

IBM i  
7.5

*Database  
Embedded SQL programming*



**Note**

Before using this information and the product it supports, read the information in [“Notices” on page 199](#).

This edition applies to IBM i 7.5 (product number 5770-SS1) and to all subsequent releases and modifications until otherwise indicated in new editions. This version does not run on all reduced instruction set computer (RISC) models nor does it run on CISC models.

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# Embedded SQL programming

This topic collection explains how to create database applications in host languages that use Db2® for i SQL statements and functions.

**Note:** By using the code examples, you agree to the terms of the [“Code license and disclaimer information”](#) on page 198.

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## What's new for IBM i 7.5

Read about new or significantly changed information for the Embedded SQL programming topic collection.

- The ILE C and C++, ILE COBOL, and ILE RPG precompilers support the SQL Boolean data type.

### What's new since IBM i 7.4

- The WHENEVER statement has been extended to allow a call to a host language routine to handle SQL errors and warnings. [“Handling exception conditions with the WHENEVER statement”](#) on page 10
- The ILE precompilers support IFS source in UTF-8 (CCSID 1208). [“Source file CCSIDs in the SQL precompiler”](#) on page 147
- The ILE precompilers support the DBGVIEW(\*STMT) and DBGVIEW(\*LIST) options. [“Compiling an ILE application program that uses SQL”](#) on page 153

### How to see what's new or changed

To help you see where technical changes have been made, this information uses:

- The  image to mark where new or changed information begins.
- The  image to mark where new or changed information ends.

In PDF files, you might see revision bars (|) in the left margin of new and changed information.

To find other information about what's new or changed this release, see the [Memo to users](#).

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### Related reference

[Related information for Embedded SQL programming](#)

Product manuals and other information center topic collections contain information that relates to the Embedded SQL programming topic collection. You can view or print any of the PDF files.

## Common concepts and rules for using embedded SQL

---

Here are some common concepts and rules for using SQL statements in a host language.

### Writing applications that use SQL

You can create database applications in host languages that use Db2 for i SQL statements and functions.

To use embedded SQL, you must have the licensed program IBM® Db2 Query Manager and SQL Development Kit for i installed. Additionally, you must have the compilers for the host languages you want to use installed.

#### Related concepts

##### [Coding SQL statements in C and C++ applications](#)

To embed SQL statements in an ILE C or C++ program, you need to be aware of some unique application and coding requirements. This topic also defines the requirements for host structures and host variables.

##### [Coding SQL statements in COBOL applications](#)

There are unique application and coding requirements for embedding SQL statements in a COBOL program. In this topic, requirements for host structures and host variables are defined.

##### [Coding SQL statements in PL/I applications](#)

There are some unique application and coding requirements for embedding SQL statements in a PL/I program. In this topic, requirements for host structures and host variables are defined.

##### [Coding SQL statements in RPG/400 applications](#)

The RPG/400 licensed program supports both RPG II and RPG III programs.

##### [Coding SQL statements in ILE RPG applications](#)

You need to be aware of the unique application and coding requirements for embedding SQL statements in an ILE RPG program. In this topic, the coding requirements for host variables are defined.

##### [Coding SQL statements in REXX applications](#)

REXX procedures do not have to be preprocessed. At run time, the REXX interpreter passes statements that it does not understand to the current active command environment for processing.

##### [Preparing and running a program with SQL statements](#)

This topic describes some of the tasks for preparing and running an application program.

##### [IBM Developer Kit for Java](#)

### Using host variables in SQL statements

When your program retrieves data, the values are put into data items that are defined by your program and that are specified with the INTO clause of a SELECT INTO or FETCH statement. The data items are called host variables.

A *host variable* is a field in your program that is specified in an SQL statement, usually as the source or target for the value of a column. The host variable and column must have compatible data types. Host variables cannot be used to identify SQL objects, such as tables or views, except in the DESCRIBE TABLE statement.

A *host structure* is a group of host variables used as the source or target for a set of selected values (for example, the set of values for the columns of a row). A *host structure array* is an array of host structures that is used in the multiple-row FETCH and blocked INSERT statements.

**Note:** By using a host variable instead of a literal value in an SQL statement, you give the application program the flexibility to process different rows in a table or view.

For example, instead of coding an actual department number in a WHERE clause, you can use a host variable set to the department number you are currently interested in.

Host variables are commonly used in SQL statements in these ways:

- **In a WHERE clause:** You can use a host variable to specify a value in the predicate of a search condition, or to replace a literal value in an expression. For example, if you have defined a field called EMPID that contains an employee number, you can retrieve the name of the employee whose number is 000110 with:

```
MOVE '000110' TO EMPID.  
EXEC SQL  
  SELECT LASTNAME  
  INTO :PGM-LASTNAME  
  FROM CORPDATA.EMPLOYEE  
  WHERE EMPNO = :EMPID  
END-EXEC.
```

- **As a receiving area for column values (named in an INTO clause):** You can use a host variable to specify a program data area that is to contain the column values of a retrieved row. The INTO clause names one or more host variables that you want to contain column values returned by SQL. For example, suppose you are retrieving the EMPNO, LASTNAME, and WORKDEPT column values from rows in the CORPDATA.EMPLOYEE table. You could define a host variable in your program to hold each column, then name the host variables with an INTO clause. For example:

```
EXEC SQL  
  SELECT EMPNO, LASTNAME, WORKDEPT  
  INTO :CBLEMPNO, :CBLNAME, :CBLDEPT  
  FROM CORPDATA.EMPLOYEE  
  WHERE EMPNO = :EMPID  
END-EXEC.
```

In this example, the host variable CBLEMPNO receives the value from EMPNO, CBLNAME receives the value from LASTNAME, and CBLDEPT receives the value from WORKDEPT.

- **As a value in a SELECT clause:** When specifying a list of items in the SELECT clause, you are not restricted to the column names of tables and views. Your program can return a set of column values intermixed with host variable values and literal constants. For example:

```
MOVE '000220' TO PERSON.  
EXEC SQL  
  SELECT "A", LASTNAME, SALARY, :RAISE,  
  SALARY + :RAISE  
  INTO :PROCESS, :PERSON-NAME, :EMP-SAL,  
  :EMP-RAISE, :EMP-TTL  
  FROM CORPDATA.EMPLOYEE  
  WHERE EMPNO = :PERSON  
END-EXEC.
```

The results are:

PROCESS	PERSON-NAME	EMP-SAL	EMP-RAISE	EMP-TTL
A	LUTZ	29840	4476	34316

- **As a value in other clauses of an SQL statement:**
  - The SET clause in an UPDATE statement
  - The VALUES clause in an INSERT statement
  - The CALL statement

### Related concepts

[Db2 for i SQL reference](#)

## Assignment rules for host variables in SQL statements

SQL values are assigned to host variables during the running of FETCH, SELECT INTO, SET, and VALUES INTO statements. SQL values are assigned from host variables during the running of INSERT, UPDATE, and CALL statements.

All assignment operations observe the following rules:

- Numbers and strings are compatible:
  - Numbers can be assigned to character or graphic string columns or host variables.
  - Character and graphic strings can be assigned to numeric columns or numeric host variables.
- All character and DBCS graphic strings are compatible with UCS-2 and UTF-16 graphic columns if conversion is supported between the CCSIDs. All graphic strings are compatible if the CCSIDs are compatible. All numeric values are compatible. Conversions are performed by SQL whenever necessary. All character and DBCS graphic strings are compatible with UCS-2 and UTF-16 graphic columns for assignment operations, if conversion is supported between the CCSIDs. For the CALL statement, character and DBCS graphic parameters are compatible with UCS-2 and UTF-16 parameters if conversion is supported.
- Binary strings are only compatible with binary strings.
- A null value cannot be assigned to a host variable that does not have an associated indicator variable.
- Different types of date/time values are not compatible. Dates are only compatible with dates or string representations of dates; times are only compatible with times or string representations of times; and timestamps are only compatible with timestamps or string representations of timestamps.

### Related concepts

[i5/OS globalization](#)

### Related reference

[DECLARE VARIABLE](#)

[Numeric assignments](#)

[String assignments](#)

[Datetime assignments](#)

## Indicator variables in applications that use SQL

An *indicator variable* is a halfword integer variable used to communicate additional information about its associated host variable.

- If the value for the result column is null, SQL puts a -1 in the indicator variable.
- If you do not use an indicator variable and the result column is a null value, a negative SQLCODE is returned.
- If the value for the result column causes a data mapping error, SQL sets the indicator variable to -2.

You can also use an indicator variable to verify that a retrieved string value has not been truncated. If truncation occurs, the indicator variable contains a positive integer that specifies the original length of the string. If the string represents a large object (LOB), and the original length of the string is greater than 32 767, the value that is stored in the indicator variable is 32 767, because no larger value can be stored in a halfword integer.

Always test the indicator variable first. If the value of the indicator variable is less than zero, you know the value of the result column should not be used. When the database manager returns a null value, the host variable might or might not be set to the default value for the result column's data type (0 for numeric, blanks for fixed length character, etc).

You specify an indicator variable (preceded by a colon) immediately after the host variable. For example:

```
EXEC SQL
  SELECT COUNT(*), AVG(SALARY)
  INTO :PLICNT, :PLISAL:INDNULL
  FROM CORPDATA.EMPLOYEE
  WHERE EDLEVEL < 18
END-EXEC.
```

You can then test INDNULL in your program to see if it contains a negative value. If it does, you know SQL returned a null value (if its value is -1) or a data mapping error (if its value is -2). If the indicator value is not negative, the value returned in PLISAL can be used.

## Related reference

[Predicates](#)

### **Indicator variables used with host structures**

You can specify an *indicator array* (defined as an array of halfword integer variables) to support a host structure.

If the results column values returned to a host structure can be null, you can add an indicator array name after the host structure name. This allows SQL to notify your program about each null value returned to a host variable in the host structure.

For example, in COBOL:

```
01 SAL-REC.
   10 MIN-SAL          PIC S9(6)V99 USAGE COMP-3.
   10 AVG-SAL          PIC S9(6)V99 USAGE COMP-3.
   10 MAX-SAL          PIC S9(6)V99 USAGE COMP-3.
01 SALTABLE.
02 SALIND              PIC S9999 USAGE COMP-4 OCCURS 3 TIMES.
01 EDUC-LEVEL          PIC S9999 COMP-4.

...
MOVE 20 TO EDUC-LEVEL.
...
EXEC SQL
  SELECT MIN(SALARY), AVG(SALARY), MAX(SALARY)
  INTO   :SAL-REC:SALIND
  FROM   CORPDATA.EMPLOYEE
  WHERE  EDLEVEL>:EDUC-LEVEL
END-EXEC.
```

In this example, SALIND is an array that contains three values, each of which can be tested for a negative value. SQL selects the values for the result row and puts them into the host structure. If MIN-SAL is to return a null value, the corresponding indicator variable, SALIND(1), is set to -1. Your program must check the corresponding indicator variables first to determine which, if any, selected result variables contain the null value.

### **Indicator variables used to assign special values**

You can use an indicator variable to set a null value for a column in an INSERT or UPDATE statement. Extended indicator values can be used for OPEN and EXECUTE statements.

## Indicators for insert and update operations

There are two forms of indicators for INSERT and UPDATE statements: normal indicators and extended indicators. When you use normal indicators, an indicator set to any negative value is interpreted as the null value. When you use extended indicators, the negative values have several different meanings. Both forms of indicators can be used for inserts and updates that are part of a MERGE statement as well.

When processing update and insert using normal indicators, SQL checks the indicator variable (if it exists). If it contains a negative value, the column value is set to null. If it contains a value greater than -1, the column is set from the associated host variable value.

For example, you can specify a host variable to update a column, but you know that an actual value is not always known. To provide the capability to set a column to a null value, you can write the following statement:

```
EXEC SQL
  UPDATE CORPDATA.EMPLOYEE
  SET   PHONENO = :NEWPHONE:PHONEIND
  WHERE EMPNO = :EMPID
END-EXEC.
```

When NEWPHONE contains a non-null value, set PHONEIND to zero; otherwise, to tell SQL that NEWPHONE contains a null value, set PHONEIND to a negative value.

Using extended indicators provides your application with more flexibility when writing INSERT and UPDATE statements. In addition to providing the null value, you can set an indicator to indicate that the default value for a column is used or that the corresponding column is not updated at all.

For extended indicators, the indicator values are interpreted as follows:

- An indicator value of 0 means the value for the host variable is assigned to the column.
- An indicator value of -1, -2, -3, -4, or -6 means the null value is assigned to the column.
- An indicator value of -5 means the default value for the column is assigned.
- An indicator value of -7 means that the column is not assigned. This value causes the column to be treated as though it were not listed in the insert or update column list. For an INSERT statement it means the default value is used.

An UPDATE statement that can conditionally update several different fields can be written as follows:

```
EXEC SQL
  UPDATE CORPDATA.EMPLOYEE
  SET PHONENO = :NEWPHONE:PHONEIND,
      LASTNAME = :LASTNAME:LASTNAMEIND,
      WORKDEPT = :WORKDEPT:WORKDEPTIND,
      EDLEVEL = :EDLEVEL:EDLEVELIND
  WHERE EMPNO = :EMPID
END-EXEC.
```

With this one UPDATE statement, you can update any or all of the columns listed in the SET clause. For example, if you only want to update the EDLEVEL column, set the EDLEVEL variable to the new value and the EDLEVELIND indicator to 0. Set the other three indicators (PHONEIND, LASTNAMEIND, and WORKDEPTIND) to -7. This causes the statement to be processed as though you had written it this way.

```
EXEC SQL
  UPDATE CORPDATA.EMPLOYEE
  SET EDLEVEL = :EDLEVEL:EDLEVELIND
  WHERE EMPNO = :EMPID
END-EXEC.
```

You can use extended indicators for INSERT, UPDATE, and MERGE statements only if they are explicitly enabled for your program. To specify that your program supports extended indicators, use \*EXTIND on the OPTION parameter of the precompiler command or EXTIND(\*YES) on the SET OPTION statement.

