values; in the second example, the restriction determines which rows will be omitted from the result table.

The following example uses an outer join in the from clause to display all employees along with the name of their department, if any:

```
select e.ename, d.dname from
  (employees e left join departments d
    on e.dept = d.dept);
```

Join Relationships

The simple joins illustrated in the two preceding examples depend on equal values in the join columns. This type of join is called an *equijoin*. Other types of relationships can be specified in a join. For example, the following query lists salespersons that have met or exceeded their sales quota:

```
select s.name, s.sales_ytd
  from sales s, quotas q
 where s.empnum = d.empnum and
       s.sales_ytd >= d.quota;
```

Subqueries

Subqueries are select statements placed in a where or having clause. The results returned by the subquery are used to evaluate the conditions specified in the where or having clause. Subqueries are also referred to as *subselects*.

Subqueries must return a single column, and cannot include an order by or union clause.

The following example uses a subquery to display all employees whose salary is above the average salary:

```
select * from employees where salary >
  (select avg(salary) from employees);
```

In the preceding example, the subquery returns a single value: the average salary. Subqueries can also return sets of values. For example, the following query returns all employees in all departments managed by Barth.

```
select ename from employees where edept in
  (select ddept from departments
    where dmgr = 'Barth');
```

For details about the operators used in conjunction with subqueries, see [Predicates](#) in the chapter "Elements of OpenSQL Statements."

The Order By Clause

The order by clause specifies the columns on which the results table is to be sorted. Columns in the order by clause can be specified using either the column name or a number corresponding to the position of the column in the from clause. (You must specify unnamed result columns using a number.) In a union select, use numbers to specify the columns in the order by clause; column names cannot be used.

For example, if the employees table contains the following data:

ename	eddept	emanager
Murtagh	shipping	Myron
Obidinski	lumber	Myron
Reilly	finance	Costello
Barth	lumber	Myron
Karol	editorial	Costello
Smith	shipping	Myron
Loram	editorial	Costello
Delore	finance	Costello
Kugel	food prep	Snowden

then this query:

```
select emanager, ename, eddept from employees
order by emanager, eddept, ename
```

produces this list of managers, the departments they manage, and the employees in each department:

Costello	editorial	Karol
Costello	editorial	Loram
Costello	finance	Delore
Costello	finance	Reilly
Myron	lumber	Barth
Myron	lumber	Obidinski
Myron	shipping	Murtagh
Myron	shipping	Smith
Snowden	food prep	Kugel

... and this query:

```
select ename, edept, emanager from employees  
order by ename
```

produces this alphabetized employee list:

Barth	lumber	Myron
Delore	finance	Costello
Karol	editorial	Costello
Kugel	food prep	Snowden
Loram	editorial	Costello
Murtagh	shipping	Myron
Obidinski	lumber	Myron
Reilly	finance	Costello
Smith	shipping	Myron

To display result columns sorted in descending order (numeric or alphabetic), specify `order by columnname desc`. For example, to display the employees in each department from oldest to youngest:

```
select edept, ename, eage from employees  
order by edept, eage desc;
```

If a nullable column is specified in the order by clause, nulls are sorted to the beginning or end of the results table, depending on the host DBMS.

Note: If the order by clause is omitted, the order of the rows in the results table is not guaranteed by the DBMS. In particular, the order of the rows in the results table is not guaranteed to have any relationship to the source tables' storage structure or key structure.

The Group By Clause

The group by clause combines results for identical values in a column. This clause is typically used in conjunction with aggregate functions to generate a single figure for each unique value in a column.

For example, to obtain the number of orders for each part number in the orders table:

```
select partno, count(*) from orders  
group by partno;
```

The preceding query returns one row for each part number in the orders table, even though there may be many orders for the same part number.

Nulls are used to represent unknown data, and two nulls are typically not considered equal in OpenSQL comparisons. However, the group by clause treats nulls as equal and returns a single row for nulls in a grouped column.

Grouping can be performed on multiple columns. For example, to display the number of orders for each part placed each day:

```
select odate, partno, count(*) from orders
group by odate, partno;
```

If the group by clause is specified, all columns in the select clause must be specified in the group by clause or be aggregate functions.

The Having Clause

The having clause filters the results of the group by clause, in the same way the where clause filters the results of the select...from clauses. The having clause uses the same restriction operators as the where clause.

For example, to return the number of orders placed today for each part:

```
select odate, partno, count(*) from orders
group by odate, partno
having odate = date('today');
```

The Union Clause

The union clause enables the results of select statements to be combined into a single result table. For example, to list all employees in the table of active employees plus those in the table of retired employees:

```
select ename from active_emps
union
select ename from retired_emps;
```

By default, the union clause eliminates any duplicate rows in the result table. To retain duplicates, specify union all. You can combine any number of select statements using the union clause, and you can use both union and union all when combining multiple tables.

Unions are subject to the following restrictions:

- The select statements must return the same number of columns.
- The columns returned by the select statements must correspond in order and data type. The column names do not have to be identical.

- The select statements cannot include individual order by clauses.

To sort the result table, specify the order by clause following the last select statement. The result columns returned by a union are named according to the first select statement.

By default, unions are evaluated from left to right. To specify a different order of evaluation, use parentheses.

Any number of select statements can be combined using the union clause. There is a maximum of 126 tables allowed in any query.

Note: The maximum number of tables referenced in a single query is dependent on the host DBMS. The 126 maximum listed here is for the Ingres DBMS; other DBMSs supported by Enterprise Access and EDBC may have a higher or lower limit.

Examples

1. Find all employees who make more than their managers. This example illustrates the use of correlation names.

```
select e.ename
  from employee e, dept, employee m
 where e.dept = dept.dno and dept.mgr = m.eno
   and e.salary > m.salary;
```

2. Select all information for employees that have salaries above the average salary.

```
select * from employee
  where salary > (select avg(salary) from employee);
```

3. Select employee information sorted by department and, within department, by name.

```
select e.ename, d.dname from employee e, dept d
  where e.dept = d.dno
  order by dname, ename;
```

4. Select lab samples analyzed by lab #12 from both production and archive tables.

```
select * from samples s
  where s.lab = 12
  union
  select * from archived_samples s
  where s.lab = 12
```

Select (embedded)

SQL	ESQL
*	

Retrieves values from the database.

Syntax

Non-cursor version:

```
exec sql [repeated] select [all|distinct]
  * | result_expression {, result_expression}
  into variable[:indicator_var] {, variable[:indicator_var]}
  from from_source {, from_source}
  [where search_condition]
  [group by column {, column}]
  [having search_condition]
  [union [all] full_select]
  [order by result_column [asc | desc]
  {, result_column [asc | desc]}]
[exec sql begin;
  program code;
exec sql end;]
```

where *result_expression* is one of the following:

- *[schema.]tablename.** (to select all columns)
- *[schema.]tablename.]columnname as result_column* (to select one column)
- *expression as result_column*

Cursor version (embedded within a declare cursor statement):

```
select [all|distinct]
  * | result_expression {, result_expression}
  from from_source {, from_source}
  [where search_condition]
  [group by column {, column}]
  [having search_condition]
  [union [all] full_select]
  [order by result_column [asc|desc]
  {, result_column [asc|desc]}];
```

Description

The embedded select statement returns values from tables to host language variables in an embedded OpenSQL program. For details about the various clauses of the select statement, see [Select \(interactive\)](#) in this chapter. The following sections discuss details of interest to the embedded OpenSQL programmer.

Non-Cursor Select

The non-cursor version of the embedded OpenSQL select statement can be used to retrieve a single row or a set of rows from the database.

If the optional begin-end block syntax is not used, then the embedded select statement can retrieve only one row from the database. This kind of select statement is called the *singleton* select and is compatible with the ISO standard. If the singleton select does try to retrieve more than one row, an error occurs and the result variables hold information from the first row. For example, the following example retrieves a single row from the database:

```
exec sql select ename, sal
  into :ename, :sal
  from employee
  where eno = :eno;
```

Select Loops

A select loop can be used to read a table and process its rows individually. When a program needs to read a table without issuing any other database statements during the retrieval (such as for report generation), use a select loop. In other cases, such as when database updates are required, or when other tables need to be browsed while the current retrieval is in progress, use a cursor.

The begin-end statements delimit the statements in the select loop. The code is executed once for each row as it is returned from the database. Statements cannot be placed between the select statement and the begin statement.

Within the select loop, no other statements that access the database can be issued. This will cause a runtime error. To see how to manipulate and update rows and tables within the database while data is being retrieved, see [Data Manipulation with Cursors](#) in the chapter "Embedded OpenSQL."

However, if your program is connected to multiple database sessions, queries can be issued from within the select loop by switching to another session. To return to the outer select loop, switch back to the session in which the select statement was issued. To avoid preprocessor errors, the nested queries cannot be within the syntactic scope of the loop but must be referenced by a subroutine call or some form of a goto statement. For more information about multiple sessions, see "[Chapter 7: OpenSQL Features](#)."

There are two ways to terminate the select loop: run it to completion or issue the endselect statement. A host language goto statement cannot be used to exit or return to the select loop.

To terminate a select loop before all rows are retrieved the application must issue the endselect statement. The endselect statement must be syntactically within the begin-end block that delimits the select loop. For more information, see [Endselect](#) in this chapter.

The following example retrieves a set of rows from the database:

```
exec sql select ename, sal, eno
  into :ename, :sal, :eno
  from employee
  order by eno;
exec sql begin;
browse data;
if error condition then
  exec sql endselect;
end if;
exec sql end;
```

Retrieving Values into Host Language Variables

The into clause specifies the host program variables into which the values retrieved by the select are loaded. There must be a one-to-one correspondence between expressions in the select clause and the variables in the into clause. If the statement does not retrieve any rows, the variables are not modified. If the number of values retrieved from the database is different from the number of columns, an error is issued and the sqlwarn3 variable of the SQLCA is assigned the value 'W'. Each result variable may have an indicator variable for null data.

Host language variables can be used as expressions in the select clause and the *search_condition*, in addition to their use in the into clause. Variables used in *search_conditions* must denote constant values and cannot represent names of database columns or include any operators. Host string variables can also substitute for the complete search condition.

Host Language Variables in the Union Clause

When select statements are combined using the union clause, the into clause must appear only after the first list of select result expressions, because all result rows of the select statements that are combined by the union clause must be identical. The following example shows the correct use of host language variables in a union. Result variables are specified only for the first select statement.

```
exec sql select ename, enumber
  into :name, :number
  from employee
union
select dname, dnumber
  from directors
  where dnumber < 100;
```

Repeated Queries

To reduce the overhead required to repeatedly execute a select query statement, specify the query as a repeated query. For repeated queries, OpenSQL saves the query execution plan after the first time the query is executed. This provides significant performance on subsequent executions of the same select.

If your application needs to be able to change the search conditions, dynamically constructed search conditions cannot be used with repeated queries. The saved execution plan is based on the initial value of the search condition and subsequent changes are ignored.

Cursor Select

The cursor select statement is specified as part of a declare cursor statement. Within the declare cursor statement, the select statement is not preceded by exec sql. The cursor select statement specifies the data to be retrieved by the cursor. When executed, the declare cursor statement does not perform the retrieval—the retrieval occurs when the cursor is opened. If the cursor is declared for update, the select cannot refer to more than one table, cannot refer to a view and cannot include a group by, having, order by, or union clause.

The cursor select can return multiple rows, because the cursor provides the means to process and update retrieved rows one at a time. The correlation of expressions to host language variables takes place with the fetch statement, so the cursor select does not include an into clause. The rules for the remaining clauses are the same as in the non-cursor select.

Error Handling

If the select statement retrieves no rows, the SQLCA variable sqlcode is set to 100. The number of rows returned from the database is in the SQLCA variable sqlerrd(3). In a select loop, if the endselect statement was issued, sqlerrd(3) contains the number of rows retrieved before endselect was issued.

Embedded Usage

Host language variables can be used as expressions in the select clause and the *search_conditions*. Variables used in *search_conditions* must specify constant values and cannot represent names of database columns or include any operators. Host string variables can also substitute for the complete search condition.

Examples

1. The following examples illustrate the non-cursor select. For examples of the cursor select statement, see [Declare Cursor](#) in this chapter.

Retrieve the name and salary of an employee. Drop locks by committing the transaction.

```
exec sql select ename, sal
  into :namevar, :salvar
  from employee
  where eno = :numvar;
exec sql commit;
```

2. Select all columns in a row into a host language variable structure. (The emprec structure has members that correspond in name and type to columns of the employee table.)

```
exec sql select *
  into :emprec
  from employee
  where eno = 23;
```

3. Select a constant into a variable.

```
exec sql select 'Name: ', ename
  into :title, :ename
  from employee
  where eno >= 148 and age = :age;
```

4. Select the row in the employee table whose number and name correspond to the variables, numvar and namevar. The columns are selected into a host structure called, emprec. Because this statement is issued many times (in a subprogram, perhaps), it is formulated as a repeat query.

```
exec sql repeated select *
  into :emprec
  from employee
  where eno = :numvar and ename = :namevar;
```

5. Example of a select loop: insert new employees, and then select all employees and generate a report. If an error occurs during the process, end the retrieval and back out the changes. No database statements are allowed inside the select loop (begin-end block).

```
error = 0;
exec sql insert into employee
  select * from newhires; exec sql select eno, ename, eage, esal, dname
  into :eno, :ename, :eage, :esal, :dname
  from employee e, dept d
  where e.dept = d.deptno
  group by ename, dname
exec sql begin;
  generate report of information;
  if error condition then
    error = 1;
    exec sql endselect;
  end if;
exec sql end;
```

```

/*
** Control transferred here by completing the
** retrieval or because the endselect statement
** was issued.
*/
if error = 1
  print 'Error encountered after row',
    sqlca.sqlerrd(3);
  exec sql rollback;
else
  print 'Successful addition and reporting';
  exec sql commit;
end if;

```

6. The following select statement uses a string variable to substitute for the complete search condition. The variable *search_condition* is constructed from an interactive forms application in query mode, and during the select loop the employees who satisfy the qualification are displayed.

```

run forms in query mode;
construct search_condition of employees;

exec sql select *
  into :emprec
  from employee
  where :search_condition;
exec sql begin;
  load emprec into a table field;
exec sql end;
display table field for browsing;

```

7. The following example illustrates session switching inside a select loop. The main program processes sales orders and calls the subroutine, *new_customer*, for every new customer.

The main program:

```

...
exec sql include sqlca;
exec sql begin declare section;

/* Include output of dclgen for declaration of
** record order_rec */
exec sql include 'decls';
exec sql end declare section;

exec sql connect customers session 1;
exec sql connect sales session 2;
...

exec sql select * into :order_rec from orders;
exec sql begin;
  if (order_rec.new_customer = 1) then
    call new_customer(order_rec);
  endif
  process order;
exec sql end;
...

exec sql disconnect;

```

The subroutine, *new_customer*, which is called from the select loop, contains the session switch:

```

subroutine new_customer(record order_rec)
begin;
exec sql set_sql(session = 1);
  exec sql insert into accounts
    values (:order_rec);
process any errors;
exec sql set_sql(session = 2);
/* Reset status information before resuming
** select loop */
sqlca.sqlcode = 0;
sqlca.sqlwarn.sqlwarn0 = ' ';
end subroutine;

```

Set

SQL	ESQL
*	*

Sets a session option.

Syntax

`[exec sql] set autocommit on |off`

Description

The set statement specifies a runtime option for the current session. The selected runtime option remains in effect until the end of the session or another set statement changes its value within the session.

The Set Autocommit Option

The set autocommit on statement causes an implicit commit to occur after every successfully executed query. Set autocommit off means an explicit commit statement is required to commit a transaction. By default, autocommit is off.

The set autocommit statement cannot be issued within a transaction. For a description of OpenSQL transaction behavior, see “[Chapter 7: OpenSQL Features](#).”

Set_sql

SQL	ESQL
	*

Sets a variety of session options.

Syntax

```
exec sql set_sql {object = value [, object = value]}
```

Description

The set_sql statement can switch sessions in a multiple session application, specify the type of DBMS error to be returned to an application, change the default behavior when a connection error is experienced, set trace functions, and set other session characteristics.

Set_sql can be used to override II_EMBED_SET. For more information about II_EMBED_SET, see the *System Administrator Guide*.

The following table provides a summary of the valid objects and values for the set_sql statement:

Object	Data Type	Description
dbeventdisplay	integer	Enables or disables the display of events as they are queued to an application. Specify 1 to enable display, 0 to disable display.
dbeventhandler	function pointer	Specifies a user-defined routine to be called when an event notification is queued to an application. The event handler must be specified as a function pointer.
dbmserror	integer	Sets the value returned by the inquire_sql(dbmserror) statement. For details about the values returned by the inquire_sql(dbmserror) statement, see Local and Generic Errors in the chapter "OpenSQL Features."
errorhandler	function pointer	Specifies a user-defined routine to be called when an OpenSQL error occurs in an embedded application. The error handler must be specified as a function pointer.
errno	integer	Sets the value returned by the inquire_sql(errno) statement. For details about the values returned by the inquire_sql(errno) statement, see Local and Generic Errors in the chapter "OpenSQL Features."