## Indicators for execute and open operations

Extended indicators can be used with EXECUTE and OPEN statements as well. Only the -7 (Unassigned) extended indicator value is recognized. For these statements, the extended indicator value determines whether the corresponding host variable is used for the statement or whether the host variable should be omitted from processing.

For example, an open of a cursor could provide four host variables.

```
EXEC SQL
  OPEN EMPLOYEE_CURSOR
  USING SUBSET :EMPID, :HIREDATE:HIREDATEIND, :WORKDEPT:WORKDEPTIND, :PHONE:PHONEIND
END-EXEC.
```

If the statement that was built dynamically for an instance of this cursor only contains parameter markers for the employee ID and work department, the HIREDATEIND and PHONEIND indicator variables should be set to -7. This would be run as if it were written as the following OPEN statement.

```
EXEC SQL
  OPEN EMPLOYEE_CURSOR
  USING :EMPID, :WORKDEPT:WORKDEPTIND
END-EXEC.
```

## Handling SQL error return codes using the SQLCA

When an SQL statement is processed in your program, SQL places a return code in the SQLCODE and SQLSTATE fields. The return codes indicate the success or failure of the running of your statement.

If SQL encounters an error while processing the statement, the SQLCODE is a negative number and SUBSTR(SQLSTATE,1,2) is not '00', '01', or '02'. If SQL encounters an exception but valid condition while processing your statement, the SQLCODE is a positive number and SUBSTR(SQLSTATE,1,2) is '01' or '02'. If your SQL statement is processed without encountering an error or warning condition, the SQLCODE is zero and the SQLSTATE is '00000'.

**Note:** There are situations when a zero SQLCODE is returned to your program and the result might not be satisfactory. For example, if a value was truncated as a result of running your program, the SQLCODE returned to your program is zero. However, one of the SQL warning flags (SQLWARN1) indicates truncation. In this case, the SQLSTATE is not '00000'.

**Note:** If you do not test for negative SQLCODEs or specify a WHENEVER SQLERROR statement, your program will continue to the next statement. Continuing to run after an error can produce unpredictable results.

The main purpose for SQLSTATE is to provide common return codes for common return conditions among the different IBM relational database systems. SQLSTATES are particularly useful when handling problems with distributed database operations.

Because the SQLCA is a valuable problem-diagnosis tool, it is a good idea to include in your application programs the instructions necessary to display some of the information contained in the SQLCA. Especially important are the following SQLCA fields:

### **SQLCODE**

Return code.

### **SQLSTATE**

Return code.

### **SQLERRD(3)**

The number of rows updated, inserted, or deleted by SQL.

### **SQLWARN0**

If set to W, at least one of the SQL warning flags (SQLWARN1 through SQLWARNA) is set.

### **Related concepts**

[Db2 for i SQL reference](#)

[SQL messages and codes](#)

## Using the SQL diagnostics area

The SQL diagnostics area is used to keep the returned information for an SQL statement that has been run in a program. It contains all the information that is available to you as an application programmer through the SQLCA.

There are additional values available to provide more detailed information about your SQL statement including connection information. More than one condition can be returned from a single SQL statement. The information in the SQL diagnostics area is available for the previous SQL statement until the next SQL statement is run.

To access the information from the diagnostics area, use the GET DIAGNOSTICS statement. In this statement, you can request multiple pieces of information at one time about the previously run SQL statement. Each item is returned in a host variable. You can also request to get a string that contains all the diagnostic information that is available. Running the GET DIAGNOSTICS statement does not clear the diagnostics area.

### **Related reference**

[GET DIAGNOSTICS](#)

## Updating applications to use the SQL diagnostics area

You might consider changing your applications to use the SQL diagnostics area instead of the SQL communication area (SQLCA), because the SQL diagnostics area provides some significant advantages over the SQLCA.

One of the best reasons is that the SQLERRM field in the SQLCA is only 70 bytes in length. This is often insufficient for returning meaningful error information to the calling application. Additional reasons for considering the SQL diagnostics area are multiple row operations, and long column and object names. Reporting even simple warnings is sometimes difficult within the restrictions of the 136 byte SQLCA. Quite often, the returned tokens are truncated to fit the restrictions of the SQLCA.

Current applications include the SQLCA definition by using the following:

```
EXEC SQL INCLUDE SQLCA; /* Existing SQLCA */
```

With the conversion to using the SQL diagnostics area, the application would first declare a stand-alone SQLSTATE variable:

```
char SQLSTATE[6]; /* Stand-alone sqlstate */
```

And possibly a stand-alone SQLCODE variable:

```
long int SQLCODE; /* Stand-alone sqlcode */
```

The completion status of the SQL statement is verified by checking the stand-alone SQLSTATE variable. If upon the completion of the current SQL statement, the application chooses to retrieve diagnostics, the application would run the SQL GET DIAGNOSTICS statement:

```
char hv1[256];  
long int hv2;  
  
EXEC SQL GET DIAGNOSTICS :hv1 = COMMAND_FUNCTION,  
:hv2 = COMMAND_FUNCTION_CODE;
```

## IBM i programming model

In the IBM i Integrated Language Environment® (ILE), the SQL diagnostics area is scoped to a thread and an activation group. This means that for each activation group in which a thread runs SQL statements, a separate diagnostics area exists for the activation.

## Additional notes on using the SQL diagnostics area

In an application program, the SQLCA is replaced with an implicit or a stand-alone SQLSTATE variable, which must be declared in the program.

With multiple condition areas existing in the SQL diagnostics area, the most severe error or warning is returned in the first diagnostics area. There is no specific ordering of the multiple conditions, except that the first diagnostics area will contain the information for the SQLSTATE that is also returned in the SQLSTATE variable.

With the SQLCA, the application program provides the storage for the SQLCA that is used to communicate the results of the run of an SQL statement. With the SQL diagnostics area, the database manager manages the storage for the diagnostics, and the GET DIAGNOSTICS statement is provided to retrieve the contents of the diagnostics area.

Note that the SQLCA will continue to be supported for application programs. Also, the GET DIAGNOSTICS statement can be used in an application program that uses the SQLCA.

## Example: SQL routine exception

In this application example, a stored procedure signals an error when an input value is out of range.

```
EXEC SQL CREATE PROCEDURE check_input (IN p1 INT)
LANGUAGE SQL READS SQL DATA
test: BEGIN
    IF p1 < 0 THEN
        SIGNAL SQLSTATE VALUE '99999'
        SET MESSAGE_TEXT = 'Bad input value';
    END IF;
END test;
```

The calling application checks for a failure and retrieves the information about the failure from the SQL diagnostics area:

```
char SQLSTATE[6]; /* Stand-alone sqlstate */
long int SQLCODE; /* Stand-alone sqlcode */

long int hv1;
char hv2[6];
char hv3[256];

hv1 = -1;
EXEC SQL CALL check_input(:hv1);

if (strncmp(SQLSTATE, "99999", 5) == 0)
{
    EXEC SQL GET DIAGNOSTICS CONDITION 1
        :hv2 = RETURNED_SQLSTATE,
        :hv3 = MESSAGE_TEXT;
}
else
{
}
```

## Example: Logging items from the SQL diagnostics area

In this example, an application needs to log all errors for security reasons. The log can be used to monitor the health of a system or to monitor for inappropriate use of a database.

For each SQL error that occurs, an entry is placed in the log. The entry includes when the error occurred, what user was using the application, what type of SQL statement was run, the returned SQLSTATE value, and the message number and corresponding complete message text.

```
char stmt_command[256];
long int error_count;
long int condition_number;
char auth_id[256];
char error_state[6];
char msgid[128];
char msgtext[1024];

EXEC SQL WHENEVER SQLERROR GOTO error;

(application code)

error:
EXEC SQL GET DIAGNOSTICS :stmt_command = COMMAND_FUNCTION,
                        :error_count = NUMBER;

for (condition_number=1;condition_number<=error_count;++condition_number)
{
    EXEC SQL GET DIAGNOSTICS CONDITION :condition_number
        :auth_id = DB2_AUTHORIZATION_ID,
        :error_state = RETURNED_SQLSTATE,
        :msgid = DB2_MESSAGE_ID,
        :msgtext = DB2_MESSAGE_TEXT;

    EXEC SQL INSERT INTO error_log VALUES(CURRENT_TIMESTAMP,
        :stmt_command,
        :condition_number,
        :auth_id,
        :error_state,
```

```
    :msgid,  
    :msgtext);  
}
```

**Related reference**  
[GET DIAGNOSTICS](#)

## Handling exception conditions with the WHENEVER statement

The WHENEVER statement causes SQL to check the SQLSTATE and SQLCODE and continue processing your program, or branch to another area in your program if an error, exception, or warning exists as a result of running an SQL statement.

An exception condition handling subroutine (part of your program) can then examine the SQLCODE or SQLSTATE field to take an action specific to the error or exception situation.

**Note:** The WHENEVER statement is not allowed in REXX procedures.

The WHENEVER statement allows you to specify what you want to do whenever a general condition is true. You can specify more than one WHENEVER statement for the same condition. When you do this, the first WHENEVER statement applies to all subsequent SQL statements in the source program until another WHENEVER statement is specified.

The WHENEVER statement looks like this:

```
EXEC SQL  
WHENEVER condition action  
END-EXEC.
```

There are three conditions you can specify:

### SQLWARNING

Specify SQLWARNING to indicate what you want done when SQLWARN0 = W or SQLCODE contains a positive value other than 100 or (SUBSTR(SQLSTATE,1,2) = '01').

**Note:** SQLWARN0 could be set for several different reasons. For example, if the value of a column was truncated when it was moved into a host variable, your program might not regard this as an error.

### SQLERROR

Specify SQLERROR to indicate what you want done when an error code is returned as the result of an SQL statement (SQLCODE < 0)

### NOT FOUND

Specify NOT FOUND to indicate what you want done when an SQLCODE of +100 or a SQLSTATE of '02000' is returned because:

- After a single-row SELECT is issued or after the first FETCH is issued for a cursor, the data the program specifies does not exist.
- After a subsequent FETCH, no more rows satisfying the cursor select-statement are left to retrieve.
- After an UPDATE, a DELETE, or an INSERT, no row meets the search condition.

You can also specify the action you want taken:

### CONTINUE

This causes your program to continue to the next statement.

### GO TO label

This causes your program to branch to an area in the program. The label for that area may be preceded with a colon. The WHENEVER ... GO TO statement:

- Must be a section name or an unqualified paragraph name in COBOL
- Is a label in PL/I and C
- Is the label of a TAG in RPG

**DO host-procedure ()**

This causes your program to call a host language procedure in the program. After the procedure has completed, execution will continue with the next sequential instruction of the program. This clause can only be used in C, C++, ILE COBOL, and ILE RPG.

**DO EXSR subroutine**

This causes your program to call an RPG subroutine with the RPG Invoke Subroutine (EXSR) operation. After the subroutine has completed, execution will continue with the next sequential instruction of the program. This clause can only be used in ILE RPG. The subroutine must be an RPG subroutine name.

**DO PERFORM host-procedure**

This causes your program to call a COBOL procedure with the COBOL PERFORM statement. After the procedure has completed, execution will continue with the next sequential instruction of the program. This clause can only be used in ILE COBOL. The host-procedure must be a COBOL procedure name.

For example, if you are retrieving rows using a cursor, you expect that SQL will eventually be unable to find another row when the FETCH statement is issued. To prepare for this situation, specify a WHENEVER NOT FOUND GO TO ... statement to cause SQL to branch to a place in the program where you issue a CLOSE statement in order to close the cursor properly.

**Note:** A WHENEVER statement affects all subsequent *source* SQL statements until another WHENEVER is encountered.

In other words, all SQL statements coded between two WHENEVER statements (or following the first, if there is only one) are governed by the first WHENEVER statement, regardless of the path the program takes.

Because of this, the WHENEVER statement *must precede* the first SQL statement it is to affect. If the WHENEVER *follows* the SQL statement, the branch is not taken on the basis of the value of the SQLCODE and SQLSTATE set by that SQL statement. However, if your program checks the SQLCODE or SQLSTATE directly, the check must be done after the SQL statement is run.

## Coding SQL statements in C and C++ applications

---

To embed SQL statements in an ILE C or C++ program, you need to be aware of some unique application and coding requirements. This topic also defines the requirements for host structures and host variables.

**Note:** By using the code examples, you agree to the terms of the [“Code license and disclaimer information”](#) on page 198.

**Related concepts**

[Writing applications that use SQL](#)

You can create database applications in host languages that use Db2 for i SQL statements and functions.

**Related reference**

[Example programs: Using Db2 for i statements](#)

Here is a sample application that shows how to code SQL statements in each of the languages that Db2 for i supports.

[Example: SQL statements in ILE C and C++ programs](#)

This example program is written in the C programming language.

## Defining the SQL communication area in C and C++ applications that use SQL

A C or C++ program can be written to use the SQLCA to check return status for embedded SQL statements, or the program can use the SQL diagnostics area to check return status.