Object	Data Type	Description
errortype	character string	Specifies the type of error number returned to errno and sqlcode. Value can be either genericerror, specifying generic error numbers, or dbmserror, specifying local DBMS error numbers. Generic error numbers are returned by default. For information about local and generic errors, see Local and Generic Errors in the chapter "OpenSQL Features."
gcafile	character string	Specifies an alternate text file to which OpenSQL writes GCA information. The default file name is "iiprtgca.log". To enable this feature, use the set_sql printgca option. If a directory or path specification is omitted, the file is created in the current default directory.
printgca	integer	Turns the printgca debugging feature on or off. Printgca prints all communications (GCA) messages from the application as it executes (by default, to the file "iiprtgca.log" in the current directory). Value can be either 1, to turn the feature on, or 0, to turn the feature off.
printqry	integer	Turns the printqry debugging feature on or off. Printqry prints all query text and timing information from the application as it executes (by default to the file "iiprtqry.log" in the current directory). Value can be either 1, to turn the feature on, or 0, to turn the feature off.
printtrace	integer	Enable/disable trapping of DBMS trace messages to a text file (by default, "iiprttrc.log"). Specify 1 to enable trapping of trace output, 0 to disable trapping.
programquit	integer	Specifies whether OpenSQL aborts on one of the following errors: An application issues a query, but is not connected to a database. The Enterprise Access product or DBMS fails. Communications services fail. Specify 1 to abort on these conditions, 0 to continue.
qryfile	character string	Specifies an alternate text file to which OpenSQL writes query information. The default file name is "iiprtqry.log". To enable this feature, use the set_sql printqry option. If a directory or path specification is omitted, the file is created in the current default directory.

Object	Data Type	Description
savequery	integer	Enables/disables saving of the text of the last query issued. Specify 1 to enable, 0 to disable. To obtain the text of the last query, issue the inquire_sql(querytext) statement. To determine whether saving is enabled, use the inquire_sql(savequery) statement.
session	integer	Sets the current session. Value can be any session identifier associated with an open session in the application.
tracefile	character string	Specifies an alternate text file to which OpenSQL writes tracepoint information. The default file name is "iiprttrc.log". To enable this feature, use the set_sql printtrace option. If a directory or path specification is omitted, the file is created in the current default directory.

Update

SQL	ESQL
*	*

Updates column values in a table.

Syntax

Interactive version:

```
update tablename
  set columnname = expression {, columnname = expression}
  [where search_condition]
```

Embedded versions:

- Non-cursor version:

```
exec sql [repeated] update tablename
  set column = expression {, column = expression}
  [where search_condition]
```

- Cursor version:

```
exec sql update tablename
  set column = expression {, column = expression}
  where current of cursor_name
```

Description

The update statement replaces the values of the specified columns by the values of the specified expressions for all rows of the table that satisfy the *search_condition*. For a discussion of search conditions, see ["Chapter 4: Elements of OpenSQL Statements."](#)

The expressions in the set clause can use constants or expressions involving column values from the table being updated. The data type of the column must agree with the data type of the value being assigned to it. To place a null in a nullable column, use the null constant.

If an update to a row would violate an integrity constraint defined on the table, that row remains unchanged.

If a subselect is specified, the subselect must not select rows from the table in which you are updating rows.

Embedded Usage

Host language variables can only be used within expressions in the set clause and the *search_condition*. (Variables used in *search_condition* must denote constant values and cannot represent names of database columns or include any operators.) A host string variable can be used to specify the complete search condition.

If the update did not update any rows, the sqlcode of the SQLCA is set to 100. If the update succeeded, the sqlerrd(3) of the SQLCA contains the number of rows updated by the statement.

To formulate the non-cursor update as a repeated query, specify the keyword repeated. The repeated keyword directs OpenSQL to encode the update and save its execution plan when the update is first executed. This encoding can improve the performance of subsequent executions of the same update. The repeated keyword is available only for non-cursor updates, and is ignored if used with the cursor or dynamic versions.

If your statement includes a dynamically constructed *search_condition*, that is, if the complete *search_condition* is specified by a host string variable, do not use the repeated option if you intend to change the *search_condition* after the statement's initial execution. The saved execution plan is based on the initial value of the *search_condition* and any changes to *search_condition* would be ignored. This rule does not apply to simple variables used in a *search_condition*.

Cursor Updates

The cursor version of update is similar to the interactive update, except for the where clause. The where clause, required in the cursor update, specifies that the update occur to the row the cursor currently points to. If the cursor is not pointing to a row, as would be the case immediately after an open or delete statement, a runtime error message is generated indicating that a fetch must first be performed. If the row the cursor is pointing to has been deleted from the underlying database table (as the result, for example, of a non-cursor delete), no row is updated and the sqlcode is set to 100. Following a cursor update, the cursor continues to point to the same row.

Two cursor updates not separated by a fetch may cause the same row to be updated twice, or may cause an error, depending on the host DBMS.

In performing a cursor update, make sure that certain conditions are met:

- A cursor must be declared in the same file in which any update statement referencing that cursor appears. This applies also to any cursor referenced in a dynamic update statement string.
- A cursor name in a dynamic update statement must be unique among all open cursors in the current transaction.
- The cursor stipulated in the update must be open before the statement is executed.
- The update statement and the from clause in the cursor's declaration must refer to the same database table.
- The columns in the set clause must have been declared for update at the time the cursor was declared (see the declare cursor statement).
- Host language variables can be used only for the cursor names or for expressions in the set clause.

The commit and rollback statements close all open cursors. A common programming error is to update the current row of a cursor, commit the change, and then attempt to loop and repeat the process—the commit closes the cursor, and subsequent fetches will fail.

Examples

1. Give all employees who work for Smith a 10% raise.

```
update emp
set salary = .1 * salary
where dept in
  (select dno
   from dept
   where mgr in
     (select eno
      from emp
      where ename like '%Smith'));
```

2. Set all salaried people who work for Smith to null.

```
update emp
set salary = null
where dept in
  (select dno
  from dept
  where mgr in
  (select eno
  from emp
  where ename like '%Smith'));
```

Whenever

SQL	ESQL
*	

Performs an action when a specified condition becomes true.

Syntax

```
exec sql whenever condition action
```

Description

The whenever statement provides a convenient method for handling error and exception conditions arising from embedded OpenSQL database statements. It stipulates that some action occur when the program attains a specified condition. Whether or not a condition is true is determined by variables in the SQLCA. For this reason, an SQLCA must be included in your program before you issue the whenever statement.

Once a whenever has been declared, it remains in effect until another whenever is specified for the same condition. Since whenever is a declarative and not an executable statement, its physical location in the program's source code, rather than its sequence in the program's execution, determines its scope.

Whenever statements can be repeated for the same condition and can appear anywhere after the include sqlca statement.

The *condition* can be any of the following:

- **sqlwarning**—True when the sqlwarn0 variable of the SQLCA is set to "W," indicating that the last embedded OpenSQL database statement produced a warning condition.

- **sqlerror**—True when the sqlcode of the SQLCA is set to a negative value, indicating that an error occurred in the last embedded OpenSQL database statement.
- **not found**—True when the sqlcode is set to a value of 100, indicating that a select, fetch, update, delete, insert, copy, create index, or create as *subselect* statement affected no rows.
- **dbevent**—Indicates that an event has been raised. The sqlcode variables of the SQLCA is set to 710. This condition occurs only for events that the application is registered to receive.

Action may be any of the following:

- **continue**—No action will be taken when the condition occurs. The program proceeds with the next executable statement. If a fatal error occurs, an error message is printed and the program aborts.
- **stop**—The program will display an error message and terminate when the condition occurs. If the program is connected to a database when the condition occurs, the program disconnects from the database without committing pending updates. The stop action cannot be specified for the not found condition.
- **goto *label***—Specifies a label in the program to which control is transferred when the condition occurs (same as a host language “go to” statement). The *label* (or paragraph name, in COBOL) must be specified using the rules of your host language. The keyword goto can also be specified as go to.
- **call *procedure***—Specifies a host language procedure to be called (in COBOL, a paragraph to be performed) when the condition occurs. The *procedure* must be specified according to the conventions of the host language. No arguments can be passed to the procedure. To direct the program to print any error or warning message and continue with the next statement, specify call sqlprint. (The sqlprint routine is a procedure provided by OpenSQL, not a user-written procedure.)

If your program does not include an SQLCA (and therefore no whenever statements), OpenSQL displays all errors. If your program includes an SQLCA, OpenSQL continues execution (and does not display errors) for all conditions for which you do not issue a whenever statement. To override the continue default and direct OpenSQL to display errors and messages, set II_EMBED_SET to sqlprint.

The program’s condition is automatically checked after each embedded OpenSQL database statement. If one of the conditions has become true, the *action* specified for that condition is taken. If the *action* is goto, then the label must be within the scope of the statements affected by the whenever statement at compile time.

An *action* specified for a *condition* affects all subsequent embedded OpenSQL source statements until another whenever is encountered for that condition.

The embedded SQL preprocessor does not generate any code for the whenever statement. Therefore, in a language that does not allow empty control blocks, (for example, COBOL, which does not allow empty IF blocks), the whenever statement should not be the only statement in the block.

Be careful to avoid coding potentially infinite loops with whenever statements. Within a sequence of statements functioning as an error handling block for a particular condition, the first statement should be a whenever continue that turns off the action. For example, consider the following program fragment:

```
exec sql whenever sqlerror goto error_label;
exec sql create table worktable
  (workid integer2, workstats varchar(15));
  ...
process data;
  ...
error_label:
exec sql whenever sqlerror continue;
exec sql drop worktable;
exec sql disconnect;
  ...
```

If the error handling block did not specify continue for condition sqlerror and the drop statement caused an error, at runtime the program would infinitely loop between the drop statement and the label, error_label.

Host language variables cannot be used in a whenever statement. This statement must be terminated according to the rules of your host language.

Examples

1. During program development, print all errors and continue with next statement.

```
exec sql whenever sqlerror call sqlprint;
```

2. During database cursor manipulation, close the cursor when no more rows are retrieved.

```
exec sql open cursor1;
exec sql whenever not found goto close_cursor;
loop until whenever not found is true
  exec sql fetch cursor1
    into :var1, :var2;
    print and process the results;
end loop;
close_cursor:
  exec sql whenever not found continue;
  exec sql close cursor1;
```

3. Stop program upon detecting an error or warning condition.

```
exec sql whenever sqlerror stop;
exec sql whenever sqlwarning stop;
```

4. Reset whenever actions to default within an error handling block.

```
error_handle:
  exec sql whenever sqlerror continue;
  exec sql whenever sqlwarning continue;
  exec sql whenever not found continue;

  ...
  handle cleanup
  ...
```

5. Always confirm that the connect statement succeeded before continuing.

```
exec sql whenever sqlerror stop;
exec sql connect :dbname;
exec sql whenever sqlerror continue;
```

Chapter 9: Extended Statements

This chapter lists statements and extensions that may be available in OpenSQL. To determine whether these statements and extensions are supported, check for the following row in the iidbcapabilities catalog:

CAP_CAPABILITIES	CAP_VALUE
SQL92_COMPLIANCE	ENTRY

If the statements and extensions are not supported, the cap_value column contains NONE.

Create Schema

SQL	ESQL
*	*

Creates a named collection of database objects.

Syntax

```
[exec sql] create schema authorization schema_name  
[object_definition {object_definition}];
```

where *object_definition* is a create table, create view, or grant statement.

Description

The create schema statement creates a named collection of database objects (tables, views and privileges). The *schema_name* parameter must be the same as the effective user for the session issuing the create schema statement. All objects specified in the create schema statement are owned by that user. You cannot create a schema for another user. Each user has one schema per database.

The statements in the create schema statement must not be separated by semicolon delimiters. However, the create schema statement must be terminated with a semicolon following the last object definition statement (create table, create view, or grant).

If object definitions are omitted, an empty schema is created. For details about the statements used to create tables and privileges, see [Create Table \(extended\)](#) and [Grant](#) respectively in this chapter. If an error occurs within the create schema statement, the entire statement is rolled back. If you issue a create schema specifying an existing schema (*schema_name*), OpenSQL issues an error.

To add objects to your schema, issue the required create statements outside of a create schema statement. If no schema exists for your user identifier, one is implicitly created when you create any database object. Thereafter, if you issue a create schema statement, OpenSQL issues an error.

If, within a create schema statement, you create tables that have referential constraints, the order of create table statements is not significant. This is unlike the requirements for creating tables with referential constraints outside of a Create Schema statement, where the referenced table must exist before a constraint that references it can be created. For details about referential constraints, see [Create Table \(extended\)](#) in this chapter.

Other users can reference objects in your schema if you have granted them the required permissions. To reference an object in a schema other than your own, specify the object name as follows:

schema.object

For example, user harry can select data from user joe's employees table (if joe has granted harry select permission). Harry can issue the following select statement:

```
select lname, fname from joe.employees  
  where dname = 'accounting';
```

Restrictions

The following restrictions apply to create table statements within a create schema statement:

- Create table...as select cannot be used.
- A with clause cannot be specified.
- The following data types cannot be used:
 - integer2
 - integer4
 - float4
 - float8
 - date

The only valid with clause option for create view statements within a create schema statement is with check option.

Embedded Usage

Syntax elements cannot be replaced with host language variables.

Permissions

Any user can issue the create schema statement.

Example

Create a schema authorization containing tables, views, and privileges.

```
create schema authorization joe
create table employees(lname character(30) not null,
                      fname character(30) not null,
                      salary decimal,
                      dname character(10)
                        references dept(deptname),
                      primary key (lname, fname)
create table dept(deptname character(10)
                  not null unique,
                  budget decimal,
                  expenses decimal default 0)
create view mgr (mlname, mfname, mdname) as
  select lname, fname, deptname from employees,dept
  where dname = deptname
grant references(lname, fname)
on table employees to harry;
```

Create Table (extended)

SQL	ESQL
*	*

Creates a new base table.

Syntax

```
[exec sql] create table tablename
  [(column_specification {, column_specification}
  (column_specification {, column_specification }
  [, [constraint constraint_name] table_constraint
  {, [constraint constraint_name] table_constraint}])
  [with with_clause]
```

To create a table and load rows from another table:

```
[exec sql] create table tablename
  (column_name {, column_name}) as
    subselect
    {union [all]
      subselect}
    [with with_clause]
```

For the syntax of *subselect*, see [Select](#) in this chapter.

The *with_clause* parameter consists of the word *with* followed by a comma-separated list of *with* clause options. For an overview of the Enterprise Access *with* clause, see [DBMS Extensions](#) in the chapter “OpenSQL Features.” For a list of the valid *with* clause options for a specific Enterprise Access, see your Enterprise Access manual. For a list of valid *with* clause options for the Ingres DBMS, see the *SQL Reference Guide*.

The *column_specification* has the following syntax:

```
column_name datatype
[[with] default default_spec | with default | not default]
[with null | not null]
[[constraint constraint_name] column_constraint
{ [constraint constraint_name] column_constraint}]
```

where *column_constraint* is one or more of the following:

```
unique [with constraint_with_clause]
primary key [with constraint_with_clause]
references [schema.]table_name[(column_name)]
  [with constraint_with_clause]
```

Table constraints must be specified as one or more of the following:

```
unique (column_name {, column_name}) [with constraint_with_clause]
primary key (column_name {, column_name}) [with constraint_with_clause]
foreign key (column_name {, column_name})
references [schema.]table_name [(column_name
  {, column_name})] [with constraint_with_clause]
```

Constraints are described in detail later in this statement description.

Description

The *create table* statement creates a new base table owned by the user who issues the statement. If you use the *create table...as select* syntax, the table that you create will contain a subset of the columns and values in existing tables specified by the *subselect*.

Tablename specifies the name of the new table, and must be a valid object name. For the rules for naming database objects, see [Object Names](#) in the chapter “Overview of OpenSQL.”

Column Specifications

The following characteristics of the new column can be specified:

- **Name**—A valid name must be assigned to each column.
- **Data type**—A valid data type must be assigned to each column.
If create table...as select is specified, the new table takes its column names and formats from the results of the select clause of the *subselect* specified in the as clause (unless different column names are specified).
- Nullability and defaults—Specify:
 - whether a column will accept nulls
 - whether the column is mandatory
 - the value to be assigned if no value is specified by the user (the *default* value)
- **Constraints**—Specify checks to be performed on the contents of a column. When the table is updated, if the column fails the checks, OpenSQL issues an error and aborts the statement that attempted to insert the invalid value.

The following sections describe these characteristics in detail.

Column Defaults and Nullability

The following sections explain how to specify whether columns accept nulls and how default values are assigned to columns.

Default Values

To specify whether a column requires an entry (is mandatory), use the *not default* clause. If the column does not require an entry, specify a value to be inserted if none is provided by the user (a *default* value). Valid options are:

- **not default**—The column is mandatory.
- **default default_spec | user | null**—OpenSQL inserts the specified value if the user or program does not specify a value for the column. The default value must be compatible with the data type of the column.

If the default clause is omitted, the column default depends on whether the column is nullable. Nullable columns default to nulls, and non-nullable columns are mandatory.