When using the SQLCA, a C or C++ program that contains SQL statements must include one or both of the following:

- An SQLCODE variable declared as long SQLCODE
- An SQLSTATE variable declared as char SQLSTATE[6]

Or,

- An SQLCA (which contains an SQLCODE and SQLSTATE variable).

The SQLCODE and SQLSTATE values are set by the database manager after each SQL statement is run. An application can check the SQLCODE or SQLSTATE value to determine whether the last SQL statement was successful.

You can code the SQLCA in a C or C++ program directly or by using the SQL INCLUDE statement. When coding it directly, initialize the SQLCA using the following statement:

```
struct sqlca sqlca = {0x0000000000000000};
```

Using the SQL INCLUDE statement requests the inclusion of a standard declaration:

```
EXEC SQL INCLUDE SQLCA ;
```

A standard declaration includes a structure definition and a data area that are named sqlca.

The SQLCODE, SQLSTATE, and SQLCA variables must appear before any executable statements. The scope of the declaration must include the scope of all SQL statements in the program.

The included C and C++ source statements for the SQLCA are:

```
struct sqlca {
    unsigned char sqlcaid[8];
    long         sqlcabc;
    long         sqlcode;
    short        sqlerrml;
    unsigned char sqlerrmc[70];
    unsigned char sqlerrp[8];
    long         sqlerrd[6];
    unsigned char sqlwarn[11];
    unsigned char sqlstate[5];
};
#define SQLCODE sqlca.sqlcode
#define SQLWARN0 sqlca.sqlwarn[0]
#define SQLWARN1 sqlca.sqlwarn[1]
#define SQLWARN2 sqlca.sqlwarn[2]
#define SQLWARN3 sqlca.sqlwarn[3]
#define SQLWARN4 sqlca.sqlwarn[4]
#define SQLWARN5 sqlca.sqlwarn[5]
#define SQLWARN6 sqlca.sqlwarn[6]
#define SQLWARN7 sqlca.sqlwarn[7]
#define SQLWARN8 sqlca.sqlwarn[8]
#define SQLWARN9 sqlca.sqlwarn[9]
#define SQLWARNA sqlca.sqlwarn[10]
#define SQLSTATE sqlca.sqlstate
struct sqlca sqlca = {0x0000000000000000};
```

When a declare for SQLCODE is found in the program and the precompiler provides the SQLCA, SQLCADE replaces SQLCODE. When a declare for SQLSTATE is found in the program and the precompiler provides the SQLCA, SQLSTOTE replaces SQLSTATE.

**Note:** Many SQL error messages contain message data that is of varying length. The lengths of these data fields are embedded in the value of the SQLCA sqlerrmc field. Because of these lengths, printing the value of sqlerrmc from a C or C++ program might give unpredictable results.

### Related concepts

[Using the SQL diagnostics area](#)

The SQL diagnostics area is used to keep the returned information for an SQL statement that has been run in a program. It contains all the information that is available to you as an application programmer through the SQLCA.

### Related reference

[SQL communication area](#)

[GET DIAGNOSTICS](#)

## Defining SQL descriptor areas in C and C++ applications that use SQL

There are two types of SQL descriptor areas. One is defined with the ALLOCATE DESCRIPTOR statement. The other is defined using the SQL descriptor area (SQLDA) structure. In this topic, only the SQLDA form is discussed.

The following statements can use an SQLDA:

- EXECUTE...USING DESCRIPTOR *descriptor-name*
- FETCH...USING DESCRIPTOR *descriptor-name*
- OPEN...USING DESCRIPTOR *descriptor-name*
- DESCRIBE *statement-name* INTO *descriptor-name*
- DESCRIBE CURSOR *cursor-name* INTO *descriptor-name*
- DESCRIBE INPUT *statement-name* INTO *descriptor-name*
- DESCRIBE PROCEDURE *procedure-name* INTO *descriptor-name*
- DESCRIBE TABLE *host-variable* INTO *descriptor-name*
- PREPARE *statement-name* INTO *descriptor-name*
- CALL...USING DESCRIPTOR *descriptor-name*

Unlike the SQLCA, more than one SQLDA can be in the program, and an SQLDA can have any valid name. The following list includes the statements that require a SQLDA. You can code an SQLDA in a C or C++ program either directly or by using the SQL INCLUDE statement. Using the SQL INCLUDE statement requests the inclusion of a standard SQLDA declaration:

```
EXEC SQL INCLUDE SQLDA;
```

A standard declaration includes only a structure definition with the name 'sqlda'.

C and C++ declarations that are included for the SQLDA are:

```
struct sqlda {
    unsigned char sqldaid[8];
    long sqldbc;
    short sqln;
    short sqld;
    struct sqlvar {
        short sqltype;
        short sqlen;
        union {
            unsigned char *sqldata;
            long long sqld_result_set_locator; };
        union {
            short *sqlind;
            long sqld_row_change;
            long sqld_result_set_rows; };
        struct sqlname {
            short length;
            unsigned char data[30];
        } sqlname;
    } sqlvar[1];
};
```

One benefit from using the INCLUDE SQLDA SQL statement is that you also get the following macro definition:

```
#define SQLDASIZE(n) (sizeof(struct sqlda) + (n-1)* sizeof(struct sqlvar))
```

This macro makes it easy to allocate storage for an SQLDA with a specified number of SQLVAR elements. In the following example, the SQLDASIZE macro is used to allocate storage for an SQLDA with 20 SQLVAR elements.

```
#include <stdlib.h>
EXEC SQL INCLUDE SQLDA;
```

```

struct sqlda *mydaptr;
short numvars = 20;
.
.
mydaptr = (struct sqlda *) malloc(SQLDASIZE(numvars));
mydaptr->sqln = 20;

```

Here are other macro definitions that are included with the INCLUDE SQLDA statement:

**GETSQLDOUBLED(daptr)**

Returns 1 if the SQLDA pointed to by daptr has been doubled, or 0 if it has not been doubled. The SQLDA is doubled if the seventh byte in the SQLDAID field is set to '2'.

**SETSQLDOUBLED(daptr, newvalue)**

Sets the seventh byte of SQLDAID to a new value.

**GETSQLDALONGLEN(daptr,n)**

Returns the length attribute of the nth entry in the SQLDA to which daptr points. Use this only if the SQLDA was doubled and the nth SQLVAR entry has a LOB data type.

**SETSQLDALONGLEN(daptr,n,len)**

Sets the SQLLONGLEN field of the SQLDA to which daptr points to len for the nth entry. Use this only if the SQLDA was doubled and the nth SQLVAR entry has a LOB datatype.

**GETSQLDALENPTR(daptr,n)**

Returns a pointer to the actual length of the data for the nth entry in the SQLDA to which daptr points. The SQLDATALEN pointer field returns a pointer to a long (4 byte) integer. If the SQLDATALEN pointer is zero, a NULL pointer is returned. Use this only if the SQLDA has been doubled.

**SETSQLDALENPTR(daptr,n,ptr)**

Sets a pointer to the actual length of the data for the nth entry in the SQLDA to which daptr points. Use this only if the SQLDA has been doubled.

When you have declared an SQLDA as a pointer, you must reference it exactly as declared when you use it in an SQL statement, just as you would for a host variable that was declared as a pointer. To avoid compiler errors, the type of the value that is assigned to the sqldata field of the SQLDA must be a pointer of unsigned character. This helps avoid compiler errors. The type casting is only necessary for the EXECUTE, OPEN, CALL, and FETCH statements where the application program is passing the address of the host variables in the program. For example, if you declared a pointer to an SQLDA called mydaptr, you would use it in a PREPARE statement as:

```
EXEC SQL PREPARE myname INTO :*mydaptr FROM :mysqlstring;
```

SQLDA declarations can appear wherever a structure definition is allowed. Normal C scope rules apply.

Dynamic SQL is an advanced programming technique. With dynamic SQL, your program can develop and then run SQL statements while the program is running. A SELECT statement with a variable SELECT list (that is a list of the data to be returned as part of the query) that runs dynamically requires an SQL descriptor area (SQLDA). This is because you will not know in advance how many or what type of variables to allocate in order to receive the results of the SELECT.

**Related concepts**

[Dynamic SQL applications](#)

**Related reference**

[SQL descriptor area](#)

## Embedding SQL statements in C and C++ applications that use SQL

SQL statements can be coded in a C or C++ program wherever executable statements can appear.

Each SQL statement must begin with EXEC SQL and end with a semicolon (;). The EXEC SQL keywords must be on one line. The remaining part of the SQL statement can be on more than one line.

Example: An UPDATE statement coded in a C or C++ program might be coded in the following way:

```
EXEC SQL
  UPDATE DEPARTMENT
  SET MGRNO = :MGR_NUM
  WHERE DEPTNO = :INT_DEPT ;
```

Do not use *#pragma convert* to modify the CCSID of any literals that could be used by SQL. All literals used by SQL are assumed to be in the CCSID of the source file.

## Comments in C and C++ applications that use SQL

In addition to using SQL comments (--), you can include C comments (*/\*...\*/*) and single-line comments (comments that start with *//*) within embedded SQL statements whenever a blank is allowed, except between the keywords EXEC and SQL.

Comments can span any number of lines. You cannot nest comments.

## Continuation for SQL statements in C and C++ applications that use SQL

SQL statements can be contained in one or more lines.

You can split an SQL statement wherever a blank can appear. The backslash (\) can be used to continue a string constant or delimited identifier. Identifiers that are not delimited cannot be continued.

Constants containing DBCS data may be continued across multiple lines in two ways:

- If the character at the right margin of the continued line is a shift-in and the character at the left margin of the continuation line is a shift-out, then the shift characters located at the left and right margin are removed.

This SQL statement has a valid graphic constant of G'<AABBCCDDEEFFGGHHIIJJKK>'. The redundant shifts at the margin are removed.

```
*...+...1...+...2...+...3...+...4...+...5...+...6...+...7...*...8
EXEC SQL SELECT * FROM GRAPHTAB          WHERE GRAPHCOL =  G'<AABBCCDDEEFFGGHH>
<IIJJKK>;
```

- It is possible to place the shift characters outside of the margins. For this example, assume the margins are 5 and 75. This SQL statement has a valid graphic constant of G'<AABBCCDDEEFFGGHHIIJJKK>'.

```
*...(. ...1...+...2...+...3...+...4...+...5...+...6...+...7...)...8
EXEC SQL SELECT * FROM GRAPHTAB          WHERE GRAPHCOL =  G'<AABBCCDD>
<EEFFGGHHIIJJKK>;
```

## Including code in C and C++ applications that use SQL

You can include SQL statements, C, or C++ statements by embedding the following SQL statement in the source code.

```
EXEC SQL INCLUDE member-name;
```

You cannot use C and C++ *#include* statements to include SQL statements or declarations of C or C++ host variables that are referred to in SQL statements.

## Margins in C and C++ applications that use SQL

When you precompile using a source member, you must code SQL statements within the margins that are specified by the MARGINS parameter on the **CRTSQLCI** or **CRTSQLCPPI** command.

If the MARGINS parameter is specified as *\*SRCFILE*, the record length of the source file will be used. If a value is specified for the right margin and that value is larger than the source record length, the entire record will be read. The value will also apply to any included members. For example, if a right margin of

200 is specified and the source file has a record length of 80, only 80 columns of data will be read from the source file. If an included source member in the same precompile has a record length of 200, the entire 200 from the include will be read.

When you precompile using a source stream file, the MARGINS parameter is ignored; the entire file is read. Any source stream file included using the SQL INCLUDE statement is read up to the length of the longest line in the primary source stream file, which is specified on the SRCSTMF parameter.

If EXEC SQL does not start within the margins, the SQL precompiler does not recognize the SQL statement.

### **Related concepts**

[CL command descriptions for host language precompilers](#)

The IBM Db2 Query Manager and SQL Development Kit for i licensed program provides commands for precompiling programs coded in these programming languages.

## **Names in C and C++ applications that use SQL**

You can use any valid C or C++ variable name for a host variable. It is subject to these restrictions.

Do not use host variable names or external entry names that begin with SQL, RDI, or DSN in any combination of uppercase or lowercase letters. These names are reserved for the database manager. The length of host variable names is limited to 128.

If the name **SQL** in any combination of uppercase or lowercase letters is used, unpredictable results might occur.

## **NULLs and NULs in C and C++ applications that use SQL**

C, C++, and SQL use the word null, but for different meanings.

The C and C++ languages have a null character (NUL), a null pointer (NULL), and a null statement (just a semicolon (;)). The C NUL is a single character that compares equal to 0. The C NULL is a special reserved pointer value that does not point to any valid data object. The SQL null value is a special value that is distinct from all non-null values and denotes the absence of a (non-null) value.

## **Statement labels in C and C++ applications that use SQL**

Executable SQL statements can be preceded with a label.

## **Preprocessor sequence for C and C++ applications that use SQL**

You must run the SQL preprocessor before the C or C++ preprocessor. You cannot use C or C++ preprocessor directives within SQL statements.

## **Trigraphs in C and C++ applications that use SQL**

Some characters from the C and C++ character set are not available on all keyboards. You can enter these characters into a C or C++ source program by using a sequence of three characters that is called a *trigraph*.

The following trigraph sequences are supported within host variable declarations:

- ??( left bracket
- ??) right bracket
- ??< left brace
- ??> right brace
- ??= pound
- ??/ backslash

## **WHENEVER statement in C and C++ applications that use SQL**

The target for the GOTO clause in an SQL WHENEVER statement must be within the scope of any SQL statements affected by the WHENEVER statement. The target for the DO clause must be a C or C++ function name. The scope rules for functions must be observed.