The following is an example of the default option:

```
create table dept( dname  character(10),
    budget      decimal  default 100000.00,
    creation     date    default date('01/01/94'));
```

The following considerations and restrictions apply when specifying a default value for a column:

- The data type and length of the default value must not conflict with the data type and length of the column.
- The maximum length for a default value is 1500 characters or the declared length of the column, whichever is shorter.
- For fixed length string columns, if the column is wider than the default value, the default value is padded with blanks to the full width of the column.
- For numeric columns that accept fractional values (floating-point and decimal), the decimal point character specified for the default value must match the decimal point character in effect when the value is inserted. To specify the decimal point character, set `II_DECIMAL`.
- For date columns, the default value must be a valid date specified using the `date()` function. If the time zone is omitted, the time zone defaults to the time zone of the user inserting the row.
- User (meaning the session's current user ID) can be specified as the default value or, for nullable columns, null.

Nullability

To specify whether a column accepts null values, use the `with|not null` clause:

- **with null**—The column accepts nulls. OpenSQL inserts null as the default value if no value is supplied by the user. If the `with | not null` clause is omitted, the column is created with null.
- **not null**—The column does not accept nulls. If the default clause is omitted or `not default` is specified, the column is mandatory.

The with | not null clause works in combination with the with | not default clause, as shown in the following table:

Nullability and Default Specification	Result
with null	The column accepts nulls. If no value is provided, a null is inserted.
not null	The column is mandatory and does not accept nulls. Typical for primary key columns.
with null default	The column accepts null values. If no value is provided, the default value is inserted.
with null not default	The column accepts null values. The user must provide a value (mandatory column).
not null default	The column does not accept nulls. If no value is provided, the default value is inserted. (The specified default value cannot be null.)
not null not default	The column is mandatory and does not accept nulls. Typical for primary key columns.

Constraints

To ensure that the contents of columns fulfills your database requirements, specify *constraints*. The types of constraints are:

- **Unique constraints**—Ensures that a value appears in a column only once. Unique constraints are specified using the unique option.
- **Check constraints**—Ensures that the contents of a column fulfills user-specified criteria (for example, “salary >0”). Check constraints are specified using the check option.
- **Referential constraints**—Ensures that a value assigned to a column appears in a corresponding column in another table. Referential constraints are specified using the references option.
- **Primary key constraints**—Declares one or more columns for use in referential constraints in other tables.

Constraints are checked at the end of every statement that modifies the table. If the constraint is violated, OpenSQL returns an error and aborts the statement. If the statement is within a multi-statement transaction, the transaction is not aborted.

Note: Constraints are not checked when adding rows to a table using the copy statement.

Each type of constraint is described in detail in the following sections. Constraints can be specified for individual columns or for the entire table. For details, see [Column-Level Constraints versus Table-Level Constraints](#) in this chapter.

The Unique Constraint To ensure that no two rows have the same value in a particular column or set of columns, specify not null unique. (If you specify a column as unique, you must also specify not null.) The following is an example of a column-level unique constraint:

```
create table dept (dname character(10)
    not null unique, ...);
```

In the preceding example, the unique constraint ensures that no two departments have the same name.

To ensure that the data in a group of columns is unique, the unique constraint must be specified at the table level (rather than specifying unique constraints for individual columns). A maximum of 32 columns can be specified in a table-level unique constraint.

The following is an example of a table-level unique constraint:

```
create table depts (dname character(10) not null,
    dlocation character(10) not null,
    unique (dname, dlocation));
```

In the preceding example, the unique constraint ensures that no two departments in the same location have the same name. Note that the columns are declared not null, as required by the unique constraint.

Any column or set of columns that is designated as the primary key is implicitly unique and not null. A table can have only one primary key, but can have any number of unique constraints.

Note: Unique constraints may create system indexes that cannot be explicitly dropped by the table owner. These indexes are used to enforce the unique constraint.

The Check Constraint To create conditions that a particular column or set of columns must fulfill, specify a check constraint using the check option. For example, to ensure that salaries are positive numbers:

```
create table emps (name character(25), sal decimal
    check (sal > 0));
```

The expression specified in the check constraint must be a Boolean expression. For details, see [Expressions](#) in the chapter “Elements of OpenSQL Statements.”

To specify a check constraint for a group of columns, the check constraint must be specified at the table level (rather than specifying check constraints for individual columns). The following is an example of a table-level check constraint:

```
create table dept (dname character(10),
    location character(10),
    budget decimal,
    expenses decimal,
    check (budget > 0 and expenses <= budget));
```

The preceding example ensures that each department has a budget and that expenses do not exceed the budget.

Check constraints cannot include the following:

- Subqueries
- Set functions (aggregate functions)
- Dynamic parameters
- Host language variables

Column-level check constraints cannot refer to other columns.

The Referential Constraint

To validate an entry against the contents of a column in another table (or another column in the same table), specify a referential constraint using the references option. The references option maintains the referential integrity of your tables.

The column-level referential constraint uses the following syntax:

references [schema.] table_name (column_name)[referential actions]
[constraint_with_clause]

The following is an example of a column-level referential constraint:

```
create table emp (ename char(10),
    edept char(10) references dept(dname));
```

In the preceding example, the referential constraint ensures that no employee is assigned to a department that is not present in the dept table.

The table-level referential constraint uses the following syntax, including the foreign key... references option:

foreign key (column_name{,column_name})
references [schema.] table_name [(column_name{,column_name})]
[referential actions] [constraint_with_clause]

The following is an example of a table-level referential constraint:

```
create table mgr (name char(10),
    empno char(5),
    ...
    foreign key (name, empno) references emp);
```

The preceding example verifies the contents of the name and empno columns against the corresponding columns in the emp table to ensure that anyone entered into the table of managers is on file as an employee. This example omits the names of the referenced column. The emp table must have a primary key constraint that specifies the corresponding name and employee number columns.

Referential actions allow the definition of alternate processing options in the event a referenced row is deleted, or referenced columns are updated when there are existing matching rows. A referential action specifies either an *update rule* or a *delete rule*, or both, in either sequence.

The on update and on delete rules, use the following syntax:

on update {cascade | set null | restrict | no action}

or

on delete {cascade | set null | restrict | no action}

The “on update cascade” causes the values of the updated referenced column(s) to be propagated to the referencing columns of the matching rows of the referencing table.

The “on delete cascade” specifies that if a delete is attempted on a referenced row that has matching referencing rows, the delete is “cascaded” to the referencing table as well. That is, the matching referencing rows are also deleted. If the referencing table is itself a referenced table in some other referential relationship, the delete rule for that relationship is applied, and so forth. (Since rule types can be mixed in a referential relationship hierarchy, the second delete rule may be different from the first delete rule.) If an error occurs somewhere down the line in a cascaded operation, the original delete fails, and no update is performed.

In addition to cascade, the no action, set null, and restrict actions are also supported for both delete and update.

- *No action* is the default behavior of returning an error upon any attempt to delete or update a referenced row with matching referencing rows.
- *Restrict* is a similar to no action, with a minor variation; it behaves identically, but returns a different error code. Both options are supported for ANSI SQL compliance.

- *Set null* causes the referencing column(s) of the matching rows to be set to the null value (signifying that they do not currently participate in the referential relationship). The column(s) can be updated later to a non-null value(s), at which time the resulting row must find a match somewhere in the referenced table.

The following is example of the delete and update rules:

```
create table employee (empl_no int not null,
    emp_name char(20) not null,
    dept_id char(6) references department (dept_id)
        on delete cascade on update cascade,
    mgrno int references employee (empl_no) on update
    cascade
        on delete set null);
```

If a department row is deleted, all employees in that department are also deleted. If a department ID is changed in the department table, it is also changed in all referencing employee rows.

If a manager's ID is changed, his employees are changed to match. If the manager is fired, all his employees have `mgr_id` set to null.

The following considerations apply to the table and column being referenced (the column specified following the keyword, `references`):

- The referenced table must be an existing base table (it cannot be a view).
- The data types of the columns must be comparable.
- You must have references privilege for the referenced columns. For details, see [Grant](#) in this chapter.
- If the table and column names are specified, the referenced columns must compose a unique or primary key constraint for the referenced table.
- If multiple columns in a table-level referential constraint are specified, the columns specified for the referencing table must correspond in number, data type, and position to the columns specified for the referenced table, and they must compose a unique or primary key constraint for the referenced table.
- If the referenced table is specified and the column name is omitted, the referenced table must have a primary key constraint. The referencing columns are verified against the referenced table's primary key.

The Primary Key Constraint

The primary key constraint is used to denote one or more columns to which other tables will refer in referential constraints. A table can have only one primary key; the primary key for a table is implicitly unique and must be declared not null.

The following is an example of a primary key constraint and a related referential constraint:

Referenced table:

```
create table partnumbers(partno int primary key...);
```

Referencing table:

```
create table inventory(ipartno int...
    foreign key (ipartno) references (partnumbers));
```

In this case, the part numbers in the inventory table are checked against those in the partnumbers table; the referential constraint for the inventory table is a table-level constraint and therefore must specify the foreign key clause. The referential constraint for the inventory does not specify the column that is referenced in the partnumbers table. By default, the DBMS checks the column declared as the primary key. For related details, see [The Referential Constraint](#) in this chapter.

The Constraint Index Options

The primary key/unique and referential constraint definitions can optionally include a with clause to describe the characteristics of the indexes that are created by Ingres to enforce the constraints. The constraint with clause can be appended to both column and table level constraint definitions.

The column_constraint has the following syntax:

```
unique [with constraint_with_clause]
primary key [with constraint_with_clause]
references [schema.]table_name[(column_name)] [referential_actions] [with
constraint_with_clause]
```

The table_constraint has the following syntax:

```
unique (column_name {,column_name}) [with constraint_with_clause]
primary key (column_name {,column_name}) [with constraint_with_clause]
foreign key (column_name {,column_name})
    references [schema.]table_name[(column_name
    {,column_name})] [referential_actions] [with constraint_with_clause]
```

The constraint with clause consists of one or more of the following options:

- no index
- index = base table structure
- index = index_name
- structure = hash | btree | isam
- fillfactor = *n*
- minpages = *n*
- maxpages = *n*
- leaffill = *n*
- nonleaffill = *n*
- allocation = *n*
- extend = *n*
- location = (location_name{, location_name})

The no index and index = base table structure options cannot be used in conjunction with any other constraint with option. All other options can be used in combination, provided they are separated by commas and enclosed in parentheses. For example, "with (structure = hash, fillfactor = 70)" is a sample of the correct syntax to use when more than one option is coded. If the with clause includes a single option, parentheses are not required.

No Index Option

The no index option indicates that no secondary index is created to support the constraint. It is only permissible for referential constraints and results in no index being available to check the integrity of deletes and updates to the referenced table. The database procedures that perform the integrity checks will still execute in the absence of these indexes. However, the query plan may use some other user-defined index on the same column(s), or it may resort to a full table scan of the referencing table, if there is no alternative.

To avoid poor performance, the no index option should only be used if:

- An alternate index on referencing columns is available
- There are very few rows in the referencing table (as in a prototype application)
- Deletes and updates are rarely (if ever) performed on the referenced table

The Index = Base Table Structure Option

The index = base table structure option indicates that the base table structure of the constrained table be used for integrity enforcement, rather than a newly created secondary index. Obviously, the base table structure must not be heap, and it must match the column(s) in the constraint definition. Since non-heap base table structures can only be specified using the modify statement (after the table has been created), with index = base table structure can only be used for table constraints defined with alter table (rather than the create table statement).

The alter table statement, which adds the constraint, must be preceded by the with index = base table statement. For example:

```
modify [schema.] table_name to unique_scope = statement
```

which indicates that the uniqueness semantics enforced by the index are consistent with Ingres and ANSI rules.

The Index = Index_Name Option

The index = *index_name* option can be used for several purposes. If the named index already exists and is consistent with the column(s) constrained by the constraint definition, no new index is created. If the named index does not already exist, the generated index created for constraint enforcement uses the name, *index_name*. Finally, if more than one constraint in the same table definition specifies index = *index_name* with the same *index_name*, an index will be generated with that name and will be shared among the constraints.

In any case where an existing index is used for a constraint or a single index is shared among several constraints, the key columns of the index and the columns of the constraints must be compatible.

All other *constraint with options* perform the same function as the corresponding with options of the create index statement and the index related with options of the create table ... as select statement. Note, though, that they are limited to those options documented above. For example, the key and compression options of create index and create table ... as select are NOT supported for constraint definition.

Column-Level Constraints versus Table-Level Constraints

Constraints can be specified for individual columns as part of the column specification (*column-level constraints*) or for groups of columns as part of the table definition (*table-level constraints*). Following are examples of each:

Column-level constraints:

```
create table mytable(name char(10) not null,
                     id integer references idtable(id),
                     age integer check (age > 0));
```

Table-level constraints:

```
create table yourtable(firstname char(20) not null,  
                      lastname char(20) not null,  
                      unique(firstname, lastname));
```

Note: Multiple column constraints are space separated.

Names can be assigned to both column-level and table-level constraints. If the constraint name is omitted, the DBMS assigns one. To drop a constraint (using the alter table statement), specify the constraint name. It is advisable to specify a name when creating a constraint—otherwise system catalogs must be queried to determine the name assigned by the DBMS when the constraint was created.

Using “Create table...as Select”

The create table...as select syntax allows you to create a table from another table or tables. (The create table...as select syntax is an OpenSQL extension, and is not part of the ANSI/ISO Entry SQL-92 standard.) The new table is populated with the set of rows resulting from execution of the specified select statement.

By default, the columns of the new table have the same names as the corresponding columns of the base table from which you are selecting data. Different names can be specified for the new columns.

The data types of the new columns are the same as the data types of the source columns. The nullability of the new columns is determined as follows:

- If a source table column is nullable, then the column in the new table is nullable.
- If a source table column is not nullable, then the column in the new table is defined as not null.

If the source column has a default value defined, the column in the new table retains the default definition. However, if the default value in the source column is defined using an expression, the default value for the result column is unknown and its nullability depends on the source columns used in the expression. If all the source columns in the expression are not nullable, the result column is not nullable. If any of the source columns are nullable, the result column is nullable.

A system-maintained logical key column cannot be created using the create table...as select syntax. When creating a table using create table...as select, any logical key columns in the source table that are reproduced in the new table are assigned the format of not system_maintained.

Embedded Usage

- Host language variables can be used to specify constant expressions in the *subselect* of a create table...as statement.
- *Locationname* can be specified using a host language string variable.
- The preprocessor does not validate the syntax of the *with_clause*.

Permissions

This statement is available to all users.

Examples

1. Create the employee table with columns eno, ename, age, job, salary, and dept.

```
create table employee
  (eno    smallint,
   ename  varchar(20) not null,
   age    smallint,
   job    smallint,
   salary float4,
   dept   smallint);
```

2. Create a table listing employee numbers for employees who make more than the average salary.

```
create table highincome as
  select eno
  from employee
  where salary >
    (select avg (salary)
     from employee);
```

3. Create a table specifying defaults.

```
create table dept
  ( dname      char(10)
    location    char(10) default 'LA'
    creation_date date default date('1/1/93'));
```

4. Create a table specifying referential constraints. When a department number is assigned to an employee, it will be checked against the entries in the dept table.

```
create table emps (
  empno  char(5),
  deptno char(5) references dept),
  ...);
```

5. Create a table specifying check constraints. In this example, department budgets default to \$100,000, expenses to \$0. The check constraint insures that expenses do not exceed the budget.

```
create table dept (
  dname    char(10),
  budget   decimal default 100000,
  expenses decimal default 0,
  check    (budget >= expenses));
```

6. Create a table specifying unique constraints and keys.

```
create table dept (
    deptno    char(5) primary key,
    dname     char(10) not null,
    dlocation char(10) not null,
    unique (dname, dlocation));
```

7. Create a table specifying null constraints.

```
create table emp (
    salary    decimal not default with null ,
    hiredate  date not default with null,
    sickdays  float default 5.0 with null );
```

8. Unique constraint uses base table structure, not a generated index:

```
alter table department add primary key (dept_id)
    with index = base table structure;
```

9. Unique constraint generates index in non-default location. First referential constraint generates no index at all:

```
create table employee (empl_no int not null
    unique with location = (ixloc1),
    emp_name char(20) not null,
    dept_id char(6) references department (dept_id) with no index,
    mgrno int references employee (empl_no));
```

10. Referential and primary key constraints share the same named index:

```
create table assignment (empl_no int not null
    references employee (empl_no) with (index = assnpkix,
    location = (ixloc2)),
    proj_id int not null references project (proj_id),
    task char(20),
    primary key (empl_no, proj_id) with index = assnpkix);
```

11. Referential action:

```
create table employee (empl_no int not null
    unique with location = (ixloc1),
    emp_name char(20) not null,
    dept_id char(6) references department (dept_id)
        on delete cascade on update cascade with no index,
    mgrno int references employee (empl_no) on update cascade
        on delete set null);
```

Grant

SQL	ESQL
*	*

Grants privileges on the database as a whole or on individual tables, views, or procedures.

Syntax

```
[exec sql] grant all [privileges] | privilege {, privilege}
  on [table] [schema.]table_name
    to public | auth_id {, auth_id}
  [with grant option];
```

Description

The grant statement enables a DBA or user to control access to tables. To remove privileges, use the revoke statement. The following table describes the grant statement parameters.

Parameter	Description
<i>table_name</i>	Name of the table for which the privilege is being defined.
<i>auth_id</i>	The name of the users to which you are granting privileges.

By default, neither the public nor any user has any table privileges. Table privileges must be granted explicitly. Valid table privileges are:

- Select
- Insert
- Update

For update, a list of columns can optionally be specified; if the column list is omitted, update privilege is granted to all updatable columns of the table or view.

- Delete
- References—The references privilege enables specified users to create referential constraints that reference the specified tables and columns. For details about referential constraints, see [Create Table \(extended\)](#) in this chapter.

A list of columns can optionally be specified. If the column list is omitted, references privilege is granted to all updateable columns of the table. You cannot grant the references privilege on a view.

- All [privileges]—All grants select, insert, update, delete, and references on the specified objects to the specified users.

The Grant All Privileges Option

To grant a privilege on an object you do not own, you must have been granted the privilege with grant option—only the privileges for which you have grant option are granted.

The results of granting all privileges on a view you do not own are determined as follows:

- **Select**—Granted if you can grant select privilege on all tables and views in the view definition.
- **Update**—Granted for all columns for which you can grant update privilege; if you were granted update...with grant option on a subset of the columns of a table, update is granted only for those columns.
- **Insert**—Granted if you can grant insert privilege on all tables and views in the view definition.
- **Delete**—Granted if you can grant delete privilege on all tables and views in the view definition.
- **References**—The references privilege is not valid for views.

The following example illustrates the results of the grant all privileges option. The accounting_mgr user creates the following employee table:

```
create table employee (name character(25),  
                      department character(5), salary decimal)...
```

Using the following grant statement, grants the accounting_supervisor user the ability to select all columns but only allows accounting_supervisor to update the department column (to prevent unauthorized changes of the salary column):

```
grant select, update (department) on table employees  
  to accounting_supervisor with grant option;
```

If the accounting_supervisor user issues the following grant statement:

```
grant all privileges on table employees to  
  accounting_clerk;
```

the accounting_clerk user receives select and update(department) privileges.

The Grant Option

To enable a user to grant a privilege to another user, specify the with grant option clause.

For example, if user tony, creates a table called mytable, and issues the following statement:

```
grant select on tony.mytable to laura
  with grant option;
```

user laura can select data from tony.mytable and can authorize user evan to select data from tony.mytable by issuing the following statement:

```
grant select on tony.mytable to evan;
```

Because laura did not specify the with grant option clause, evan cannot authorize another user to select data from tony.mytable.

The owner of an object can grant any privilege to any user (or to public). The user to whom the privilege is granted with grant option can grant only the specified privilege. In the preceding example, laura can grant select privilege but cannot grant, for example, insert privilege.

In the previous example, the second grant (to evan) depends on the first grant (to laura). If tony revokes select permission from laura (using the revoke statement), tony must specify how OpenSQL should handle dependent grants that laura has issued. The choices are:

- **Revoke with cascade**—Revokes all dependent grants; in the preceding example, select permission will be revoked from user, evan.
- **Revoke with restrict**—Do not revoke specified grant if there are dependent grants. In the preceding example, select permission will not be revoked from laura because her grant to evan depends on the grant she received from tony.

For more details, see [Revoke](#) in this chapter, and in the *Database Administrator Guide*.

Embedded Usage

Specify the with clause using a host string variable (with `:hostvar`).

Permissions

To grant privileges on an object, you must own the object or have the grant option for the privilege you are granting.

Examples

- Grant update privileges on the columns, empname and empaddress in the employee table to the users, joank and gerryr.

```
grant update(empname, empaddress)
  on table employee
  to joank, gerryr;
```

- Enable any user to select data from the employee roster.

```
grant select on emp_roster to public;
```

- Enable the accounting manager, rickr, complete access to salary information and to grant permissions to other users.

```
grant all on employee to rickr with grant option;
```

- Enable any user to create a table constraint that references the employee roster.

```
grant references on emp_roster to public;
```

Revoke

SQL	ESQL
*	*

Revokes database privileges.

Syntax

```
[exec sql] revoke [grant option for]
  all [privileges] | privilege {, privilege}
  on [table] [schema.]table_name
  from public | auth_id{, auth_id}
  [cascade | restrict];
```

Description

The revoke statement removes database privileges granted to the specified users or public. (To confer privileges, use the grant statement.) You cannot revoke privileges granted by other users. The following table lists the valid parameters for this statement:

Parameter	Description
<i>privilege</i>	Specifies the privilege you want to revoke. (To revoke all privileges for the object, specify all.) The privilege must be one of the following: <ul style="list-style-type: none"><input type="checkbox"/> Select<input type="checkbox"/> Update<input type="checkbox"/> Insert<input type="checkbox"/> Delete<input type="checkbox"/> References
<i>table_name</i>	The name of the table on which the privileges were granted.
<i>auth_id</i>	Specifies the authorization identifier from which privileges are being revoked.

For more information about privileges, see [Grant](#) in this chapter.

Revoking the Grant Option

The grant statement grant option enables users other than the owner of an object to grant privileges on that object. For example:

```
grant select on employee_roster to mike with grant
option;
```

enables mike to grant the select privilege (with or without grant option) to other users.

The grant option can be revoked without revoking the privilege with which it was granted. For example:

```
revoke grant option for select on employees to
mike...
```

means that mike can still select data from the employees table, but cannot grant the select privilege to other users.

Restrict versus Cascade

The restrict and cascade options specify how OpenSQL handles dependent privileges. The cascade option (default) directs OpenSQL to revoke the specified privileges plus all privileges that depend on the privileges being revoked. The restrict option directs OpenSQL not to revoke the specified privilege if there are any dependent privileges.

The owner of an object can grant privileges on that object to any user. Privileges granted by users who do not own the object are dependent on the privileges granted with grant option by the owner. For example, if user jerry owns the employees table, he can grant tom the ability to select data from the table and to enable other users to select data from the table:

```
grant select on employees to tom with grant option;
```

User tom can now enable another user to select data from the employees table:

```
grant select on employees to sylvester with grant option;
```

The grant tom conferred on sylvester is dependent on the grant the table's owner jerry conferred on tom. In addition, sylvester can enable other users to select data from the employees table.

- To remove his grant to tom and all grants tom may have issued, jerry must specify revoke...cascade:

```
revoke select on employees from tom cascade;
```

As a result of this statement, the select privilege granted by tom to sylvester is revoked, as are any select grants issued by sylvester to other users conferring select privilege for the employees table.

- To prevent dependent privileges from being revoked, jerry must specify revoke... restrict:

```
revoke select on employees from tom restrict;
```

Because there are dependent privileges (tom has granted select privilege on the employees table to sylvester), this revoke statement will fail, and no privileges will be revoked.

The restrict and cascade parameters have the same effect whether you are revoking a specific privilege or the grant option for a specific privilege. In either case, restrict prevents the operation from occurring if there are dependent privileges, and cascade causes dependent privileges to be deleted. When you revoke a grant option with cascade, all dependent privileges are revoked, not just the grant option portion of the dependent privileges.

Embedded Usage

Any portion of the syntax cannot be replaced with host language variables.

Permissions

Any user can issue the revoke statement.

Example

Prevent any user from granting any form of access to the payroll table. Delete all dependent grants.

```
revoke grant option for all on payroll  
    from public cascade;
```

Select

SQL	ESQL
*	

Retrieves values from one or more tables or views.

Syntax

```
select [all|distinct] * | result_expression {, result_expression}  
    from from_source {, from_source}  
    [where search_condition]  
    [group by column {, column}]  
    [having search_condition]  
    {union [all] (select)}  
    [order by result_column [asc | desc]  
        {, result_column [asc | desc]}];
```

where *result_expression* is one of the following:

- *[schema.]tablename.** (to select all columns)
- *[[schema.]tablename.]columnname [as result_column]*
(to select one column)
- *expression [as] result_column*

For SQL-92 compliant installations, the as keyword in the result expression is optional. All other select syntax and semantics are documented in the chapter "OpenSQL Statements."

Chapter 10: OpenSQL Limits

OpenSQL Limits

To maintain application portability, your OpenSQL application should observe the limits listed in the following table. Individual host DBMS's may permit values in excess of those listed here.

Item	Min/Max	Limit
Char length	Max	240 characters
Columns in index	Max	16 columns
Columns in order by clause	Max	16 columns
Columns in table	Max	127 columns
Columns in view	Max	127 columns
Columns: total length in group by clause	Max	2000 bytes
Columns: total length in order by clause	Max	2000 bytes
Elements in select list	Max	127 elements
Negative float value	Min	Processor-dependent
Negative float value	Max	Processor-dependent
Positive float value	Min	Processor-dependent
Positive float value	Max	Processor-dependent
Host variables in OpenSQL statement	Max	256 variables
Integer value	Min	-2,147,483,648
Integer value	Max	+2,147,483,647
Predicates in having clause	Max	50 predicates
Predicates in where clause	Max	50 predicates
Row length (including overhead)	Max	2000 bytes
Scalar functions in select list	Max	127 functions
Smallint value	Min	-32,768
Smallint value	Max	32,767

Item	Min/Max	Limit
SQL identifier	Max	18 characters
Tables in SQL statement	Max	15 tables
User ID	Max	18 characters
Varchar length	Max	2000 characters

Chapter 11: OpenSQL Standard Catalogs

This chapter describes the Standard Catalog Interface catalogs. The Standard Catalog Interface described here corresponds to the formats you will find when the iidbcapabilities catalog contains the values in the following table.

CAP_CAPABILITY	CAP_VALUE
STANDARD_CATALOG_LEVEL	00602

The Standard Catalog Interface is a group of tables and views defined on the system catalogs of the underlying DBMS. Users who need to query the system catalogs must use the Standard Catalog Interface.

Unless otherwise noted, values in system catalogs are left justified, and columns are non-nullable.

The length of char fields, as listed in the Data Type column, is a maximum length. The actual length of the field is installation-dependent. When developing applications that access these catalogs, allocate storage based on the length as shown in the Data Type column.

All dates stored in system catalogs have the following format (underscores and colons are required):

yyyy_mm_dd hh:mm:ss GMT (Greenwich Mean Time)

Note: In this chapter, “default” means the assumed value if no other value is present.

Standard Catalog Interface

The Standard Catalog Interface catalogs are read-only views built on system catalogs of the underlying DBMS. The Standard Catalog Interface provides a portable representation for information about OpenSQL.

The iidbcapabilities Catalog

The iidbcapabilities catalog contains information about the capabilities provided by the Enterprise Access product or Ingres DBMS. The following table describes the columns in the iidbcapabilities catalog:

Column Name	Data Type	Description
cap_capability	char(32)	Contains one of the values listed in the capability column of the following table.
cap_value	char(32)	The contents of this field depend on the capability. See the Values column in the following table.

The CAP_CAPABILITY Column The cap_capability column in the iidbcapabilities catalog contains one or more of the following values:

Capability	Value
CAP_SLAVE2PC	Indicates if the DBMS supports Ingres two-phase commit slave protocol: Version 6.3 and above: Y Distributed Option: Y Enterprise Access product: usually N
DBEVENTS	Y if the DBMS supports database events, N if not.
DBEVENT_GRANT	Y if DBEvent related grant statements are accepted, N if rejected.
DB_NAME_CASE	Case sensitivity of the database with respect to database object names: LOWER, UPPER, MIXED. Defaults to LOWER. If the value is MIXED, case must be carefully preserved when specifying database objects. This field applies to names of database objects (tables, views, columns, and owners.) Names of user interface objects (such as forms or reports) are always lower case.

Capability	Value
DB_DELIMITED_CASE	Case conversion performed by the DBMS for object names specified using delimited identifiers (that is, in double quotes). LOWER if delimited identifiers are translated to lower case, UPPER if delimited identifiers are translated to upper case, or MIXED if no case translation is performed.
DBMS_TYPE	The type of DBMS the application is communicating with. Valid values are the same as those accepted by the with dbms clause used in queries. Examples: INGRES, STAR, RMS. The default value is INGRES.
DISTRIBUTED	Y if the DBMS is distributed, N if not.
ESCAPE	Contains Y if DBMS supports the ESCAPE clause of the LIKE predicate in the WHERE clause of search statements. Contains N if ESCAPE is not supported.
ESCAPE_CHAR	Character used to escape pattern characters in LIKE predicate.
IDENT_CHAR	Characters permitted in non-delimited identifiers beyond alphanumeric and '_'.
INGRES	Set to Y if the DBMS supports all versions of Ingres Release 6 and Ingres Release 1; otherwise N. Default is Y.
INGRES/SQL_LEVEL	<p>Version of Ingres SQL supported by the DBMS. Examples:</p> <p>00600 = 6.0 00601 = 6.1 00602 = 6.2 00603 = 6.3 00604 = 6.4 00605 = OpenIngres 1.x 00800 = OpenIngres 2.0 and Ingres II 2.0 00850 = Ingres II 2.5 00860 = Ingres 2.6 00902 = Ingres r3</p>

Capability	Value
	00000 = DBMS does not support Ingres SQL Default is 00000.
INGRES/QUEL_LEVEL	Version of Ingres QUEL supported by the DBMS. Examples: 00600 = 6.0 00601 = 6.1 00602 = 6.2 00603 = 6.3 00604 = 6.4 00605 = OpenIngres 1.x 00800 = OpenIngres 2.0 and Ingres II 2.0 00850 = Ingres II 2.5 00860 = Ingres 2.6 00902 = Ingres r3 00000 = Does not support QUEL Default is 00000.
INGRES_AUTH_GROUP	Y if the DBMS supports group identifiers.
INGRES_AUTH_ROLE	Y if the DBMS supports role identifiers.
INGRES_LOGICAL_KEY	Y if the DBMS supports Ingres logical keys.
INGRES_RULES	Y if the DBMS supports Ingres rules; N if it does not.
INGRES_UDT	Y if the DBMS supports Ingres user-defined data types, N if the DBMS does not support user-defined data types.
MAX_COLUMNS	Maximum number of columns allowed in a table. Default is 127.
NATIONAL_CHARACTER_SET	Y if the DBMS supports Unicode, N if it does not.

Capability	Value
NULL_SORTING	<p>How NULL values are sorted relative to other values:</p> <p>HIGH NULLS are considered the highest possible value.</p> <p>LOW NULLS are considered the lowest possible value.</p> <p>FIRST NULLS appear at start regardless of ascending/descending.</p> <p>LAST NULLS appear at end regardless of ascending/descending.</p>
OPEN_SQL_DATES	<p>Contains LEVEL 1 if the Enterprise Access product supports the OpenSQL date data type.</p>
OPEN/SQL_LEVEL	<p>Version of OpenSQL supported by the DBMS. Examples:</p> <p>00600 = 6.0 00601 = 6.1 00602 = 6.2 00603 = 6.3 00604 = 6.4 00605 = OpenIngres 1.x 00800 = OpenIngres 2.0 and Ingres II 2.0 00850 = Ingres II 2.5 00860 = Ingres 2.6 00902 = Ingres r3 Default is 00602.</p>
OPENSQI_SCALARS	<p>Can be one of three values: 'NATIVE', 'FULL' or LEVEL 1. The default value is 'NATIVE'. 'NATIVE' indicates only native DBMS scalar functions are supported. 'FULL' indicates full Ingres scalar function support is provided.</p> <p>LEVEL 1 indicates <i>some</i> mapping of Ingres scalar functions. When OPENSQI_SCALARS is set to LEVEL 1, an additional table, <i>iigwscalars</i>, is provided which shows support details for individual scalar functions. See The iigwscalars Catalog in this chapter.</p>

Capability	Value
OUTER_JOIN	Whether outer joins are supported: N for no, Y for yes.
OWNER_NAME	Contains N if <i>owner.table</i> table name format not supported. Contains Y if <i>owner.table</i> format supported. Contains QUOTED if <i>owner.table</i> supported with optional quotes ("owner".table).
PHYSICAL_SOURCE	T indicates that both iitable and iiphysical_table contain physical table information. P indicates that only iiphysical_table contains the physical table information.
SAVEPOINTS	Y if savepoints behave exactly as in Ingres, else N. Default is Y.
STANDARD_CATALOG_LEVEL	Version of the standard catalog interface supported by this database. Valid values: 00602 (default) 00604 00605 00800 00850 00860 00902 For catalog formats, see the appendix "System Catalogs" in the <i>Database Administrator Guide</i> .
SQL92_COMPLIANCE	The level of SQL-92 supported: NONE SQL-92 Entry level not supported ENTRY SQL-92 Entry level FIPS-IEF SQL-92 Entry level plus FIPS Integrity Enhancements features INTERMEDIATE SQL-92 Intermediate level FULL SQL-92 Full level

Capability	Value
SQL_MAX_CHAR_COLUMN_LEN	Maximum length of a CHAR column. Permits 0 for unsupported and -1 for unknown or unlimited.
SQL_MAX_VCHR_COLUMN_LEN	Maximum length of a VARCHAR column. Permits 0 for unsupported and -1 for unknown or unlimited.
SQL_MAX_NCHAR_COLUMN_LEN	Maximum length of an NCHAR column.
SQL_MAX_NVCHR_COLUMN_LEN	Maximum length of a NVARCHAR column.
SQL_MAX_BYTE_COLUMN_LEN	Maximum length of a BYTE column. Permits 0 for unsupported and -1 for unknown or unlimited.
SQL_MAX_VBYT_COLUMN_LEN	Maximum length of a VARBYTE column. Permits 0 for unsupported and -1 for unknown or unlimited.
SQL_MAX_CHAR_LITERAL_LEN	Maximum length of a string literal. Permits 0 for unsupported and -1 for unknown or unlimited.
SQL_MAX_BYTE_LITERAL_LEN	Maximum length of a hex literal. Permits 0 for unsupported and -1 for unknown or unlimited.
SQL_MAX_USER_NAME_LEN	Maximum length of a user name. Permits 0 for unsupported and -1 for unknown or unlimited.
SQL_MAX_ROW_LEN	Maximum length of a row. Permits 0 for unsupported and -1 for unknown or unlimited.
SQL_MAX_STATEMENTS	Maximum number of active (prepared) statements. Permits 0 for unsupported and -1 for unknown or unlimited.
UNION	Whether UNION selects are supported: N No Y Yes ALL Yes and UNION ALL.
UNIQUE_KEY_REQ	Set to Y if the database service requires that some or all tables have a unique key. Set to N or not present if the database service allows tables without unique keys.