## **Using host variables in C and C++ applications that use SQL**

All host variables used in SQL statements must be explicitly declared prior to their first use.

In C, the C statements that are used to define the host variables should be preceded by a BEGIN DECLARE SECTION statement and followed by an END DECLARE SECTION statement. If a BEGIN DECLARE SECTION and END DECLARE SECTION are specified, all host variable declarations used in SQL statements must be between the BEGIN DECLARE SECTION and the END DECLARE SECTION statements. Host variables declared using a typedef identifier also require a BEGIN DECLARE SECTION and END DECLARE SECTION; however, the typedef declarations do not need to be between these two sections.

In C++, the C++ statements that are used to define the host variables must be preceded by a BEGIN DECLARE SECTION statement and followed by an END DECLARE SECTION statement. You cannot use any variable that is not between the BEGIN DECLARE SECTION statement and the END DECLARE SECTION statement as a host variable.

All host variables within an SQL statement must be preceded by a colon (:).

The names of host variables must be unique within the program, even if the host variables are in different blocks or procedures.

An SQL statement that uses a host variable must be within the scope of the statement in which the variable was declared.

Host variables cannot be union elements.

Host variables cannot contain continuation characters within the name.

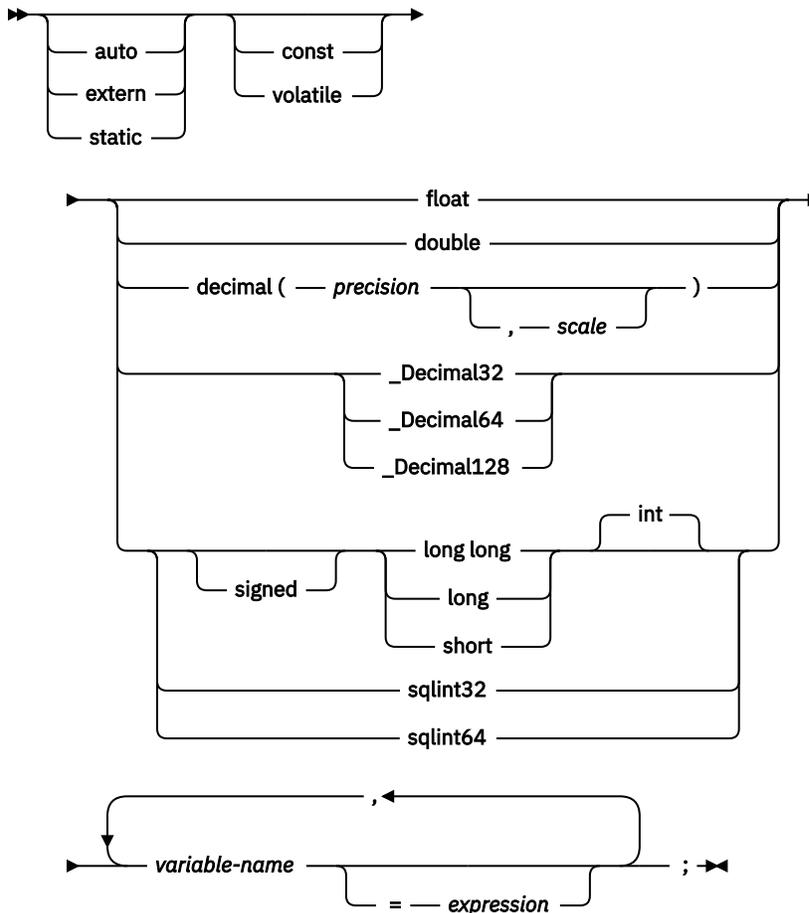
## Declaring host variables in C and C++ applications that use SQL

The C and C++ precompilers recognize only a subset of valid C and C++ declarations as valid host variable declarations.

### ***Numeric host variables in C and C++ applications that use SQL***

This figure shows the syntax for valid numeric host variable declarations.

#### **Numeric**



#### **Notes:**

1. Precision and scale must be integer constants. Precision may be in the range from 1 to 63. Scale may be in the range from 0 to the precision.
2. If using the decimal data type, the header file `decimal.h` must be included.
3. If using `sqlint32` or `sqlint64`, the header file `sqlsystem.h` must be included.
4. `_Decimal32`, `_Decimal64`, and `_Decimal128` are only supported for C.

### ***Character host variables in C and C++ applications that use SQL***

There are three valid forms for character host variables.

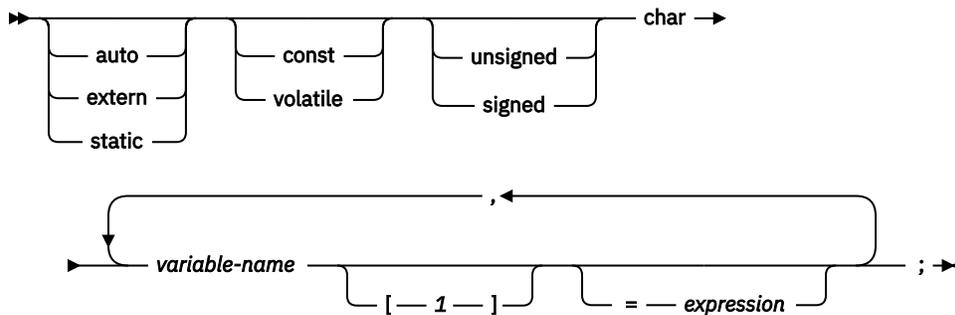
These forms are:

- Single-character form
- NUL-terminated character form
- VARCHAR structured form

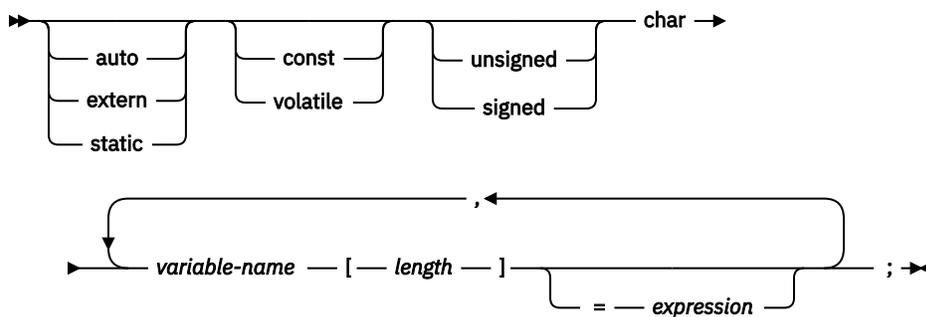
In addition, an SQL VARCHAR declare can be used to define a varchar host variable.

All character types are treated as unsigned.

### Single-character form



### NUL-terminated character form



### Notes:

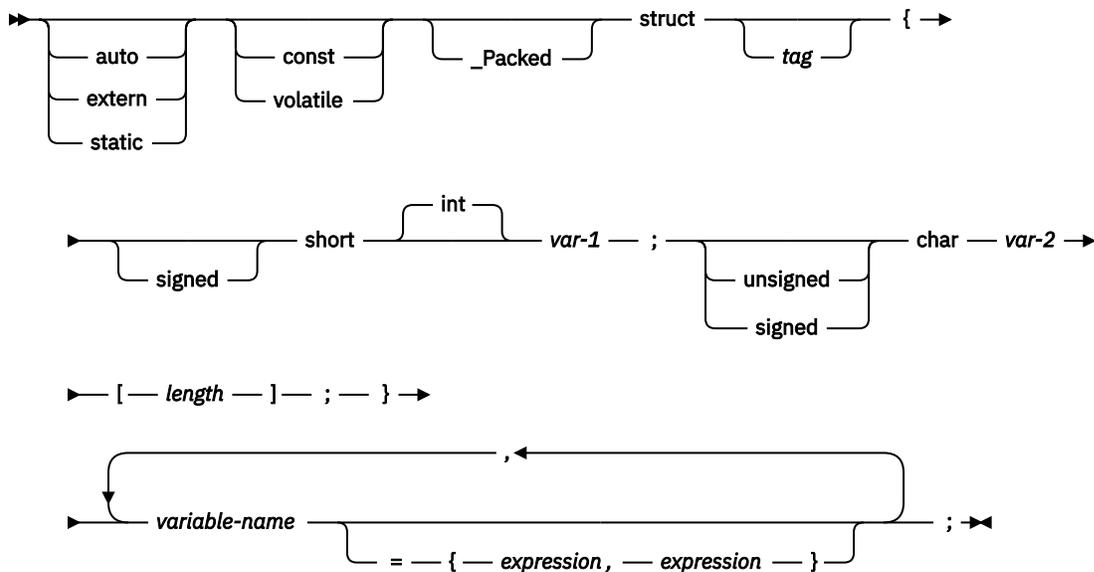
1. The length must be an integer constant that is greater than 1 and not greater than 32 741.
2. If the `*CNULRQD` option is specified on the **CRTSQLCI** or **CRTSQLCPPI** command, the input host variables must contain the NUL-terminator. Output host variables are padded with blanks, and the last character is the NUL-terminator. If the output host variable is too small to contain both the data and the NUL-terminator, the following actions are taken:
  - The data is truncated
  - The last character is the NUL-terminator
  - `SQLWARN1` is set to 'W'
3. If the `*NOCNULRQD` option is specified on the **CRTSQLCI** or **CRTSQLCPPI** command, the input variables do not need to contain the NUL-terminator.

The following applies to output host variables.

- If the host variable is large enough to contain the data and the NUL-terminator, then the following actions are taken:
  - The data is returned, but the data is not padded with blanks
  - The NUL-terminator immediately follows the data
- If the host variable is large enough to contain the data but not the NUL-terminator, then the following actions are taken:
  - The data is returned
  - A NUL-terminator is not returned
  - `SQLWARN1` is set to 'N'
- If the host variable is not large enough to contain the data, the following actions are taken:

- The data is truncated
- A NUL-terminator is not returned
- SQLWARN1 is set to 'W'

## VARCHAR structured form



### Notes:

1. `length` must be an integer constant that is greater than 0 and not greater than 32 740.
2. `var-1` and `var-2` must be simple variable references and cannot be used individually as integer and character host variables.
3. The struct tag can be used to define other data areas, but these cannot be used as host variables.
4. The VARCHAR structured form should be used for bit data that may contain the NULL character. The VARCHAR structured form will not be ended using the nul-terminator.
5. `_Packed` must not be used in C++. Instead, specify `#pragma pack(1)` prior to the declaration and `#pragma pack()` after the declaration.

**Note:** You can use `#pragma pack (reset)` instead of `#pragma pack()` because they are the same.

```
#pragma pack(1)
struct VARCHAR {
    short len;
    char s[10];
} vstring;
#pragma pack()
```

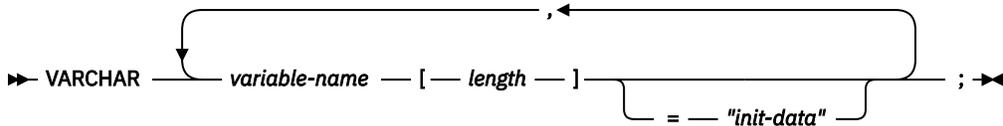
### Example:

```
EXEC SQL BEGIN DECLARE SECTION;

/* valid declaration of host variable vstring */
struct VARCHAR {
    short len;
    char s[10];
} vstring;

/* invalid declaration of host variable wstring */
struct VARCHAR wstring;
```

## SQL VARCHAR form



### Notes:

1. VARCHAR can be in mixed case.
2. *length* must be an integer constant that is greater than 0 and not greater than 32 740.
3. The SQL VARCHAR form should be used for bit data that may contain the NULL character. The SQL VARCHAR form will not be ended using the nul-terminator.

### Example

The following declaration:

```
VARCHAR vstring[528]="mydata";
```

Results in the generation of the following structure:

```
_Packed struct { short len;  
                 char data[528];}  
vstring={6, "mydata"};
```

The following declaration:

```
VARCHAR vstring1[111],  
        vstring2[222]="mydata",  
        vstring3[333]="more data";
```

Results in the generation of the following structures:

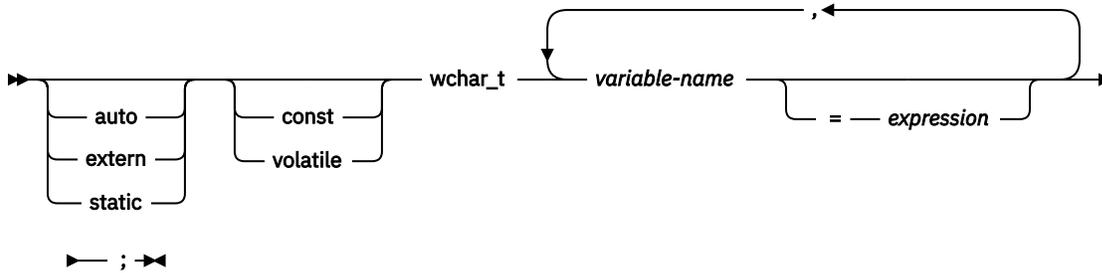
```
_Packed struct { short len;  
                 char data[111];}  
vstring1;  
  
_Packed struct { short len;  
                 char data[222];}  
vstring2={6, "mydata"};  
  
_Packed struct { short len;  
                 char data[333];}  
vstring3={9, "more data"};
```

### Graphic host variables in C and C++ applications that use SQL

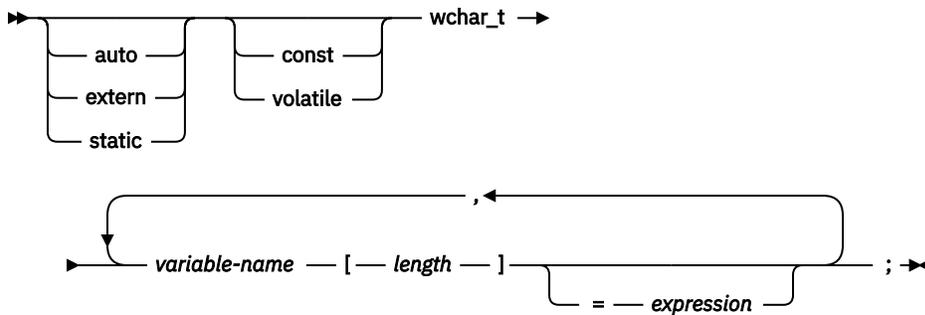
There are three valid forms for graphic host variables.

- Single-graphic form
- NUL-terminated graphic form
- VARGRAPHIC structured form

## Single-graphic form



## NUL-terminated graphic form



### Notes:

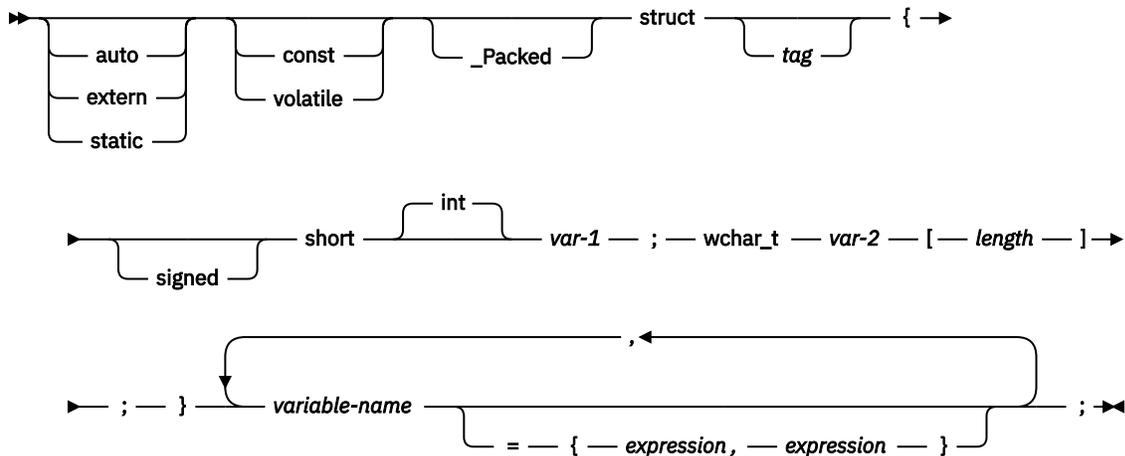
1. *length* must be an integer constant that is greater than 1 and not greater than 16371.
2. If the `*CNULRQD` option is specified on the **CRTSQLCI** or **CRTSQCPPI** command, then input host variables must contain the graphic NUL-terminator (`/0/0`). Output host variables are padded with DBCS blanks, and the last character is the graphic NUL-terminator. If the output host variable is too small to contain both the data and the NUL-terminator, the following actions are taken:

- The data is truncated
- The last character is the graphic NUL-terminator
- `SQLWARN1` is set to 'W'

If the `*NOCNULRQD` option is specified on the **CRTSQLCI** or **CRTSQCPPI** command, the input host variables do not need to contain the graphic NUL-terminator. The following is true for output host variables.

- If the host variable is large enough to contain the data and the graphic NUL-terminator, the following actions are taken:
  - The data is returned, but is not padded with DBCS blanks
  - The graphic NUL-terminator immediately follows the data
- If the host variable is large enough to contain the data but not the graphic NUL-terminator, the following actions are taken:
  - The data is returned
  - A graphic NUL-terminator is not returned
  - `SQLWARN1` is set to 'N'
- If the host variable is not large enough to contain the data, the following actions are taken:
  - The data is truncated
  - A graphic NUL-terminator is not returned
  - `SQLWARN1` is set to 'W'

## VARGRAPHIC structured form



### Notes:

1. *length* must be an integer constant that is greater than 0 and not greater than 16370.
2. *var-1* and *var-2* must be simple variable references and cannot be used as host variables.
3. The struct tag can be used to define other data areas, but these cannot be used as host variables.
4. *\_Packed* must not be used in C++. Instead, specify `#pragma pack(1)` prior to the declaration and `#pragma pack()` after the declaration.

```
#pragma pack(1)  
struct VARGRAPH {  
    short len;  
    wchar_t s[10];  
} vstring;  
#pragma pack()
```

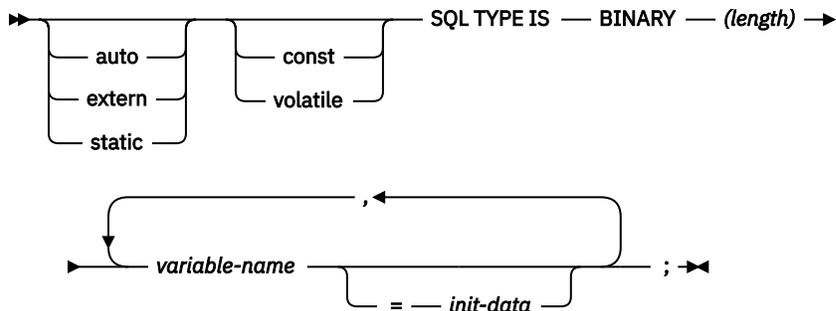
### Example

```
EXEC SQL BEGIN DECLARE SECTION;  
  
/* valid declaration of host variable graphic string */  
  
struct VARGRAPH {  
    short len;  
    wchar_t s[10];  
} vstring;  
  
/* invalid declaration of host variable wstring */  
  
struct VARGRAPH wstring;
```

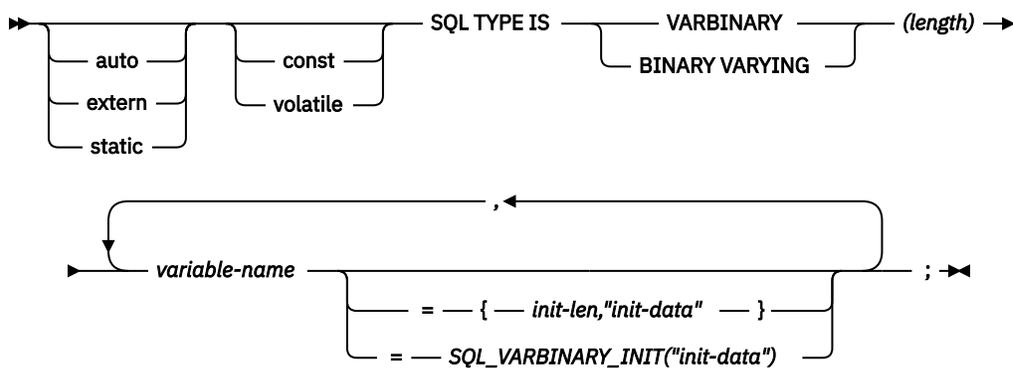
## Binary host variables in C and C++ applications that use SQL

C and C++ do not have variables that correspond to the SQL binary data types. To create host variables that can be used with these data types, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a C language structure in the output source member.

### BINARY



### VARBINARY



### Notes:

1. For BINARY host variables, the length must be in the range 1 to 32 766.
2. For VARBINARY and BINARY VARYING host variables, the length must in the range 1 to 32 740.
3. SQL TYPE IS, BINARY, VARBINARY, and BINARY VARYING can be in mixed case.

### BINARY example

The following declaration:

```
SQL TYPE IS BINARY(4) myBinField;
```

Results in the generation of the following code:

```
char myBinField[4];
```

### VARBINARY example

The following declaration:

```
SQL TYPE IS VARBINARY(12) myVarBinField;
```

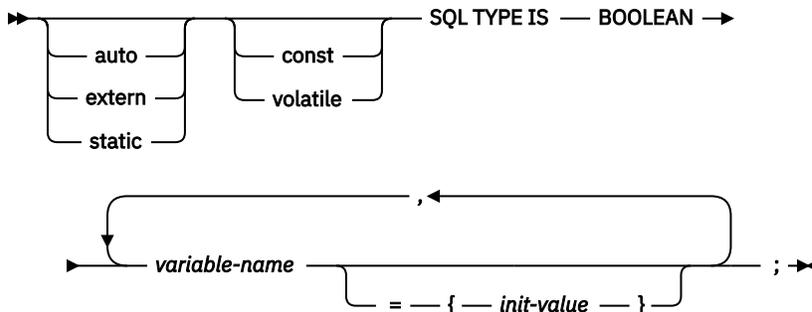
Results in the generation of the following structure:

```
_Packed struct myVarBinField_t {
    short length;
    char data[12]; }
myVarBinField;
```

### Boolean host variables in C and C++ applications that use SQL

C and C++ do not have variables that correspond to the SQL data type for Boolean. To create host variables that can be used with these data types, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a C language structure in the output source member.

#### Boolean host variable



#### BOOLEAN example

The following declaration:

```
SQL TYPE IS BOOLEAN myBooleanField;
```

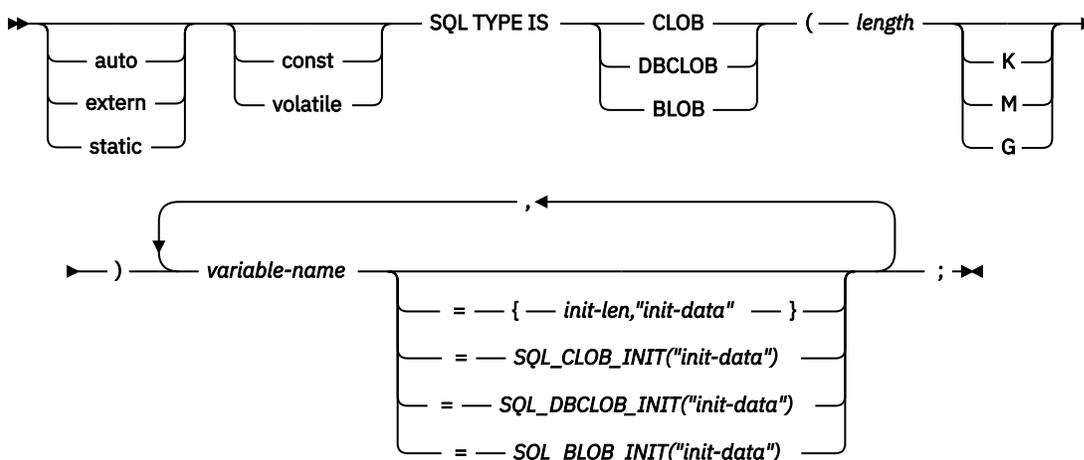
Results in the following code generation:

```
char myBooleanField;
```

### LOB host variables in C and C++ applications that use SQL

C and C++ do not have variables that correspond to the SQL data types for LOBs (large objects). To create host variables that can be used with these data types, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a C language structure in the output source member.

#### LOB host variable



## Notes:

1. K multiplies *length* by 1024. M multiplies *length* by 1 048 576. G multiplies *length* by 1 073 741 824.
2. For BLOB and CLOB,  $1 \leq \textit{length} \leq 2\,147\,483\,647$
3. For DBCLOB,  $1 \leq \textit{length} \leq 1\,073\,741\,823$
4. SQL TYPE IS, BLOB, CLOB, DBCLOB, K, M, G can be in mixed case.
5. The maximum length allowed for the initialization string is 32 766 bytes.
6. The initialization length, *init-len*, must be a numeric constant (that is, it cannot include K, M, or G).
7. If the LOB is not initialized within the declaration, then no initialization will be done within the precompiler generated code.
8. The precompiler generates a structure tag which can be used to cast to the host variable's type.
9. Pointers to LOB host variables can be declared, with the same rules and restrictions as for pointers to other host variable types.
10. CCSID processing for LOB host variables will be the same as the processing for other character and graphic host variable types.
11. If a DBCLOB is initialized, it is the user's responsibility to prefix the string with an 'L' (indicating a wide-character string).

## CLOB example

The following declaration:

```
SQL TYPE IS CLOB(128K) var1, var2 = {10, "data2data2"};
```

The precompiler will generate for C:

```
_Packed struct var1_t {  
  unsigned long length;  
  char data[131072];  
} var1,var2={10,"data2data2"};
```

## DBCLOB example

The following declaration:

```
SQL TYPE IS DBCLOB(128K) my_dbclob;
```

The precompiler will then generate:

```
_Packed struct my_dbclob_t {  
  unsigned long length;  
  wchar_t data[131072]; } my_dbclob;
```

## BLOB example

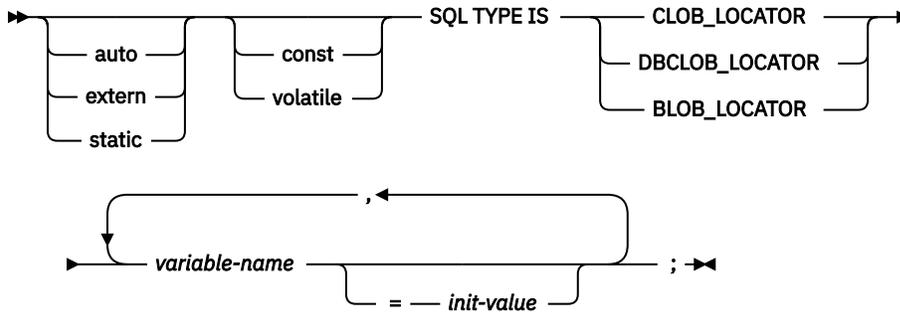
The following declaration:

```
static SQL TYPE IS BLOB(128K)  
my_blob=SQL_BLOB_INIT("mydata");
```

Results in the generation of the following structure:

```
static struct my_blob_t {  
  unsigned long length;  
  char data[131072];  
} my_blob=SQL_BLOB_INIT("my_data");
```

## LOB locator



### Notes:

1. SQL TYPE IS, BLOB\_LOCATOR, CLOB\_LOCATOR, DBCLOB\_LOCATOR can be in mixed case.
2. *init-value* permits the initialization of pointer locator variables. Other types of initialization will have no meaning.
3. Pointers to LOB locators can be declared with the same rules and restrictions as for pointers to other host variable types.