The iidbconstants Catalog

The iidbconstants catalog contains values required by the Ingres tools. The following table describes the columns in the iidbconstants catalog:

Column Name	Data Type	Description
user_name	char(32)	Name of the current user
dba_name	char(32)	Name of the owner of the database
system_owner	char(32)	The name of the system catalog owner (for example, \$ingres)

The iievents Catalog

The iievents catalog contains an entry for each database event that has been created. This catalog is present only if the DBEVENTS entry in the iidbcapabilities catalog section has a value of Y. For complete information about database events, see [Database Events](#) in the chapter “OpenSQL Features.”

The information is stored in the following format:

Column Name	Data Type	Description
event_name	char(32)	Name of the event. This name is unique among all events owned by user.
event_owner	char(32)	Owner of the event. This name can be referenced in the different event statements to qualify the event.
text_sequence	integer	Text sequence of createdbevent text.
text_segment	varchar (240)	Text segment of createdbevent text.

The iigwscalars Catalog

The iigwscalars catalog contains an entry for each function that an Enterprise Access Product supports. This catalog is present only if the OPENSQ_L_SCALARS entry in the iidbcapabilities catalog section has a value of LEVEL 1. If this catalog is present in your database, it details the level of support provided for functions.

The information is stored in the following format:

Column Name	Data Type	Description
function_name	char(32)	Name identifying the function.
support	char(10)	This column has one of four values: RESTRICT indicates this function is supported but with restrictions. A restriction may be as simple as requiring a literal value for a parameter, or may indicate a slight variation from the standard Ingres behavior for this function.
		COMPAT indicates a native DMBS function exactly matches the Ingres function. No translation is performed.
		TRANS indicates that the function is translated to the target DMBS SQL without restrictions.
		NO indicates that a function is not supported.
parm1	char(10)	A value of LITERAL indicates that the first parameter to this function must be a literal value. A value of EXPR indicates that both literal values and expressions are allowed for this parameter.
parm2	char(10)	LITERAL or EXPR.
parm3	char(10)	LITERAL or EXPR.
mapping	varchar(253)	This column documents the target DBMS SQL that is generated when the Enterprise Access product does translations.
comments	varchar(400)	Comments.

The `iitables` Catalog

The `iitables` catalog contains an entry for each queryable object in the database (table, view, or index). To find out what tables, views, and indexes are owned by you or the DBA, you can query this catalog. For example:

```
select * from iitables where (table_owner = user or
table_owner = (select dba_name from iidbconstants))
```

Column Name	Data Type	Description
table_name	char(32)	The object's name. Must be a valid object name.
table_owner	char(32)	The owner's user name. Generally, the creator of the object is the owner.
create_date	char(25)	The object's creation date. Blank if unknown.
alter_date	char(25)	The last time this table was altered. This date is updated whenever the logical structure of the table changes, either through changes to the columns in the table or changes to the primary key. Physical changes to the table, such as changes to data, secondary indexes, or physical keys, do not change this date. Blank if unknown.
table_type	char(8)	Type of query object: T = Table V = View I = Index Further information about tables can be found in <code>iiphysical_tables</code> . Further information about views can be found in <code>iiviews</code> .
table_subtype	char(8)	Specifies the type of table or view. Possible values are: N (native) – For standard Ingres databases. L (links) – For the Distributed Option. I (imported tables) – For Enterprise Access products. (blank) - If unknown

Column Name	Data Type	Description
table_version	char(8)	Version of the object. Enables the user interfaces to determine where additional information about this particular object is stored. This reflects the database type, as well as the version of an object within a given database. For Ingres tables, the value for this field is II2.5.
system_use	char(8)	Contains S if the object is a system object, U if user object, or blank if unknown. Used by utilities to determine which tables need reloading. If the value is unknown, the utilities use the naming convention of "ii" for tables to distinguish between system and user catalogs. In addition, any table beginning with ii_ is assumed to be a user interface object, rather than a DBMS system object. The standard system catalogs themselves must be included in the iitable catalog and are considered system tables.
table_size	integer	Stores the page size of a table.

The following columns in iitable have values only if table_type is T (table) or I (index).

Enterprise Access products that do not supply this information set these columns to -1 for numeric data types, blank for character data types.

Column Name	Data Type	Description
table_stats	char(8)	Contains Y if this object has entries in the iistats table, N if this object does not have entries. If this field is blank, then query iistats to determine if statistics exist. This column is used for optimization of Ingres databases.
table_indexes	char(8)	Contains Y if this object has entries in the iiindexes table that refer to this as a base table, or N if this object does not have entries. If the field is blank, then query iiindexes on the base_table column. This field is used for optimization of Ingres databases.

Column Name	Data Type	Description
is_READONLY	char(8)	<p>Contains one of these values:</p> <p>N – If updates are physically allowed</p> <p>Y – If no updates are allowed</p> <p>Blank – If unknown</p> <p>Used for tables that are defined to the Enterprise Access product only for retrieval, such as tables in hierarchical database systems.</p> <p>If this field is set to Y, then no updates will work, independent of what permissions might be set. If it is set to N, updates may be allowed, depending on whether the permissions allow it.</p>
CONCURRENT_ACCESS	char(1)	Y if concurrent access is allowed.
NUM_ROWS	integer	The estimated number of rows in the table. Set to -1 if unknown.
STORAGE_STRUCTURE	char(16)	The storage structure for the table: heap, hash, btree, or isam. Blank if unknown.
IS_COMPRESSED	char(8)	Contains Y if the table is stored in compressed format, N if the table is uncompressed, blank if unknown.
KEY_IS_COMPRESSED	char(8)	Contains Y if the table uses key compression, N if no key compression, or blank if unknown.
DUPLOCATE_ROWS	char(8)	<p>D – If the table allows duplicate rows.</p> <p>U – If the table does not allow duplicate rows.</p> <p>Blank – If unknown.</p> <p>The table storage structure (unique or non-unique keys) can override this setting.</p>

Column Name	Data Type	Description
unique_rule	char(8)	D - Indicates that duplicate physical storage structure keys are allowed. (A unique alternate key may exist in iialt_columns and any storage structure keys may be listed in iicolumns.) U - If the object is an Ingres object, indicates that the object has unique storage structure key. If the object is not an Ingres object, then it indicates that the object has a unique key, described in either iicolumns or iialt_columns. Blank - If uniqueness is unknown or does not apply.
number_pages	integer	The estimated number of physical pages in the table. Set to -1 if unknown.
overflow_pages	integer	The estimated number of overflow pages in the table. Set to -1 if unknown.
row_width	integer	The size, in bytes, of the uncompressed binary value for a row of this query object.
unique_scope	char(8)	R if this object is row-level, S if statement-level, blank if not applicable.
allocation_size	integer	The allocation size, in pages. Set to -1 if unknown.
extend_size	integer	The extend size, in pages. Set to -1 if unknown.
allocated_pages	integer	Total number of pages allocated to the table.

The following columns are used by the Ingres DBMS Server. If an Enterprise Access does not supply this information, it will set these columns to the default values: -1 for numeric columns and a blank for character columns. The information in the following section is not duplicated in iiphysical_tables.

Column Name	Data Type	Description
expire_date	integer	Expiration date of table. This is an Ingres _bintim date.

Column Name	Data Type	Description
modify_date	char(25)	The date on which the last physical modification to the storage structure of the table occurred. Blank if unknown or inapplicable.
location_name	char(24)	The first location of the table. If there are additional locations for a table, they are shown in the <i>iimulti_locations</i> table and <i>multi_locations</i> is set to Y.
table_integrities	char(8)	Contains Y if this object has Ingres style integrities. If the value is blank, query the <i>iintegrities</i> table to determine if integrities exist.
table_permits	char(8)	Contains Y if this object has Ingres style permissions.
all_to_all	char(8)	Contains Y if this object has Ingres permit all to all, N if not.
ret_to_all	char(8)	Contains Y if this object has Ingres permit retrieve to all, N if not.
is_journalled	char(8)	Contains Y if Ingres journaling is enabled on this object, N if not.
view_base	char(8)	Contains Y if object is a base for a view definition, N if not, or blank if unknown.
multi_locations	char(8)	Contains Y if the table is in multiple locations, N if not.
table_ifillpct	smallint	<p>Fill factor for the index pages used on the last modify command in the <i>nonleaffill</i> clause, expressed as a percentage (0 to 100).</p> <p>Used for Ingres btree structures to rerun the last modify command.</p>
table_dfillpct	smallint	<p>Fill factor for the data pages used on the last modify command in the <i>fillfactor</i> clause, expressed as a percentage (0 to 100).</p> <p>Used for Ingres btree, hash, and isam structures to rerun the last modify command.</p>

Column Name	Data Type	Description
table_lfillpct	smallint	Fill factor for the leaf pages used on the last modify command in the leaffill clause, expressed as a percentage (0 to 100). Used for Ingres btree structures to rerun the last modify command.
table_minpages	integer	Minpages parameter from the last execution of the modify command. Used for Ingres hash structures only.
table_maxpages	integer	Maxpages parameter from the last execution of the modify command. Used for Ingres hash structures only.
table_reltstamp1	integer	High part of last create or modify timestamp for the table.
table_reltstamp2	integer	Low part of last create or modify timestamp for the table.
table_reltid	integer	The first part of the internal relation ID.
table_reltidx	integer	The second part of the internal relation ID.
table_relversion	integer	Stores the version of table.
table_reltotwidth	integer	This width includes all deleted columns.
table_reltcpri	integer	Indicates a table's priority in the buffer cache. Values can be between 0 and 8. Zero is the default, and 1-8 can be specified using the priority clause in create table or modify table.

The iicolumns Catalog

For each queryable object in the iitable catalog, there are one or more entries in the iicolumns catalog. Each row in iicolumns contains the logical information on a column of the object. User interfaces and user programs use the iicolumns catalog to perform dictionary operations and dynamic queries.

Column Name	Data Type	Description
table_name	char(32)	The name of the table.
table_owner	char(32)	The owner of the table.
column_name	char(32)	The column name.

Column Name	Data Type	Description
column_datatype	char(32)	The column data type name returned to users and applications: Decimal Integer Int Float Real Double precision Char Character Varchar Date
column_length	integer	The length of the column returned to users and applications. If a data type contains two length specifiers, this column uses the first length. Set to zero for the data types that are specified without length (date). This length is not the actual length of the column's internal storage. For decimal columns, contains the precision.
column_scale	integer	The second number in a two-part user length specification. For typename (len1, len2) it will be len2.
column_nulls	char(8)	Contains Y if the column can contain null values, N if the column cannot contain null values.
column_defaults	char(8)	Contains Y if the column is given a default value when a row is inserted, or N if the column is not given a default value.
column_sequence	integer	The number of this column in the corresponding table's create statement, numbered from 1.
key_sequence	integer	The order of this column in the primary key, numbered from 1. For an Ingres table, this indicates the column's order in the primary storage structure key. If 0, then this column is not part of the primary key.
sort_direction	char(8)	Defaults to A (for ascending) when key_sequence is greater than 0; otherwise, this value is a blank.

Column Name	Data Type	Description
column_ingdatatype	smallint	<p>Contains the numeric Ingres representation of the column's external data type (the data type returned to users and applications).</p> <p>If the installation has user-defined data types (UDTs), this column contains the data type that the UDT is converted to when returned to an Ingres user interface product.</p> <p>If the value is positive then the column is not nullable. If the value is negative, then the column is nullable. The data types and their corresponding values are:</p> <ul style="list-style-type: none"> decimal - 10/10 integer - 30/30 float - 31/31 date* - 3/3 char - 20/20 varchar - 21/21 <p>* Returned as a string</p>
column_internal_datatype	char(32)	<p>The internal data type of the column: char, c, varchar, text, integer, float, date, money, table_key, object_key. If the installation has user-defined data types, this column contains the user-specified name.</p>
column_internal_length	smallint	<p>The internal length of the column. For example, for data type smallint, this column contains 2. Contains 0 if the data type is fixed-length. The length does not include the null indicator byte for nullable columns, or the length specifier byte for varchar and text columns.</p>
column_internal_ingrouptype	smallint	<p>Contains the numeric representation of the internal datatype. For a list of valid values, see column_ingdatatype. If the installation has user-defined data types, this column contains the user-specified data type number.</p>

Column Name	Data Type	Description
column_system_maintained	char(8)	Contains Y if the column is system-maintained, or N if not system-maintained.
column_updatable	char(8)	Contains Y if the column can be updated, N if not, or blank if unknown.
column_has_default	char(8)	Contains Y if the column has a default value, N if not, or blank if unknown.
column_default_value	varchar(1501)	The default value defined for the column.

The iiphysical_tables Catalog

The information in the iiphysical_tables catalog overlaps with some of the information in iitable. This information is provided as a separate catalog primarily for use by Enterprise Access products. Query the physical_source column, in iidbcapabilities, to determine whether you must query iiphysical_tables. If you do not want to query iidbcapabilities, then you must always query iiphysical_tables to be sure of getting the correct information.

If a queryable object is type T or I (for index, in an Ingres installation only), then it is a physical table and may have an entry in iiphysical_tables as well as iitable.

In most Enterprise Access products, this table is keyed on table_name plus table_owner:

Column Name	Data Type	Description
table_name	char(32)	The table name. This is an object name.
table_owner	char(32)	The table owner's user name.
table_stats	char(8)	Y if this object has entries in the iistats table.
table_indexes	char(8)	Y if this object has entries in the iiindexes table that refer to this as a base table.
is_READONLY	char(8)	Y if updates are physically allowed on this object.
concurrent_access	char(8)	Y if concurrent access is allowed.
num_rows	integer	The estimated number of rows in the table. Set to -1 if unknown.

Column Name	Data Type	Description
storage_structure	char(16)	The storage structure of the table. Possible values are: heap, btree, isam, or hash.
is_compressed	char(8)	Indicates if the table is stored in compressed format. Y if it is compressed, N if not compressed, or blank if unknown.
key_is_compressed	char(8)	Indicates if the table uses compression. Y if the table uses compression, N if no compression, or blank if unknown.
duplicate_rows	char(8)	Contains U if rows must be unique, D if duplicates are allowed, or blank if unknown.
unique_rule	char(8)	Contains U if the storage structure is unique, D if duplicates are allowed, or blank if unknown or inapplicable.
number_pages	integer	The estimated number of physical pages in the table. Set to -1 if unknown.
overflow_pages	integer	The estimated number of overflow pages in the table. Set to -1 if unknown.
row_width	integer	The size (in bytes) of the uncompressed binary value for a row in the object for Ingres. Set to -1 if this is unknown.
allocation_size	integer	The table allocation size, in pages. Set to -1 if unknown.
extend_size	integer	The extend size , in pages. Set to -1 if unknown.
allocated_pages	integer	The total number of pages allocated to the table.
table_pagesize	integer	Stores the pages of a table

The **iiviews** Catalog

The **iiviews** catalog contains one or more entries for each view in the database (views are indicated in **iitables** by table type = "V"). Because the **text_segment** column is limited to 240 characters per row, a single view can require more than one row to contain all its text. In this case, the text will be broken in mid-word across the sequenced rows. The text column is pure text, and can contain newline characters.

Column Name	Data Type	Description
table_name	char(32)	The view name. Must be a valid object name.
table_owner	char(32)	The view owner's user name.
view_dml	char(8)	The language in which the view was created: S (for SQL) or Q (for QUEL).
check_option	char(8)	Contains Y if the check option was specified in the create view statement, N if not, or blank if unknown.
text_sequence	integer	The sequence number for the text field, starting with 1.
text_segment	varchar(256)	The text of the view definition.

The **iiindexes** Catalog

Each table with a **table_type** of I (index) in the **iitables** table has an entry in **iiindexes**. In Ingres, all indexes also have an entry in **iiphysical_tables**.

Column Name	Data Type	Description
index_name	char(32)	The index name. Must be a valid object name.
index_owner	char(32)	The index owner's user name.
create_date	char(25)	Creation date of index.
base_name	char(32)	The base table name. Must be a valid object name.
base_owner	char(32)	The base table owner. Must be a valid user name.
storage_structure	char(16)	The storage structure for the index: heap, hash, isam, or btree.

Column Name	Data Type	Description
is_compressed	char(8)	Contains Y if the table is stored in compressed format, N if the table is uncompressed, or blank if unknown.
unique_rule	char(8)	Contains U if the index is unique, D if duplicate key values are allowed, or blank if unknown.
unique_scope	char(8)	Contains S if uniqueness is checked after completion of queries or R if uniqueness is checked after each row is modified or inserted.
system_use	char(8)	Contains S if the index was created by the DBMS, U if created by a user, or blank if unknown. (The Ingres DBMS creates unique indexes to enforce unique constraints on tables.)
persistent	char(8)	Contains Y if the index is retained when its base table is modified (using the Ingres modify statement), or N if the index is dropped when the table is modified.