## CLOB locator example

The following declaration:

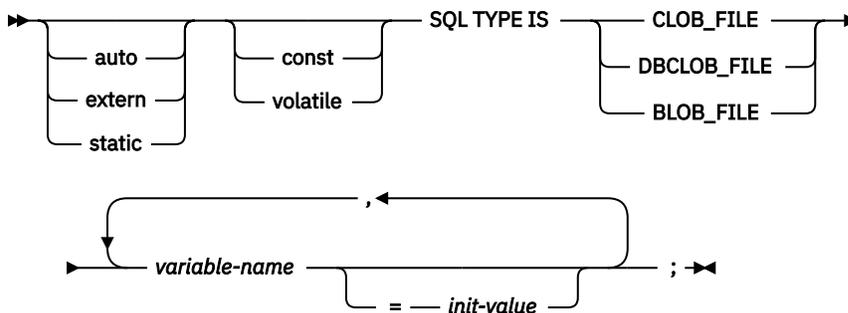
```
static SQL TYPE IS CLOB_LOCATOR my_locator;
```

Results in the following generation:

```
static long int unsigned my_locator;
```

BLOB and DBCLOB locators have similar syntax.

## LOB file reference variable



### Notes:

1. SQL TYPE IS, BLOB\_FILE, CLOB\_FILE, DBCLOB\_FILE can be in mixed case.
2. Pointers to LOB File Reference Variables can be declared, with the same rules and restrictions as for pointers to other host variable types.

## CLOB file reference example

The following declaration:

```
static SQL TYPE IS CLOB_FILE my_file;
```

Results in the generation of the following structure:

```
static _Packed struct {
    unsigned long name_length;
    unsigned long data_length;
    unsigned long file_options;
    char name[255];
} my_file;
```

BLOB and DBCLOB file reference variables have similar syntax.

The precompiler generates declarations for the following file option constants. You can use these constants to set the file\_options variable when you use file reference host variables.

- SQL\_FILE\_READ (2)
- SQL\_FILE\_CREATE (8)
- SQL\_FILE\_OVERWRITE (16)
- SQL\_FILE\_APPEND (32)

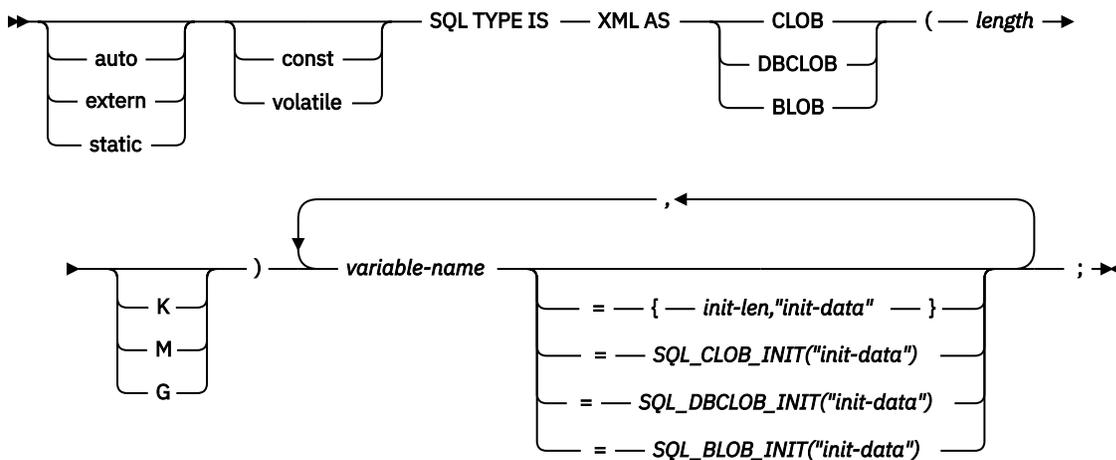
### Related reference

[LOB file reference variables](#)

## XML host variables in C and C++ applications that use SQL

C and C++ do not have variables that correspond to the SQL data type for XML. To create host variables that can be used with this data type, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a C language structure in the output source member.

### XML host variable



### Notes:

1. K multiplies *length* by 1024. M multiplies *length* by 1 048 576. G multiplies *length* by 1 073 741 824.
2. For BLOB and CLOB,  $1 \leq \textit{length} \leq 2\,147\,483\,647$
3. For DBCLOB,  $1 \leq \textit{length} \leq 1\,073\,741\,823$
4. SQL TYPE IS, XML AS, BLOB, CLOB, DBCLOB, K, M, G can be in mixed case.
5. The maximum length allowed for the initialization string is 32 766 bytes.
6. The initialization length, *init-len*, must be a numeric constant (that is, it cannot include K, M, or G).
7. If the XML variable is not initialized within the declaration, then no initialization will be done within the precompiler generated code.
8. The precompiler generates a structure tag which can be used to cast to the host variable's type.
9. Pointers to XML host variables can be declared, with the same rules and restrictions as for pointers to other host variable types.

10. The CCSID value for an XML host variable can be explicitly set by the DECLARE VARIABLE statement. Otherwise, the value specified by the SQL\_XML\_DATA\_CCSID QAQQINI option will be used. The default for this QAQQINI option is CCSID 1208.
11. If XML AS DBCLOB is initialized, it is the user's responsibility to prefix the string with an 'L' (indicating a wide-character string).

### XML example

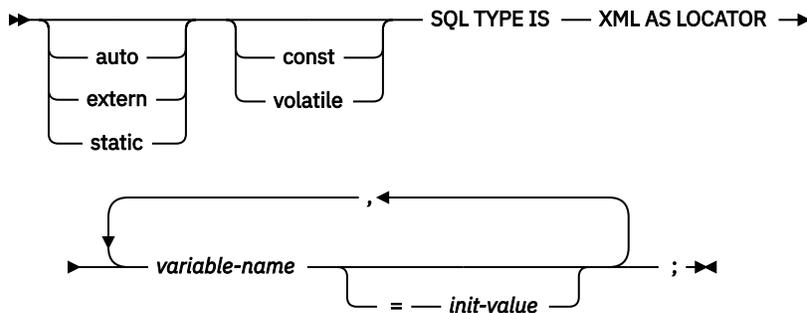
The following declaration:

```
SQL TYPE IS XML AS CLOB(5000) var1;
```

The precompiler will generate for C:

```
_Packed struct var1_t {
  unsigned long length;
  char data[5000];
} var1;
```

### XML locator



#### Notes:

1. SQL TYPE IS, XML AS LOCATOR can be in mixed case.
2. *init-value* permits the initialization of pointer locator variables. Other types of initialization will have no meaning.
3. Pointers to XML locators can be declared with the same rules and restrictions as for pointers to other host variable types.

### XML locator example

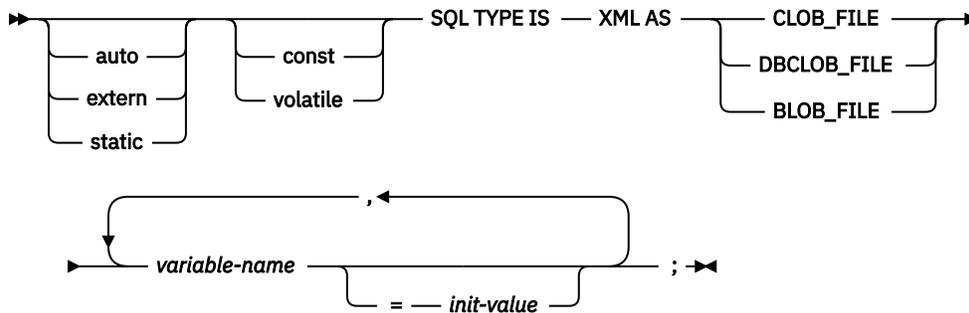
The following declaration:

```
static SQL TYPE IS XML AS LOCATOR my_locator;
```

Results in the following generation:

```
static long int unsigned my_locator;
```

## XML file reference variable



### Notes:

1. SQL TYPE IS, XML AS, BLOB\_FILE, CLOB\_FILE, DBCLOB\_FILE can be in mixed case.
2. Pointers to XML File Reference Variables can be declared, with the same rules and restrictions as for pointers to other host variable types.

## XML file reference example

The following declaration:

```
static SQL TYPE IS XML AS CLOB_FILE my_file;
```

Results in the generation of the following structure:

```
static _Packed struct {
    unsigned long    name_length;
    unsigned long    data_length;
    unsigned long    file_options;
    char             name[255];
} my_file;
```

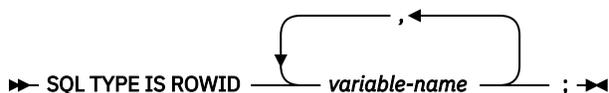
The precompiler generates declarations for the following file option constants. You can use these constants to set the file\_options variable when you use file reference host variables.

- SQL\_FILE\_READ (2)
- SQL\_FILE\_CREATE (8)
- SQL\_FILE\_OVERWRITE (16)
- SQL\_FILE\_APPEND (32)

## ROWID host variables in C and C++ applications that use SQL

C and C++ do not have a variable that corresponds to the SQL data type ROWID. To create host variables that can be used with this data type, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a C language structure in the output source member.

### ROWID



**Note:** SQL TYPE IS ROWID can be in mixed case.

## ROWID example

The following declaration:

```
SQL TYPE IS ROWID myrowid, myrowid2;
```

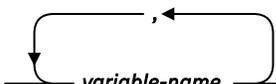
Results in the generation of the following structure:

```
_Packed struct { short len;  
                 char data[40];}  
myrowid1, myrowid2;
```

## Result set locator host variables in C and C++ applications that use SQL

C and C++ do not have a variable that corresponds to the SQL result set locator data type. To create host variables that can be used for this data type, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a C language structure in the output source member.

### Result set locator

►► SQL TYPE IS RESULT\_SET\_LOCATOR  ; ◄◄

**Note:** SQL TYPE IS RESULT\_SET\_LOCATOR can be in mixed case.

### Result set locator example

The following declaration:

```
SQL TYPE IS RESULT_SET_LOCATOR resloc1;
```

Results in the generation of the following structure:

```
long long unsigned resloc1;
```

## Using host structures in C and C++ applications that use SQL

In C and C++ programs, you can define a *host structure*, which is a named set of elementary C or C++ variables.

Host structures have a maximum of two levels, even though the host structure might itself occur within a multilevel structure. An exception is the declaration of a varying-length string, which requires another structure.

A host structure name can be a group name whose subordinate levels name elementary C or C++ variables. For example:

```
struct {  
    struct {  
        char c1;  
        char c2;  
    } b_st;  
} a_st;
```

In this example, *b\_st* is the name of a host structure consisting of the elementary items *c1* and *c2*.

You can use the structure name as a shorthand notation for a list of scalars, but only for a two-level structure. You can qualify a host variable with a structure name (for example, *structure.field*). Host structures are limited to two levels. (For example, in the above host structure example, the *a\_st* cannot be referred to in SQL.) A structure cannot contain an intermediate level structure. In the previous example, *a\_st* could not be used as a host variable or referred to in an SQL statement. A host structure for SQL data has two levels and can be thought of as a named set of host variables. After the host structure is defined,

you can refer to it in an SQL statement instead of listing the several host variables (that is, the names of the host variables that make up the host structure).