The `iiindex_columns` Catalog

For indexes, any Ingres columns that are defined as part of the primary index key will have an entry in `iiindex_columns`. For a full list of all columns in the index, use the `iicolumns` catalog.

Column Name	Data Type	Description
index_name	char(32)	The index containing <code>column_name</code> . This is an object name.
index_owner	char(32)	The index owner. Must be a valid user name.
column_name	char(32)	The name of the column. Must be a valid object name.
key_sequence	integer	Sequence of column within the key, numbered from 1.
sort_direction	char(8)	Defaults to A (ascending).

The `iialt_columns` Catalog

All columns defined as part of an alternate key have an entry in `iialt_columns`.

Column Name	Data Type	Description
table_name	char(32)	The table to which <code>column_name</code> belongs.
table_owner	char(32)	The table owner.
key_id	integer	The number of the alternate key for this table.
column_name	char(32)	The name of the column.
key_sequence	smallint	Sequence of column within the key, numbered from 1.

The `iistats` Catalog

This catalog contains entries for columns that have statistics.

Column Name	Data Type	Description
table_name	char(32)	The name of the table.
table_owner	char(32)	The table owner's user name.
column_name	char(32)	The column name to which the statistics apply.
create_date	char(25)	The date on which statistics were gathered.
num_unique	float8	The number of unique values in the column.
rept_factor	float8	The repetition factor.
has_unique	char(8)	Contains Y if the column has unique values; otherwise, N.
pct_nulls	float8	The percentage (fraction of 1.0) of the table which contains NULL for the column.
num_cells	integer	The number of cells in the histogram.
column_domain	integer	Identifies the domain from which the column draws its values.
is_complete	char(8)	Contains Y if the column contains all possible values in its domain, N if the column does not contain all possible values in its domain, or blank if unknown.

Column Name	Data Type	Description
stat_version	char(8)	Version of statistics (for example, ING6.5).
hist_data_length	integer	Length of the histogram boundary values.

The `iistograms` Catalog

The `iistograms` table contains histogram information used by the optimizer.

Column Name	Data Type	Description
table_name	char(32)	The table for the histogram. Must be a valid object name.
table_owner	char(32)	The table owner's user name.
column_name	char(32)	The name of the column.
text_sequence	integer	The sequence number for the histogram, numbered from 1. There may be several rows in this table, used to order the "text_segment" data when histogram is read into memory.
text_segment	char(228)	The encoded histogram data, created by optimizedb.

The `iiprocedures` Catalog

The `iiprocedures` catalog contains one or more entries for each database procedure defined on a database. Because the text of the procedure definition can contain more than 240 characters, `iiprocedures` may contain more than one entry for a single procedure. The text may contain newlines and may be broken mid-word across rows.

This table is keyed on `procedure_name` and `procedure_owner`:

Column Name	Data Type	Description
procedure_name	char(32)	The database procedure name, as specified in the create procedure statement.
procedure_owner	char(32)	The procedure owner's Ingres username.
create_date	char(25)	The procedure's creation date.

Column Name	Data Type	Description
proc_subtype	char(8)	The subtype of this procedure. For standard Ingres procedures, this will be N(native). For the Distributed Option, this may be I (imported).
text_sequence	smallint	The sequence number for the test_segment.
text_segment	varchar(240)	The text of the procedure definition.
system_use	char(8)	Contains S if the procedure is system-generated, U if created by a user, or blank if unknown. Ingres generates procedures to enforce table constraints.

The iiregistrations Catalog

The iiregistrations catalog contains the text of register statements, and is used by Ingres Distributed Option and Enterprise Access products.

Column Name	Data Type	Description
object_name	char(32)	The name of the registered table, view, or index.
object_owner	char(32)	The name of the owner of the table, view, or index.
object_dml	char(8)	The language used in the registration statement. S for SQL or Q for QUEL.
object_type	char(8)	Describes the object type of object_name. The values are T if the object is a table, V if it is a view, or I if it is an index.
object_subtype	char(8)	Describes the type of table or view created by the register statement. For the Distributed Option, this will be L (link). For an Enterprise Access product, this will be I (imported object).
text_sequence	smallint	The sequence number of the text field, numbered from 1.
text_segment	Varchar (240)	The text of the register statement.

The `iisynonyms` Catalog

The `iisynonyms` catalog contains information about the synonyms that have been defined for the database. Entries appear in `iisynonyms` when a create synonym statement is issued. Entries are removed when a drop synonym statement is issued for an existing synonym, or when a drop table|view|index statement drops the table on which the synonym is defined.

Column Name	Data Type	Description
<code>synonym_name</code>	char(32)	The name of the synonym.
<code>synonym_owner</code>	char(32)	The owner of the synonym.
<code>table_name</code>	char(32)	The name of the table, view or index for which the synonym was created.
<code>table_owner</code>	char(32)	The owner of the table.

Mandatory and Ingres-Only Standard Catalogs

Mandatory catalogs are required to be present on all installations. *Ingres-only* catalogs are required for Ingres installations. This section lists the catalogs in each category. For a detailed description on all catalogs, see the *Database Administrator Guide*.

Mandatory Catalogs with Entries Required

The following catalogs must be present on both Enterprise Access product and Ingres installations. These catalogs must contain entries.

- `iidbcapabilities`
- `iidbconstants`
- `iitables`
- `iicolumns`

Mandatory Catalogs Without Entries Required

The following catalogs must be present on both Enterprise Access product and Ingres installations. However, these catalogs are not required to contain entries.

- `iiphysical_tables`
- `iiviews`
- `iiindexes`
- `iiindex_columns`
- `iialt_columns`
- `iistats`
- `iihistograms`
- `iiaudittables`
- `iiconstraint_indexes`
- `iiconstraints`
- `iikeys`
- `iiref_constraints`
- `iisecurity_alarms`

Ingres-Only Catalogs

The following catalogs are required by Ingres installations.

- `iipermits`
- `iiintegrities`
- `iimulti_locations`
- `iirules`
- `iiilog_help`
- `iifile_info`

Appendix A: Keywords

This appendix lists OpenSQL keywords and indicates the contexts in which they are reserved. This list allows you to avoid assigning object names that conflict with reserved words.

Note: The keywords in this list do not necessarily correspond to supported Ingres features. Some words are reserved for future or internal use and to provide backward compatibility with older features.

Keyword List

In the following table, the column headings have the following meanings:

- **ISQL** (Interactive SQL) - These keywords are reserved by the DBMS.
- **ESQL** (Embedded SQL) - These keywords are reserved by the SQL preprocessors.
- **IQUEL** (Interactive QUEL) - These keywords are reserved by the DBMS.
- **EQUEL** (Embedded QUEL) - These keywords are reserved by the QUEL preprocessors.
- **4GL** - These keywords are reserved in the context of SQL or QUEL in 4GL routines.

Note: The ESQL and EQUEL preprocessors also reserve forms statements. For details about forms statements, see the *Forms-based Application Development Tools User Guide*.

Single Keywords

The following table displays OpenSQL keywords:

Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
abort	*	*		*	*	
activate	*	*		*	*	
add	*	*		*	*	
addform	*	*		*	*	
after	*	*		*	*	

Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
all	*	*		*	*	
alter	*	*		*	*	
and	*	*		*	*	
any	*	*		*	*	
append	*	*		*	*	
array	*	*		*	*	
as	*	*		*	*	
asc	*	*		*	*	
at	*	*		*	*	
authorization	*	*		*	*	
avg	*	*		*	*	
avgu	*	*		*	*	
before	*	*		*	*	
begin	*	*		*	*	
between	*	*		*	*	
breakdisplay	*	*		*	*	
by	*	*		*	*	
byref	*	*		*	*	
call	*	*		*	*	
callframe	*	*		*	*	
callproc	*	*		*	*	
cascade	*	*		*	*	
case	*	*				
cast	*					
check	*	*		*	*	
clear	*	*		*	*	
clearrow	*	*		*	*	
close	*	*		*	*	
coalesce	*					

Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
column	*	*		*	*	
command	*	*		*	*	
commit	*	*		*	*	
committed	*	*		*	*	
connect	*	*		*	*	
constraint	*	*		*	*	
continue	*	*		*	*	
copy	*	*		*	*	
copy_from	*					
copy_into	*					
count	*	*		*	*	
countu	*	*		*	*	
create	*	*		*	*	
current	*	*		*	*	
current_user	*	*		*	*	
curval	*	*				
cursor	*	*		*	*	
cycle	*	*				
datahandler	*	*		*	*	
dbms_password		*				
declare	*	*		*	*	
default	*	*		*	*	
define	*	*		*	*	
delete	*	*		*	*	
deleterow	*	*		*	*	
desc	*	*		*	*	
describe	*	*		*	*	
descriptor	*	*		*	*	
destroy	*	*		*	*	

Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
direct	*	*		*	*	
disconnect	*	*		*	*	
display	*	*		*	*	
distinct	*	*		*	*	
distribute	*	*		*	*	
do	*	*		*	*	
down	*	*		*	*	
drop	*	*		*	*	
else	*	*		*	*	
elseif	*	*		*	*	
enable	*	*		*	*	
end	*	*		*	*	
end-exec	*	*		*	*	
enddata	*	*		*	*	
enddisplay	*	*		*	*	
endfor	*					
endforms	*	*		*	*	
endif	*	*		*	*	
endloop	*	*		*	*	
endrepeat	*					
endretrieve	*	*		*	*	
endselect	*	*		*	*	
endwhile	*	*		*	*	
escape	*	*		*	*	
except	*					
exclude	*	*		*	*	
excluding	*	*		*	*	
execute	*	*		*	*	
exists	*	*		*	*	

Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
exit	*	*		*	*	
fetch	*	*		*	*	
field	*	*		*	*	
finalize	*	*		*	*	
first	*	*				
for	*	*		*	*	
foreign	*	*		*	*	
formdata	*	*		*	*	
forminit	*	*		*	*	
forms	*	*		*	*	
from	*	*		*	*	
full	*	*		*	*	
get	*	*		*	*	
getform	*	*		*	*	
getoper	*	*		*	*	
getrow	*	*		*	*	
global	*	*		*	*	
goto	*	*		*	*	
grant	*	*		*	*	
granted		*				
group	*	*		*	*	
having	*	*		*	*	
help	*	*		*	*	
help_forms	*	*		*	*	
help_frs	*	*		*	*	
helpfile	*	*		*	*	
identified	*	*		*	*	
if	*	*		*	*	
iimessage	*	*		*	*	

Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
iprintf	*	*		*	*	
iiprompt	*	*		*	*	
iistatement	*	*		*	*	
immediate	*	*		*	*	
import	*	*		*	*	
in	*	*		*	*	
include	*	*		*	*	
increment	*	*				
index	*	*		*	*	
indicator	*	*		*	*	
inges	*	*		*	*	
initial_user	*	*		*	*	
initialize	*	*		*	*	
inittable	*	*		*	*	
inquire_equel	*	*		*	*	
inquire_forms	*	*		*	*	
inquire_frs	*	*		*	*	
inquire_ingres	*	*		*	*	
inquire_sql	*	*		*	*	
insert	*	*		*	*	
insertrow	*	*		*	*	
integrity	*	*		*	*	
intersect	*					
into	*	*		*	*	
is	*	*		*	*	
isolation	*	*		*	*	
join	*	*		*	*	
key	*	*		*	*	
leave	*					

Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
left	*	*		*	*	
level	*	*		*	*	
like	*	*		*	*	
loadtable	*	*		*	*	
local	*	*		*	*	
max	*	*		*	*	
maxvalue	*	*				
menuitem	*	*		*	*	
message	*	*		*	*	
min	*	*		*	*	
minvalue	*	*				
mode	*	*		*	*	
modify	*	*		*	*	
module	*	*		*	*	
move	*	*		*	*	
natural	*	*		*	*	
next	*	*		*	*	
nextval	*	*				
nocache	*	*				
nocycle	*	*				
noecho	*	*		*	*	
nomaxvalue	*	*				
nominvalue	*	*				
noorder	*	*				
not	*	*		*	*	
notrim	*	*		*	*	
null	*	*		*	*	
nullif	*					
of	*	*		*	*	

Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
on	*	*		*	*	
only	*	*		*	*	
open	*	*		*	*	
option	*	*		*	*	
or	*	*		*	*	
order	*	*		*	*	
out	*	*		*	*	
outer	*	*		*	*	
param	*	*		*	*	
partition		*				
permit	*	*		*	*	
prepare	*	*		*	*	
preserve	*	*		*	*	
primary	*	*		*	*	
print	*	*		*	*	
printscreen	*	*		*	*	
privileges	*	*		*	*	
procedure	*	*		*	*	
prompt	*	*		*	*	
public	*	*		*	*	
purgetable		*			*	
putform	*	*		*	*	
putoper	*	*		*	*	
putrow	*	*		*	*	
qualification	*	*		*	*	
raise	*	*		*	*	
range	*	*		*	*	
rawpct	*	*				
read	*	*		*	*	

Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
redisplay	*	*		*	*	
references	*	*		*	*	
referencing	*	*		*	*	
register	*	*		*	*	
relocate	*	*		*	*	
remove	*	*		*	*	
rename	*	*		*	*	
repeat	*	*		*	*	
repeatable	*	*		*	*	
repeated	*	*		*	*	
replace	*	*		*	*	
replicate	*	*		*	*	
restart	*	*				
restrict	*	*		*	*	
result	*	*				
resume	*	*		*	*	
retrieve	*	*		*	*	
return	*	*		*	*	
revoke	*	*		*	*	
right	*	*		*	*	
roll		*				
rollback	*	*		*	*	
row	*	*				
rows	*	*		*	*	
run	*	*		*	*	
save	*	*		*	*	
savepoint	*	*		*	*	
schema	*	*		*	*	
screen	*	*		*	*	

Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
scroll	*	*		*	*	
scrolldown	*	*		*	*	
scrollup	*	*		*	*	
section	*	*		*	*	
select	*	*		*	*	
serializable	*	*		*	*	
session	*	*		*	*	
session_user	*	*		*	*	
set	*	*		*	*	
set_4gl	*	*		*	*	
set_equel	*	*		*	*	
set_forms	*	*		*	*	
set_frs	*	*		*	*	
set_inger	*	*		*	*	
set_sql	*	*		*	*	
sleep	*	*		*	*	
some	*	*		*	*	
sort	*	*		*	*	
sql	*	*		*	*	
start	*	*				
stop	*	*		*	*	
submenu	*	*		*	*	
substring	*	*				
sum	*	*		*	*	
sumu	*	*		*	*	
system	*	*		*	*	
system_	*	*		*	*	
maintained						
system_user	*	*		*	*	
table	*	*		*	*	

Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
tabledata	*	*		*	*	
temporary	*	*		*	*	
then	*	*		*	*	
to	*	*		*	*	
type	*	*		*	*	
uncommitted	*	*				
union	*	*		*	*	
unique	*	*		*	*	
unloadtable	*	*		*	*	
until	*	*		*	*	
up	*	*		*	*	
update	*	*		*	*	
user	*	*		*	*	
using	*	*		*	*	
validate	*	*		*	*	
validrow	*	*		*	*	
values	*	*		*	*	
view	*	*		*	*	
when	*	*		*	*	
whenever	*	*		*	*	
where	*	*		*	*	
while	*	*		*	*	
with	*	*		*	*	
work	*	*		*	*	
write	*	*				

Double Keywords

The following table lists OpenSQL double keywords:

Double Keyword	ISQL	ESQL	4GL	QUEL	EQUEL	4GL
after field	*	*		*	*	
alter default		*				
alter group	*	*		*	*	
alter location	*	*		*	*	
alter profile	*					
alter role	*	*		*	*	
alter security_audit	*	*		*	*	
alter_sequence	*	*				
alter table	*	*		*	*	
alter user	*	*		*	*	
array of	*	*		*	*	
base table structure	*					
before field	*	*		*	*	
begin transaction	*	*		*	*	
by role	*					
by user	*	*		*	*	
call on	*	*		*	*	
call procedure	*	*		*	*	
class of	*	*		*	*	
clear array		*				
close cursor	*	*		*	*	
comment on	*	*		*	*	
connect to	*	*		*	*	
copy table	*	*		*	*	
createdbevent	*	*		*	*	
create domain		*				
create group	*	*		*	*	

Double Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
create integrity	*	*		*	*	
create link	*	*		*	*	
create location	*	*		*	*	
create permit	*	*		*	*	
create procedure	*	*		*	*	
create profile	*	*	*			
create role	*	*		*	*	
create rule	*	*		*	*	
create security_alarm	*	*		*	*	
create sequence	*	*				
create synonym	*	*		*	*	
create user	*	*		*	*	
create view	*	*		*	*	
cross join	*	*				
curr value	*					
current installation	*	*		*	*	
current value	*	*				
define cursor	*	*		*	*	
declare cursor	*	*		*	*	
define integrity	*	*		*	*	
define link	*	*		*	*	
define location	*	*		*	*	
define permit	*	*		*	*	
define qry	*	*		*	*	
define query	*	*		*	*	
define view	*	*		*	*	
delete cursor	*	*		*	*	
describe form		*				
destroy integrity	*	*		*	*	
destroy link	*	*		*	*	