For example, you can retrieve all column values from selected rows of the table CORPDATA.EMPLOYEE with:

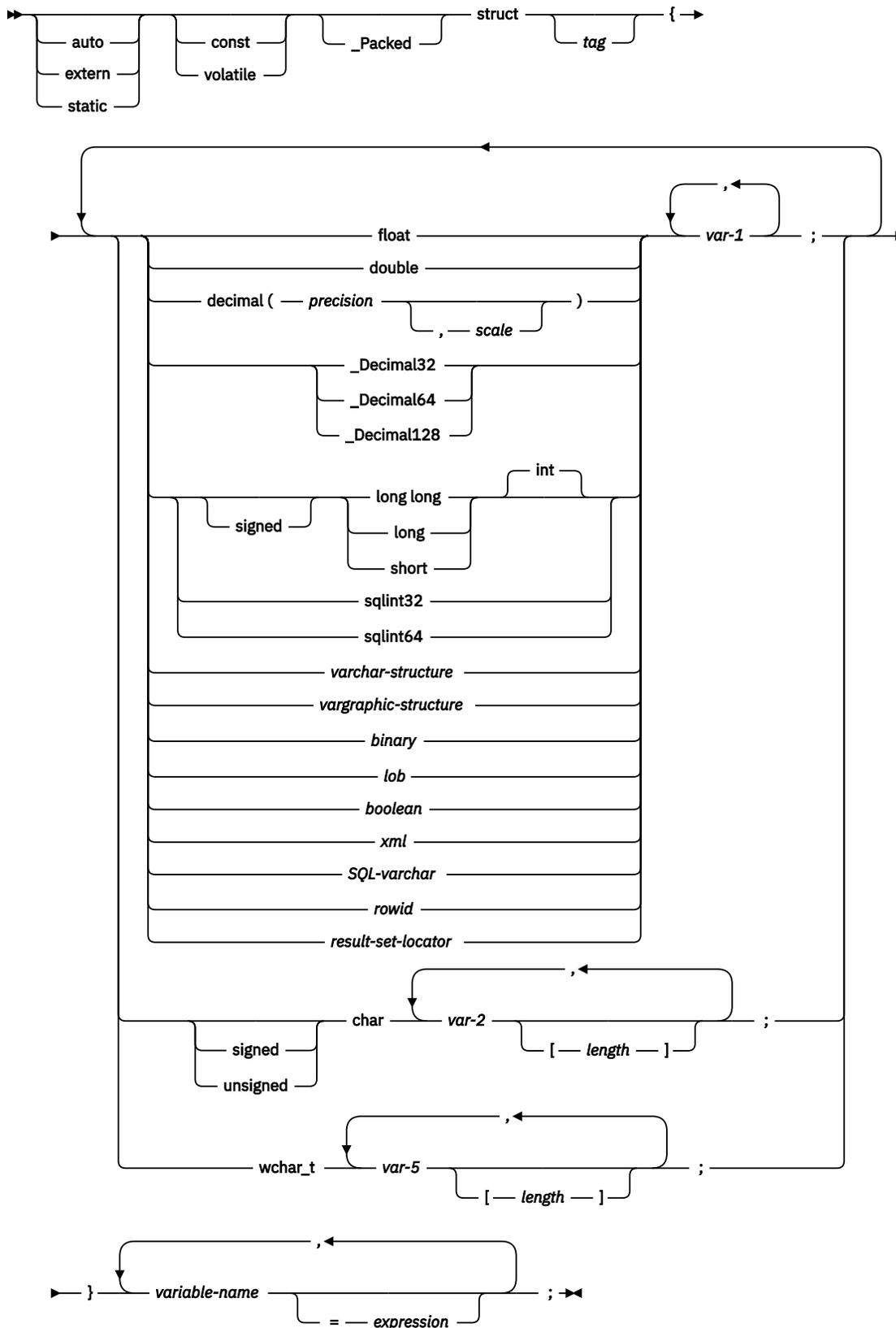
```
struct { char empno[7];
        struct
            { short int firstname_len;
              char firstname_text[12];
            } firstname;
        char midint,
        struct
            { short int lastname_len;
              char lastname_text[15];
            } lastname;
        char workdept[4];
        } pemp1;
.....
strcpy(pemp1.empno, "000220");
.....
exec sql
  SELECT *
  INTO :pemp1
  FROM corpdata.employee
  WHERE empno=:pemp1.empno;
```

Notice that in the declaration of pemp1, two varying-length string elements are included in the structure: firstname and lastname.

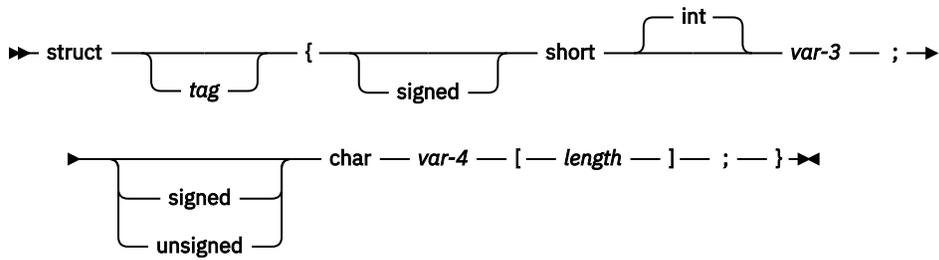
# Host structure declarations in C and C++ applications that use SQL

These figures show the valid syntax for host structure declarations.

## Host structures

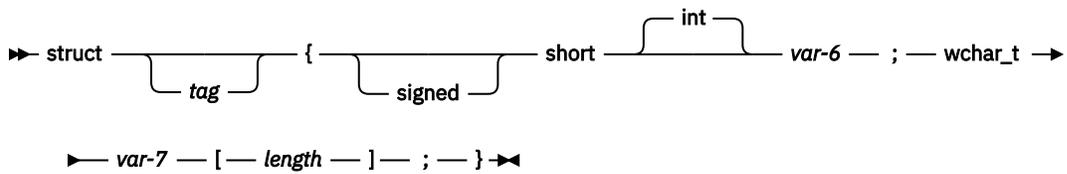


## varchar-structure

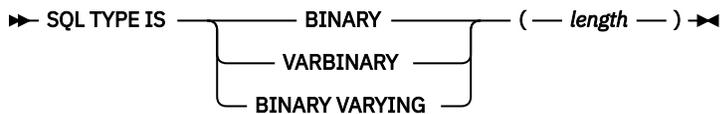


## Host structures (continued)

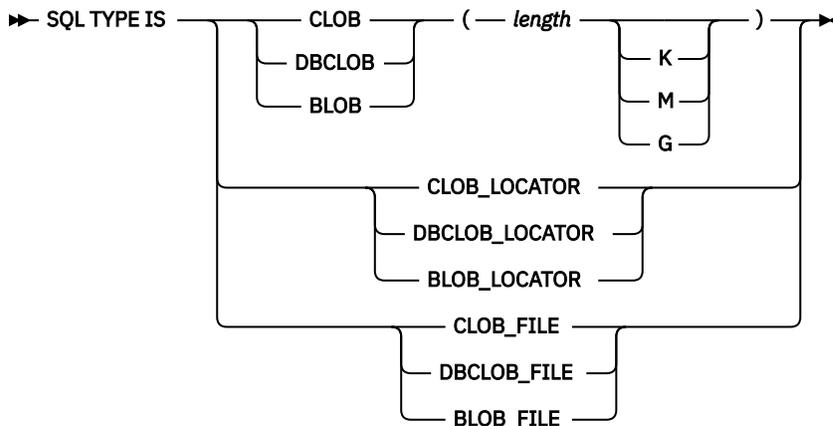
### vargraphic-structure



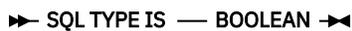
### binary



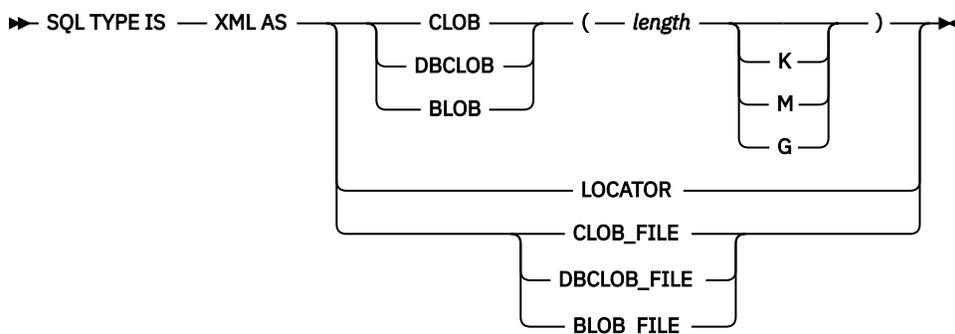
### lob



### boolean



### xml



## SQL-varchar

►► VARCHAR — *variable-name* — [ — *length* — ] —►

## rowid

►► SQL TYPE IS ROWID —►

## result-set-locator

►► SQL TYPE IS RESULT\_SET\_LOCATOR —►

## Notes:

1. For details on declaring numeric, character, graphic, binary, LOB, Boolean, XML, ROWID, and result set locator host variables, see the notes under numeric, character, graphic, binary, LOB, Boolean, XML, ROWID, and result set locator host variables.
2. A structure of a short int followed by either a char or wchar\_t array is always interpreted by the SQL C and C++ precompilers as either a VARCHAR or VARGRAPHIC structure.
3. `_Packed` must not be used in C++. Instead, specify `#pragma pack(1)` prior to the declaration and `#pragma pack()` after the declaration.

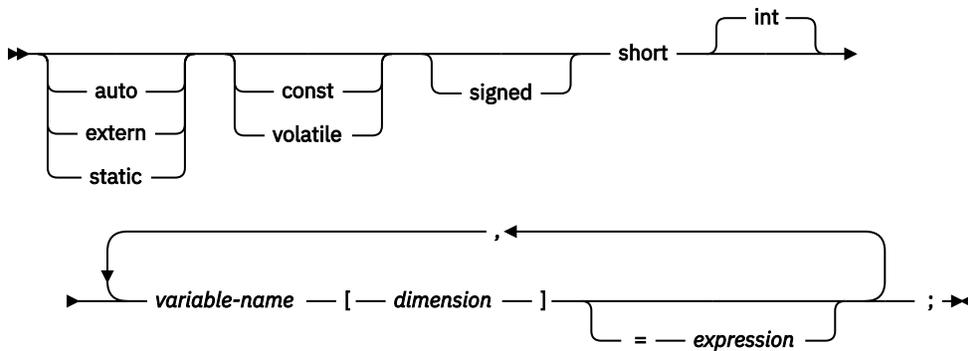
```
#pragma pack(1)
struct {
    short myshort;
    long mylong;
    char mychar[5];
} a_st;
#pragma pack()
```

4. If using `sqlint32` or `sqlint64`, the header file `sqlsystem.h` must be included.
5. `_Decimal32`, `_Decimal64`, and `_Decimal128` are only supported for C.

## Host structure indicator array in C and C++ applications that use SQL

This figure shows the valid syntax for host structure indicator array declarations.

### Host structure indicator array



## Using arrays of host structures in C and C++ applications that use SQL

In C and C++ programs, you can define a host structure array that has the dimension attribute. Host structure arrays have a maximum of two levels, even though the array might occur within a multiple-level structure. Another structure is not needed if a varying-length character string or a varying-length graphic string is not used.

In this C example,

```
struct {
    _Packed struct{
        char c1_var[20];
```

```

        short c2_var;
    } b_array[10];
} a_struct;

```

and in this C++ example,

```

#pragma pack(1)
struct {
    struct{
        char c1_var[20];
        short c2_var;
    } b_array[10];
} a_struct;
#pragma pack()

```

the following are true:

- All of the members in `b_array` must be valid variable declarations.
- The `_Packed` attribute must be specified for the struct tag.
- `b_array` is the name of an array of host structures containing the members `c1_var` and `c2_var`.
- `b_array` may only be used on the blocked forms of `FETCH` statements and `INSERT` statements.
- `c1_var` and `c2_var` are not valid host variables in any SQL statement.
- A structure cannot contain an intermediate level structure.

For example, in C you can retrieve 10 rows from the cursor with:

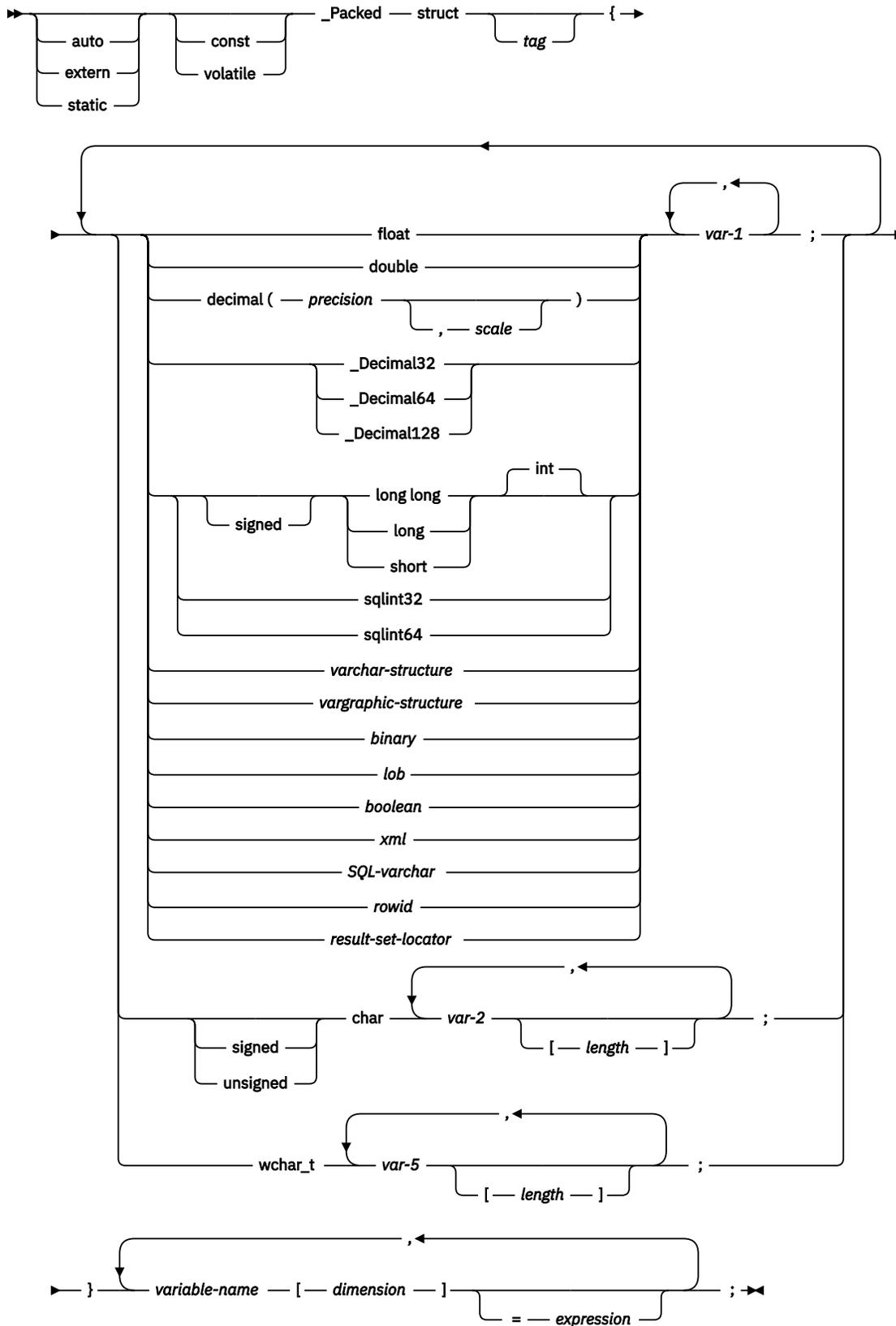
```

_Packed struct {char first_initial;
                char middle_initial;
                _Packed struct {short lastname_len;
                                char lastname_data[15];
                                } lastname;
                double total_salary;
                } employee_rec[10];
struct { short inds[4];
        } employee_inds[10];
...
EXEC SQL DECLARE C1 CURSOR FOR
SELECT SUBSTR(FIRSTNME,1,1), MIDINIT, LASTNAME,
        SALARY+BONUS+COMM
FROM CORPDATA.EMPLOYEE;
EXEC SQL OPEN C1;
EXEC SQL FETCH C1 FOR 10 ROWS INTO :employee_rec:employee_inds;
...

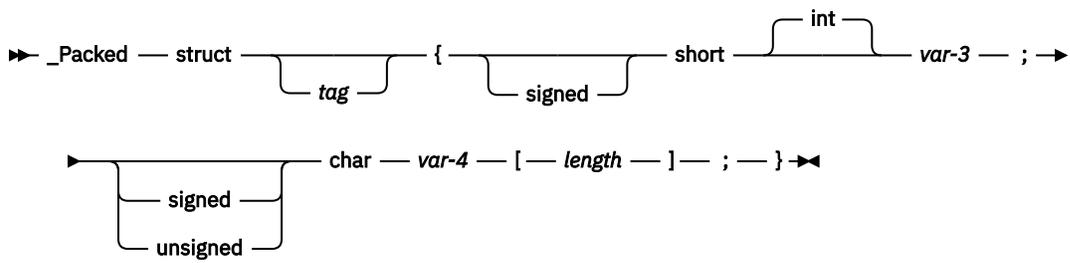
```