Double Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
destroy permit	*	*		*	*	
destroy table	*	*		*	*	
destroy view	*	*		*	*	
direct connect	*	*		*	*	
direct disconnect	*	*		*	*	
direct execute	*	*		*	*	
disable security_audit	*	*		*	*	
disconnect current	*	*		*	*	
display submenu	*	*		*	*	
drop dbevent	*	*		*	*	
drop domain		*				
drop group	*	*		*	*	
drop integrity	*	*		*	*	
drop link	*	*		*	*	
drop location	*	*		*	*	
drop permit	*	*		*	*	
drop procedure	*	*		*	*	
drop profile	*	*				
drop role	*	*		*	*	
drop rule	*	*		*	*	
drop security_alarm	*	*		*	*	
drop sequence	*	*				
drop synonym	*	*		*	*	
drop user	*	*		*	*	
drop view	*	*		*	*	
each row		*				
each statement		*				
enable security_audit	*	*		*	*	
end exclude		*				
end transaction	*	*		*	*	

Double Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
exec sql	*	*		*	*	
execute immediate	*	*		*	*	
execute on	*	*		*	*	
execute procedure	*	*		*	*	
foreign key	*	*		*	*	
for deferred	*	*		*	*	
for direct	*	*		*	*	
for readonly	*	*		*	*	
for retrieve	*	*		*	*	
for update	*	*		*	*	
from group	*	*		*	*	
from role	*	*		*	*	
from user	*	*		*	*	
full join	*	*		*	*	
full outer	*					
get attribute		*				
get data		*		*	*	
get dbevent		*		*	*	
get global		*				
global temporary	*	*		*	*	
help all		*				
help comment	*	*		*	*	
help integrity	*	*		*	*	
help permit	*	*		*	*	
help table	*	*		*	*	
help view	*	*		*	*	
identified by	*	*		*	*	
inner join	*	*		*	*	
is null	*	*		*	*	

Double Keyword	SQL	QUEL				
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
isolation level	*			*		
left join	*	*		*	*	
left outer	*		*			
modify table	*	*		*	*	
next value	*	*				
no cache	*	*				
no cycle	*	*				
no maxvalue	*	*				
no minvalue	*	*				
no order	*					
not like	*	*		*	*	
not null	*	*		*	*	
on commit	*	*		*	*	
on current	*	*		*	*	
on database	*	*		*	*	
on dbevent	*	*		*	*	
on location	*	*		*	*	
on procedure	*	*		*	*	
on sequence	*					
only where	*	*		*	*	
open cursor	*	*		*	*	
order by	*	*		*	*	
primary key	*	*		*	*	
procedure returning	*	*		*	*	
put data	*	*		*	*	
raise dbevent	*	*		*	*	
raise error	*	*		*	*	
read only		*				
read write		*				

Double Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
registerdbevent	*	*		*	*	
register table	*	*		*	*	
register view	*	*		*	*	
remote system_password		*				
remote system_user		*				
removedbevent	*	*		*	*	
removetable	*	*		*	*	
remove view	*	*		*	*	
replace cursor	*	*		*	*	
result row	*	*				
resume entry	*	*		*	*	
resume menu	*	*		*	*	
resume next	*	*		*	*	
retrieve cursor	*	*		*	*	
right join	*	*		*	*	
run submenu	*	*		*	*	
session group	*	*		*	*	
session role	*	*		*	*	
session user	*	*		*	*	
set aggregate	*	*		*	*	
set autocommit	*	*		*	*	
set cache	*	*		*	*	
set connection			*			
set cpufactor	*	*		*	*	
set date_format	*	*		*	*	
set ddl_concurrency	*	*		*	*	
set deadlock	*	*		*	*	
set decimal	*	*		*	*	
set flatten	*			*		

Double Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
set global	*					
set hash	*			*		
set io_trace	*	*		*	*	
set j_freesz1	*	*		*	*	
set j_freesz2	*	*		*	*	
set j_freesz3	*	*		*	*	
set j_freesz4	*	*		*	*	
set j_sortbufsz	*	*		*	*	
set jcpufactor	*	*		*	*	
set joinop	*	*		*	*	
set journaling	*	*		*	*	
set lock_trace	*	*		*	*	
set lockmode	*	*		*	*	
set log_trace	*	*		*	*	
set logdbevents	*	*		*	*	
set logging	*	*		*	*	
set maxconnect	*			*		
set maxcost	*	*		*	*	
set maxcpu	*	*		*	*	
set maxidle	*			*		
set maxio	*	*		*	*	
set maxpage	*	*		*	*	
set maxquery	*	*		*	*	
set maxrow	*	*		*	*	
set money_format	*	*		*	*	
set money_prec	*	*		*	*	
set nodeadlock	*	*		*	*	
set noflatten	*			*		
set nohash	*					

Double Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
set noio_trace	*	*		*	*	
set nojoinop	*	*		*	*	
set nojournaling	*	*		*	*	
set nolock_trace	*	*		*	*	
set nolog_trace	*	*		*	*	
set nologdbevents	*	*		*	*	
set nologging	*	*		*	*	
set nomaxconnect	*			*		
set nomaxcost	*	*		*	*	
set nomaxcpu	*	*		*	*	
set nomaxidle	*			*		
set nomaxio	*	*		*	*	
set nomaxpage	*	*		*	*	
set nomaxquery	*	*		*	*	
set nomaxrow	*	*		*	*	
set noojflatten	*					
set nooptimizeonly	*	*		*	*	
set noparallel	*					
set noprintdbevents	*	*		*	*	
set noprintqry	*	*		*	*	
set nopintrules	*	*		*	*	
set noqep	*	*		*	*	
set norowlabel_visible	*					
set norules	*	*		*	*	
set nosql	*	*		*	*	
set nostatistics	*	*		*	*	
set notrace	*	*		*	*	
set nounicode_substitution	*					
set offlatten	*					
set optimizeonly	*	*		*	*	

Double Keyword	SQL			QUEL		
	ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
set parallel	*					
set printdbevents	*	*		*	*	
set printqry	*	*		*	*	
set printrules	*					
set qbufsize	*	*		*	*	
set qp	*	*		*	*	
set query_size	*	*		*	*	
set random_seed	*			*		
set result_structure	*	*		*	*	
set ret_into	*	*		*	*	
set role	*					
set rowlabel_visible	*					
set rules	*	*		*	*	
set session	*	*		*	*	
set sortbufsize	*	*		*	*	
set sql	*	*		*	*	
set statistics	*	*		*	*	
set trace	*	*		*	*	
set unicode_substitution	*					
set update_rowcount	*			*		
set work	*	*		*	*	
system user	*	*		*	*	
to group	*	*		*	*	
to role	*	*		*	*	
to user	*	*		*	*	
user authorization	*	*		*	*	
with null	*	*		*	*	
with short_remark	*	*		*	*	

ANSI/ISO SQL Keywords

The following keywords are ANSI/ISO standard keywords that are not currently reserved in SQL or embedded SQL. You may want to treat these as reserved words to ensure compatibility with other implementations of SQL.

absolute	decimal	lower
action	deferrable	match
allocate	deferred	minute
alter	desc	module
are	diagnostics	month
asc	domain	names
assertion	double	national
bit	else	nchar
bit_length	except	no
both	exception	nullif
cascaded	exec	numeric
case	external	octet_length
cast	extract	only
catalog	false	option
char	first	outer
character	float	output
char_length	found	overlaps
character_length	get	pad
coalesce	go	partial
collate	hour	position
collation	identity	precision
connection	initially	prior
constraints	input	privileges
convert	insensitive	read
corresponding	int	real
cross	integer	relative
current_date	intersects	second
current_time	interval	size
current_timestamp	isolation	smallint
date	language	space
day	last	sql
deallocate	leading	sqlcode
dec	level	sqlerror

substring	translate	varchar
then	translation	varying
time	trim	work
timestamp	true	write
timezone_hour	unknown	year
timezone_minute	upper	zone
trailing	usage	
transaction	value	

Appendix B: Terminal Monitors

The terminal monitors let you interactively enter, edit, and execute individual queries or files containing queries. The terminal monitor also let you execute operating system level commands.

There are two versions of the terminal monitor:

- Forms-based
- Line-based

This chapter describes the line-based version, and includes instructions on how to invoke the Terminal Monitor and issue queries interactively.

For information about the forms-based version of the Terminal Monitor, see the *Character-based Querying and Reporting Tools User Guide*.

Accessing the Terminal Monitor

To access the line-based Terminal Monitor, type this command at the operating system prompt:

```
sql [flags]
```

The sql command accepts a variety of flags that define how the Terminal Monitor and the DBMS Server behave during your session. For details about these flags, see the sql command description in the *Command Reference Guide*.

The following table lists some useful flags:

Flag	Description
-a	Disables the autoclear function. This means that the query buffer is never automatically cleared. It is as if you inserted the \append command after every \go. This flag requires you to explicitly clear the query buffer using \reset after every query.
-d	Turns off display of the dayfile (the text file that is displayed when the Terminal Monitor is invoked).
-s	Suppresses status messages. All messages except error messages are turned off, including login and logout messages, the dayfile, and prompts. This flag is useful for executing queries redirected from files.

The Query Buffer

In the Terminal Monitor, each query that you type is placed in a query buffer, rather than executed immediately. The queries are executed when you type the execution command (\go or \g). The results, by default, appear on your terminal. For example, assume that you have a table called employee that lists all employees in your company. To see a list of those employees who live in a particular city (cityA), you could enter the following statement:

```
select name from employee where city='cityA'  
\g
```

The query is placed in the query buffer and executed when you enter \g. The returned rows display on your terminal.

Several other operations can also be performed on the query buffer. You can:

- Edit the contents.
- Print the contents.
- Write the contents to another file.

After a \go command, the query buffer is cleared if another query is typed unless a command that affects the query buffer is typed first. Commands that retain the query buffer contents are:

```
\append      or      \a  
\edit      or      \e  
\print      or      \p  
\bell  
\nobell
```

For example, typing:

```
help parts  
\go  
select * from parts
```

results in the query buffer containing:

```
select * from parts
```

whereas, typing:

```
help parts  
\go  
\print  
select * from parts
```

results in the query buffer containing:

```
help parts  
select * from parts
```

This feature can be overridden by executing the `\append` command before executing the `\go` command or by specifying the `-a` flag when issuing the `sql` command to begin your session.

Terminal Monitor Commands

The Terminal Monitor commands allow you to manipulate the contents of the query buffer or your environment. Unlike the OpenSQL statements that you type into the Terminal Monitor, Terminal Monitor commands are executed as soon as the Return key is pressed.

All of the Terminal Monitor commands must be preceded with a backslash (`\`). To enter a backslash literally, you must enclose it in quotes. For example, the following statement inserts a backslash into the Test table:

```
insert into test values('\'')\g
```

Some Terminal Monitor commands accept a file name as an argument. These commands must appear alone on a single line. The Terminal Monitor interprets all characters appearing on the line after such commands as a file name. Those Terminal Monitor commands that do not accept arguments can be stacked on a single line. For example:

```
\date\go\date
```

returns the date and time before and after execution of the current query buffer.

The Terminal Monitor commands are shown in the following table:

Command	Description
<code>\r</code> or <code>\reset</code>	Erase the entire query (reset the query buffer). The former contents of the buffer are lost and cannot be retrieved.
<code>\p</code> or <code>\print</code>	Print the current query. The contents of the buffer are printed on the user terminal.
<code>\e</code> or <code>\ed</code> or <code>\edit</code> or <code>\editor [filename]</code>	Enter the text editor of the operating system (designated by the startup file). Use the appropriate editor exit command to return to the Terminal Monitor. If no file name is given, the current contents of the query buffer are sent to the editor, and upon return, the query buffer is replaced with the edited query. If a file name is given, the query buffer is written to that file. On exit from the editor, the file contains the edited query, but the query buffer remains unchanged. ■

Windows

UNIX

VMS	Command	Description
	\edit	Enter the text editor (see the VAX EDT Editor manual). Use the EDT command exit or the sequence of commands, write followed by quit, to return to the Terminal Monitor. If no file name is given, the current contents of the query buffer are sent to the editor, and upon return, the query buffer is replaced with the edited query. If a file name is given, the query buffer is written to that file, and on exit from the editor, the file contains the edited query, but the workspace remains unchanged. ■
	\g or \go	Process the current query. The contents of the buffer are transmitted to the DBMS and run.
	\time or \date	Print the current time and date.
	\a or \append	Append to the query buffer. Typing \append after completion of a query overrides the auto-clear feature and guarantees that the query buffer will not be reset until executed again.
UNIX	\s or \sh or \shell	Escape to the UNIX shell (command line interpreter). Pressing Ctrl+D exits the shell and returns you to the Terminal Monitor. ■
VMS		Escape to the command line interpreter to execute VMS commands. The VAX command line interpreter (DCL) is initiated. Subsequently, typing the logout command exits DCL and returns you to the Terminal Monitor. ■
	\q or \quit	Exit the Terminal Monitor.
	\cd or \chdir <i>dir_name</i>	Change the working directory of the monitor to the named directory.
	\i or \include or \read <i>filename</i>	Read the named file into the query buffer. Backslash characters in the file are processed as they are read.
	\w or \write <i>filename</i>	Write the contents of the query buffer to the named file.

Command	Description
\script [filename]	Write/stop writing the subsequent SQL statements and their results to the specified file. If no file name is supplied with the \script command, output is logged to a file called script.ing in the current directory. The \script command toggles between logging and not logging your session to a file. If you supply a file name on the \script command that terminates logging to a file, the file name is ignored.
	Use this command to save result tables from SQL statements for output. The \script command in no way impedes the terminal output of your session.
\bell and \nobell	Tell the Terminal Monitor to include (\bell) or not to include (\nobell) a bell (that is, Ctrl+G) with the continue or go prompt. The default is \nobell.
\[no]continue	Tell the Terminal Monitor to continue statement processing on error or not to continue (nocontinue). In either case, the error message displays. The command can be abbreviated to \co (continue) or \noco (\nocontinue). The default action is to continue. This command can be used to change that behavior. You can also change the default by setting II_TM_ON_ERROR. For information about II_TM_ON_ERROR, see the <i>System Administrator Guide</i> .

Messages and Prompts

The Terminal Monitor has a variety of messages to keep you informed of its status and that of the query buffer.

When you log in, the Terminal Monitor prints a login message that tells the version number and the login time. Following that message, the dayfile appears.

When the Terminal Monitor is ready to accept input and the query buffer is empty, the message go appears. The message, continue, appears instead, if there is something in the query buffer.

The prompt, >>editor, indicates that you are in the text editor.

Character Input and Output

When you input non-printable ASCII characters through the Terminal Monitor, the Terminal Monitor maps these characters to blanks. Whenever this occurs, the Terminal Monitor displays the message:

Non-printing character nnn converted to blank

where *nnn* is replaced with the actual character. For example, if you enter the statement:

```
insert into test values('^La')
```

the Terminal Monitor converts the ^L to a blank before sending it to the DBMS and displays the message described above.

To insert non-printing data into a char or varchar field, specify the data as a hexadecimal value. For example:

```
insert into test values (x'07');
```

This feature can be used to insert a newline character into a column:

```
insert into test values ('Hello world'+x'0a');
```

This statement inserts 'Hello world\n' into the test table.

On output, if the data type is char or varchar, any binary data are shown as octal numbers (\000, \035, and so on.). To avoid ambiguity, any backslashes present in data of the char or varchar type are displayed as double backslashes. For example, if you insert the following into the "test" table:

```
insert into test values('\aa')
```

when you retrieve that value, you will see:

```
\\\aa
```

Help

The Help statement provides information about a variety of OpenSQL statements and features. For a complete list of help options, see Help in the chapter "OpenSQL Statements."

Aborting the Editor (VMS only)

VMS

Do not type Ctrl+Y and Ctrl+C while you are escaped to an editor (unless the editor assigns its own meaning to Ctrl+C) or VMS. VMS does not properly signal these events to the initiating process. ■

Appendix C: Generic Error Codes

This appendix lists Ingres generic error codes and maps generic errors to SQLSTATE values. Error code mapping works as follows:

- **Proprietary error codes** - Each host DBMS returns a set of proprietary error codes. These error codes are unique to the DBMS and therefore not useful for developing portable applications. Enterprise Access products map proprietary error codes to generic error codes. This is a many-to-one mapping: many proprietary error codes may map to a single generic error code. For details about proprietary error codes, see your host DBMS documentation.
- **Generic error codes** - Enterprise Access products return a consistent set of errors. To enable your application to interact with different host DBMS (through Enterprise Access products), your applications should check generic error codes.
- **SQLSTATE** - SQLSTATE is the ANSI standard error variable. If you are developing ANSI-compliant **applications**, your application should check SQLSTATE. The mapping of generic errors to the SQLSTATE is many-to-one: many generic errors may map to a single SQLSTATE value.

SQLSTATE Values

The following table lists the values returned in SQLSTATE. An asterisk in the "OpenSQL Only?" column indicates that the value is not part of the basic set of values prescribed by ANSI, but rather a value that ANSI permits the DBMS vendor to define:

SQLSTATE	OpenSQL Only?	Description
00000		Successful completion
01000		Warning
01001		Cursor operation conflict
01002		Disconnect error
01003		Null value eliminated in set function
01004		String data, right truncation
01005		Insufficient item descriptor areas
01006		Privilege not revoked

SQLSTATE	OpenSQL Only?	Description
01007		Privilege not granted
01008		Implicit zero-bit padding
01009		Search condition too long for information schema
0100A		Query expression too long for information schema
01500	*	LDB table not dropped
01501	*	DSQL UPDATE or DELETE will affect entire table
02000		No data
07000		Dynamic SQL error
07001		Using clause does not match dynamic parameter specification
07002		Using clause does not match target specification
07003		Cursor specification cannot be executed
07004		Using clause required for dynamic parameters
07005		Prepared statement not a cursor specification
07006		Restricted data type attribute violation
07007		Using clause required for result fields
07008		Invalid descriptor count
07009		Invalid descriptor index
07500	*	Context mismatch
08000		Connection exception
08001		SQL-client unable to establish SQL-connection
08002		Connection name in use
08003		Connection does not exist
08004		SQL-server rejected establishment of SQL-connection
08006		Connection failure
08007		Transaction resolution unknown
08500	*	LDB is unavailable
0A000		Feature not supported

SQLSTATE	OpenSQL Only?	Description
0A001		Multiple server transactions
0A500	*	Valid query language
21000		Cardinality violation
22001		String data, right truncation
22002		Null value, no indicator parameter
22003		Numeric value out of range
22005		Error in assignment
22007		Invalid datetime format
22008		Datetime field overflow
22009		Invalid time zone displacement value
22011		Substring error
22012		Division by zero
22015		Interval field overflow
22018		Invalid character value for cast
22019		Invalid escape character
22021		Character not in repertoire
22022		Indicator overflow
22023		Invalid parameter value
22024		Unterminated C string
22025		Invalid escape sequence
22026		String data, length mismatch
22027		Trim error
22500	*	Invalid data type
23000		Integrity constraint violation
24000		Invalid cursor state
25000		Invalid transaction state
26000		Invalid SQL statement name
27000		Triggered data change violation
28000		Invalid authorization specification
2A000		Syntax error or access rule violation in direct

SQLSTATE	OpenSQL Only?	Description
SQL statement		
2A500	*	Table not found
2A501	*	Column not found
2A502	*	Duplicate object name
2A503	*	Insufficient privilege
2A504	*	Cursor not found
2A505	*	Object not found
2A506	*	Invalid identifier
2A507	*	Reserved identifier
2B000		Dependent privilege descriptors still exist
2C000		Invalid character set name
2D000		Invalid transaction termination
2E000		Invalid connection name
33000		Invalid SQL descriptor name
34000		Invalid cursor name
35000		Invalid condition number
37000		Syntax error or access rule violation in SQL dynamic statement
37500	*	Table not found
37501	*	Column not found
37502	*	Duplicate object name
37503	*	Insufficient privilege
37504	*	Cursor not found
37505	*	Object not found
37506	*	Invalid identifier
37507	*	Reserved identifier
3C000		Ambiguous cursor name
3D000		Invalid catalog name
3F000		Invalid schema name
40000		Transaction rollback

SQLSTATE	OpenSQL Only?	Description
40001		Serialization failure
40002		Integrity constraint violation
40003		Statement completion unknown
42000		Syntax error or access rule violation
42500	*	Table not found
42501	*	Column not found
42502	*	Duplicate object name
42503	*	Insufficient privilege
42504	*	Cursor not found
42505	*	Object not found
42506	*	Invalid identifier
42507	*	Reserved identifier
44000		With check option violation
50000	*	Miscellaneous Ingres-specific errors
50001	*	Invalid duplicate row
50002	*	Limit has been exceeded
50003	*	Resource exhausted
50004	*	System configuration error
50005	*	Enterprise Access product-related error
50006	*	Fatal error
50007	*	Invalid SQL statement ID
50008	*	Unsupported statement
50009	*	Database procedure error raised
5000A	*	Query error
5000B	*	Internal error
5000D	*	Invalid cursor name
5000E	*	Duplicate SQL statement ID
5000F	*	Textual information
5000G	*	Database procedure message
5000H	*	Unknown/unavailable resource

SQLSTATE	OpenSQL Only?	Description
5000I	*	Unexpected LDB schema change
5000J	*	Inconsistent DBMS catalog
5000K	*	SQLSTATE status code unavailable
5000L	*	Protocol error
5000M	*	IPC error
HZ000		Remote Database Access

Generic Error Codes

Generic error codes are error codes that map to DBMS-specific errors returned by Ingres and by the DBMS that you access through Enterprise Access products. If your application interacts with more than one type of DBMS, it should check generic errors in order to remain portable. This table lists generic error codes:

Generic Error Code	Message	Explanation
+00050	Warning message	The request was successfully completed, but a warning was issued.
+00100	No more data	A request for data was processed, but either no data or no more data fitting the requested characteristics was found.
00000	Successful completion	The request completed normally with no errors or unexpected conditions occurring.
-00001 to -29999	Reserved	These values are reserved for warning messages.
-30100	Table not found	A table referenced in a statement doesn't exist or is owned by another user. This error may also be returned concerning an index or a view.
-30110	Column not known or not in table	A column referenced in a statement could not be found.
-30120	Unknown cursor	An invalid or unopened cursor name or identifier was specified or referenced in a statement.

Generic Error Code	Message	Explanation
-30130	Other database object not found	A database object other than a table, view, index, column or cursor was specified or referenced in a statement, but could not be identified or located. This might apply to a database procedure, a grant or permission, a rule, or other object.
-30140	Other unknown or unavailable resource	A resource, of a type other than one mentioned above, is either not known or unavailable for the request.
-30200	Duplicate resource definition	An attempt to define a database object (such as a table) was made, but the object already exists.
-30210	Invalid attempt to insert duplicate row	A request to insert a row was refused; the table will not accept duplicates, or there is a unique index defined on the table.
-31000	Statement syntax error	The statement just processed had a syntax error.
-31100	Invalid identifier	An identifier, such as a table name, cursor name or identifier, procedure name, was invalid. It may have contained incorrect characters or been too long.
-31200	Unsupported query language	A request to use an unrecognized or unsupported query language was made.
-32000	Inconsistent or incorrect query specification	A query, while syntactically correct, was logically inconsistent, conflicting or otherwise incorrect.
-33000	Runtime logical error	An error occurred at runtime. An incorrect specification was made, an incorrect host variable value or type was specified or some other error not detected until runtime was found.
-34000	Not privileged/restricted operation	An operation was rejected because the user did not have appropriate permission or privileges to perform the operation, or the operation was restricted (for example, to a certain time of day) and the operation was requested at the wrong time or in the wrong mode.

Generic Error Code	Message	Explanation
-36000	System limit exceeded	A system limit was exceeded during query processing, for example, number of columns, size of a table, row length, or number of tables in a query.
-36100	Out of needed resource	The system exhausted, or did not have enough of, a resource such as memory or temporary disk space required to complete the query.
-36200	System configuration error	An error in the configuration of the system was detected.
-37000	Communication/ transmission error	The connection between the DBMS and the client failed.
-38000	Error in the Enterprise Access product	An error occurred in an Enterprise Access product or DBMS interface.
-38100	Host system error	An error occurred in the host system.
-39000	Fatal error - session terminated	A severe error occurred that terminated the session with the DBMS or the client.
-39100	Unmappable error	An error occurred that is not mapped to a generic error.
-40100	Cardinality violation	A request tried to return more or fewer rows than allowed. This usually occurs when a singleton select request returns more than one row, or when a nested subquery returns an incorrect number of rows.
-402dd	Data exception	A data handling error occurred. The subcode <i>dd</i> defines the type of error.
-40300	Constraint violation	A DBMS constraint, such as a referential integrity or the CHECK option on a view was violated. The request was rejected.
-40400	Invalid cursor state	An invalid cursor operation was requested; for example, an update request was issued for a read-only cursor.

Generic Error Code	Message	Explanation
-40500	Invalid transaction state	A request was made that was invalid in the current transaction state; for example, an update request was issued in a read-only transaction, or a request was issued improperly in or out of a transaction.
-40600	Invalid SQL statement identifier	An identifier for an SQL statement, such as a repeat query name, was invalid.
-40700	Triggered data change violation	A change requested by a cascaded referential integrity change was invalid.
-41000	Invalid user authorization identifier	An authorization identifier, usually a user name, was invalid.
-41200	Invalid SQL statement	Unlike generic error -31000 (statement syntax error), this was a recognized statement that is either currently invalid or unsupported.
-41500	Duplicate SQL statement identifier	An identifier for an SQL statement, such as a repeat query name, was already active or known.
-49900	Serialization failure (Deadlock)	An error occurred that caused the query to be rejected. The transaction may have been rolled back (check SQLWARN6 in the SQLCA structure). The query or transaction can be resubmitted; the error was a timeout, deadlock, forced abort, log file full, or other error that Ingres resolved by aborting the query or transaction.

Generic Error Data Exception Subcodes

The following table lists subcodes returned with generic error -402 (generic errors -40200 through -40299):

Subcode	Description
00	No subcode
01	Character data truncated from right
02	Null value, no indicator variable specified

Subcode	Description
03	Exact numeric data, loss of significance (decimal overflow)
04	Error in assignment
05	Fetch orientation has value of zero
06	Invalid date or time format
07	Date/time field overflow
08	Reserved
09	Invalid indicator variable value
10	Invalid cursor name
15	Invalid data type
20	Fixed-point overflow
21	Exponent overflow
22	Fixed-point divide
23	Floating-point divide
24	Decimal divide
25	Fixed-point underflow
26	Floating-point underflow
27	Decimal underflow
28	Other unspecified math exception
99	Maximum legal subcode

SQLSTATE and Equivalent Generic Errors

SQLSTATE is the ANSI/ISO Entry SQL-92-compliant method for returning errors to applications. The following table lists the correspondence between SQLSTATE values and generic errors:

SQLSTATE	Generic Error
00000	E_GEO0000_OK
01000	E_GEO032_WARNING
01001	E_GEO032_WARNING
01002	E_GEO032_WARNING

SQLSTATE	Generic Error
01003	E_GEO032_WARNING
01004	E_GEO032_WARNING
01005	E_GEO032_WARNING
01006	E_GEO032_WARNING
01007	E_GEO032_WARNING
01008	E_GEO032_WARNING
01009	E_GEO032_WARNING
0100A	E_GEO032_WARNING
01500	E_GEO032_WARNING
01501	E_GEO032_WARNING
02000	E_GEO064_NO_MORE_DATA
07000	E_GE7D00_QUERY_ERROR
07001	E_GE7D00_QUERY_ERROR
07002	E_GE7D00_QUERY_ERROR
07003	E_GE7D00_QUERY_ERROR
07004	E_GE7D00_QUERY_ERROR
07005	E_GE7D00_QUERY_ERROR
07006	E_GE7D00_QUERY_ERROR
07007	E_GE7D00_QUERY_ERROR
07008	E_GE7D00_QUERY_ERROR
07009	E_GE7D00_QUERY_ERROR
07500	E_GE98BC_OTHER_ERROR
08000	E_GE98BC_OTHER_ERROR
08001	E_GE98BC_OTHER_ERROR
08002	E_GE80E8_LOGICAL_ERROR
08003	E_GE80E8_LOGICAL_ERROR
08004	E_GE94D4_HOST_ERROR
08006	E_GE9088_COMM_ERROR
08007	E_GE9088_COMM_ERROR
08500	E_GE75BC_UNKNOWN_OBJECT

SQLSTATE	Generic Error
0A000	E_GE98BC_OTHER_ERROR
0A001	E_GE98BC_OTHER_ERROR
0A500	E_GE79E0_UNSUP_LANGUAGE
21000	E_GE9CA4_CARDINALITY
22000	E_GE9D08_DATAEX_NOSUB
22001	E_GE9D09_DATAEX_TRUNC
22002	E_GE9D0A_DATAEX_NEED_IND
22003	E_GE9D0B_DATAEX_NUMOVR
22003	E_GE9D1C_DATAEX_FIXOVR
22003	E_GE9D1D_DATAEX_EXPOVR
22003	E_GE9D21_DATAEX_FXPUNF
22003	E_GE9D22_DATAEX_EPUNF
22003	E_GE9D23_DATAEX_DECUNF
22003	E_GE9D24_DATAEX_OTHER
22005	E_GE9D0C_DATAEX_AGN
22007	E_GE9D0F_DATAEX_DATEOVR
22008	E_GE9D0E_DATAEX_DTINV
22009	E_GE9D0F_DATAEX_DATEOVR
22011	E_GE80E8_LOGICAL_ERROR
22012	E_GE9D1E_DATAEX_FPDIV
22012	E_GE9D1F_DATAEX_FLTDIV
22012	E_GE9D20_DATAEX_DCDIV
22012	E_GE9D24_DATAEX_OTHER
22015	E_GE9D0F_DATAEX_DATEOVR
22018	E_GE7918_SYNTAX_ERROR
22019	E_GE7918_SYNTAX_ERROR
22021	E_GE9D08_DATAEX_NOSUB
22022	E_GE9D11_DATAEX_INVIND
22023	E_GE9D08_DATAEX_NOSUB
22024	E_GE98BC_OTHER_ERROR

SQLSTATE	Generic Error
22025	E_GE7918_SYNTAX_ERROR
22026	E_GE9D08_DATAEX_NOSUB
22027	E_GE7918_SYNTAX_ERROR
22500	E_GE9D17_DATAEX_TYPEINV
23000	E_GE9D6C_CONSTR_VIO
24000	E_GE9DD0_CUR_STATE_INV
25000	E_GE9E34_TRAN_STATE_INV
26000	E_GE75B2_NOT_FOUND
27000	E_GE9EFC_TRIGGER_DATA
28000	E_GEA028_USER_ID_INV
2A000	E_GE7918_SYNTAX_ERROR
2A500	E_GE7594_TABLE_NOT_FOUND
2A501	E_GE759E_COLUMN_UNKNOWN
2A502	E_GE75F8_DEF_RESOURCE
2A503	E_GE84D0_NO_PRIVILEGE
2A504	E_GE75A8_CURSOR_UNKNOWN
2A505	E_GE75B2_NOT_FOUND
2A506	E_GE797C_INVALID_IDENT
2A507	E_GE797C_INVALID_IDENT
2B000	E_GE7D00_QUERY_ERROR
2C000	E_GE7918_SYNTAX_ERROR
2D000	E_GE9E34_TRAN_STATE_INV
2E000	E_GE797C_INVALID_IDENT
33000	E_GE75BC_UNKNOWN_OBJECT
34000	E_GE75A8_CURSOR_UNKNOWN
35000	E_GE7D00_QUERY_ERROR
37000	E_GE7918_SYNTAX_ERROR
37500	E_GE7594_TABLE_NOT_FOUND
37501	E_GE759E_COLUMN_UNKNOWN
37502	E_GE75F8_DEF_RESOURCE

SQLSTATE	Generic Error
37503	E_GE84D0_NO_PRIVILEGE
37504	E_GE75A8_CURSOR_UNKNOWN
37505	E_GE75B2_NOT_FOUND
37506	E_GE797C_INVALID_IDENT
37507	E_GE797C_INVALID_IDENT
3C000	E_GE9DD0_CUR_STATE_INV
3D000	E_GE98BC_OTHER_ERROR
3F000	E_GE797C_INVALID_IDENT
40000	E_GE98BC_OTHER_ERROR
40001	E_GEC2EC_SERIALIZATION
40002	E_GE9D6C_CONSTR_VIO
40003	E_GE9088_COMM_ERROR
42000	E_GE7918_SYNTAX_ERROR
42500	E_GE7594_TABLE_NOT_FOUND
42501	E_GE759E_COLUMN_UNKNOWN
42502	E_GE75F8_DEF_RESOURCE
42503	E_GE84D0_NO_PRIVILEGE
42504	E_GE75A8_CURSOR_UNKNOWN
42505	E_GE75B2_NOT_FOUND
42506	E_GE797C_INVALID_IDENT
42507	E_GE797C_INVALID_IDENT
44000	E_GE7D00_QUERY_ERROR
50000	E_GE98BC_OTHER_ERROR
50001	E_GE7602_INS_DUP_ROW
50002	E_GE8CA0_SYSTEM_LIMIT
50003	E_GE8D04_NO_RESOURCE
50004	E_GE8D68_CONFIG_ERROR
50005	E_GE9470_GATEWAY_ERROR
50006	E_GE9858_FATAL_ERROR
50007	E_GE9E98_INV_SQL_STMT_ID

SQLSTATE	Generic Error
50008	E_GEA0F0_SQL_STMT_INV
50009	E_GEA154_RAISE_ERROR
5000A	E_GE7D00_QUERY_ERROR
5000B	E_GE98BC_OTHER_ERROR
5000C	E_GE9D0D_DATAEX_FETCH0
5000D	E_GE9D12_DATAEX_CURSINV
5000E	E_GEA21C_DUP_SQL_STMT_ID
5000F	E_GE98BC_OTHER_ERROR
5000H	E_GE75BC_UNKNOWN_OBJECT
5000I	E_GE98BC_OTHER_ERROR
5000J	E_GE98BC_OTHER_ERROR
5000K	E_GE98BC_OTHER_ERROR
5000L	E_GE9088_COMM_ERROR
5000M	E_GE9088_COMM_ERROR
HZ000	E_GE9088_COMM_ERROR

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