# Host structure array in C and C++ applications that use SQL

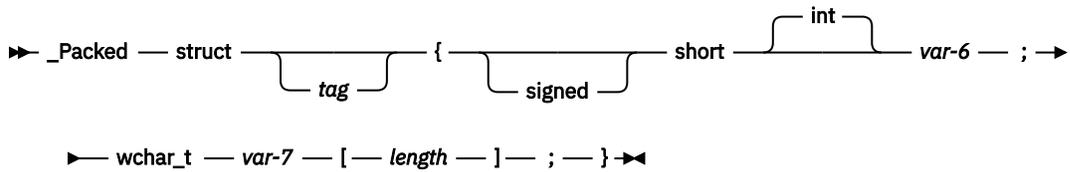
The figure shows the valid syntax for host structure array declarations.



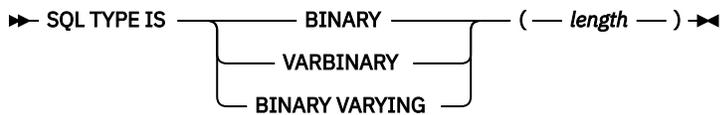
**varchar-structure**



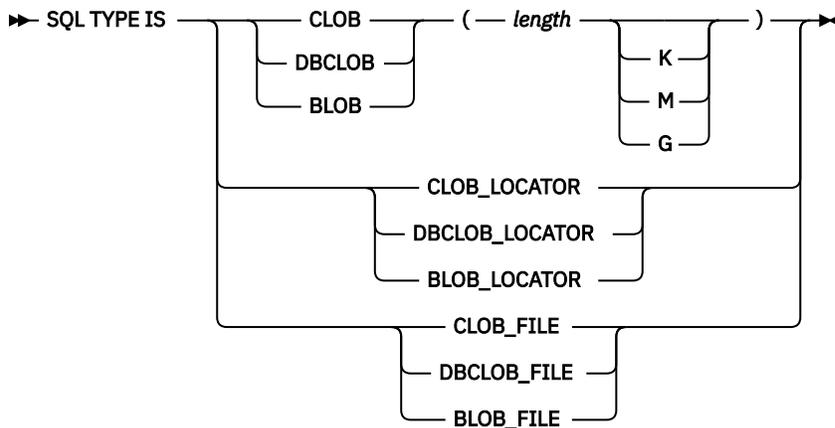
**vargraphic-structure**



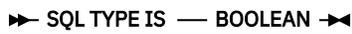
**binary**



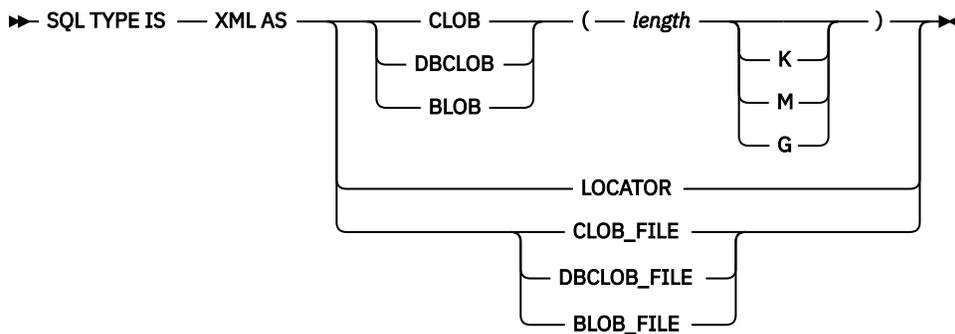
**lob**



**boolean**



**xml**



**SQL-varchar**



## rowid

➤ SQL TYPE IS ROWID ➤

## result-set-locator

➤ SQL TYPE IS RESULT\_SET\_LOCATOR ➤

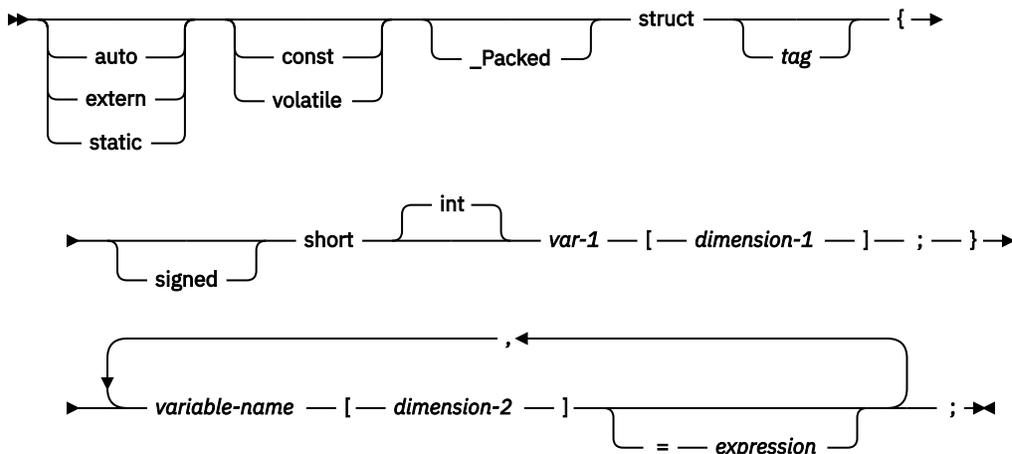
### Notes:

1. For details on declaring numeric, character, graphic, binary, LOB, Boolean, XML, ROWID, and result set locator host variables, see the notes under numeric-host variables, character-host variables, graphic-host variables, binary host variables, LOB host variables, Boolean host variables, XML host variables, ROWID host variables, and result set locator host variables.
2. The struct tag can be used to define other data areas, but these cannot be used as host variables.
3. `_Packed` must not be used in C++. Instead, specify `#pragma pack(1)` prior to the declaration and `#pragma pack()` after the declaration.
4. If using `sqlint32` or `sqlint64`, the header file `sqlsystem.h` must be included.
5. `_Decimal32`, `_Decimal64`, and `_Decimal128` are only supported for C.

## Host structure array indicator structure in C and C++ applications that use SQL

The figure shows the valid syntax for host structure array indicator structure declarations.

### Host Structure Array Indicator Structure



### Notes:

1. The struct tag can be used to define other data areas, but they cannot be used as host variables.
2. `_Packed` must not be used in C++. Instead, specify `#pragma pack(1)` prior to the declaration and `#pragma pack()` after the declaration.

## Using pointer data types in C and C++ applications that use SQL

You can also declare host variables that are pointers to the supported C and C++ data types, with the following restrictions.

- If a host variable is declared as a pointer, then that host variable must be declared with asterisks followed by a host variable. The following examples are all valid:

```
short *mynum;          /* Ptr to an integer          */
long **mynumptr;      /* Ptr to a ptr to a long integer */
char *mychar;         /* Ptr to a single character    */
char(*mychara)[20];  /* Ptr to a char array of 20 bytes */
```

```

struct {
    short mylen;          /* Ptr to a variable char array of 30 */
    char mydata[30];     /* bytes. */
} *myvarchar;

```

**Note:** Parentheses are only allowed when declaring a pointer to a NUL-terminated character array, in which case they are required. If the parentheses were not used, you would be declaring an array of pointers rather than the desired pointer to an array. For example:

```

char (*a)[10];          /* pointer to a null-terminated char array */
char *a[10];           /* pointer to an array of pointers */

```

- If a host variable is declared as a pointer, then no other host variable can be declared with that same name within the same source file. For example, the second declaration below would be invalid:

```

char *mychar;          /* This declaration is valid */
char mychar;          /* But this one is invalid */

```

- When a host variable is referenced within an SQL statement, that host variable must be referenced exactly as declared, with the exception of pointers to NUL-terminated character arrays. For example, the following declaration required parentheses:

```

char (*mychara)[20];   /* ptr to char array of 20 bytes */

```

However, the parentheses are not allowed when the host variable is referenced in an SQL statement, such as a SELECT:

```

EXEC SQL SELECT name INTO :*mychara FROM mytable;

```

- Only the asterisk can be used as an operator over a host variable name.
- The maximum length of a host variable name is affected by the number of asterisks specified, as these asterisks are considered part of the name.
- Pointers to structures are not usable as host variables except for variable character structures. Also, pointer fields in structures are not usable as host variables.
- SQL requires that all specified storage for based host variables be allocated. If the storage is not allocated, unpredictable results can occur.

## Using typedef in C and C++ applications that use SQL

You can also use the typedef declarations to define your own identifiers that will be used in place of C type specifiers such as short, float, and double.

The typedef identifiers used to declare host variables must be unique within the program, even if the typedef declarations are in different blocks or procedures. If the program contains BEGIN DECLARE SECTION and END DECLARE SECTION statements, the typedef declarations do not need to be contained with the BEGIN DECLARE SECTION and END DECLARE SECTION. The typedef identifier will be recognized by the SQL precompiler within the BEGIN DECLARE SECTION. The C and C++ precompilers recognize only a subset of typedef declarations, the same as with host variable declarations.

Examples of valid typedef statements:

- Declaring a long typedef and then declaring host variables which reference the typedef.

```

typedef long int LONG_T;
LONG_T I1, *I2;

```

- The character array length may be specified in either the typedef or on the host variable declaration but not in both.

```

typedef char NAME_T[30];
typedef char CHAR_T;
CHAR_T name1[30]; /* Valid */

```

```
NAME_T name2;      /* Valid */
NAME_T name3[10]; /* Not valid for SQL use */
```

- The SQL TYPE IS statement may be used in a typedef.

```
typedef SQL TYPE IS CLOB(5K) CLOB_T;
CLOB_T clob_var1;
```

- Storage class (auto, extern, static), volatile, or const qualifiers may be specified on the host variable declaration.

```
typedef short INT_T;
typedef short INT2_T;
static INT_T i1;
volatile INT2_T i2;
```

- typedefs of structures are supported.

```
typedef _Packed struct {char dept[3];
                       char deptname[30];
                       long Num_employees;} DEPT_T;
DEPT_T dept_rec;
DEPT_T dept_array[20]; /* use for blocked insert or fetch */
```

## Using ILE C compiler external file descriptions in C and C++ applications that use SQL

You can use the C or C++ #pragma mapinc directive with the #include directive to include external file descriptions in your program.

When used with SQL, only a particular format of the #pragma mapinc directive is recognized by the SQL precompiler. If all of the required elements are not specified, the precompiler ignores the directive and does not generate host variable structures. The required elements are:

- Include name
- Externally described file name
- Format name or a list of format names
- Options
- Conversion options

The library name, union name, conversion options, and prefix name are optional. Although typedef statements coded by the user are not recognized by the precompiler, those created by the #pragma mapinc and #include directives are recognized. SQL supports input, output, both, and key values for the options parameter. For the conversion options, the supported values are D, p, z, \_P, and 1BYTE\_CHAR. These options may be specified in any order except that both D and p cannot be specified. Unions declared using the typedef union created by the #pragma mapinc and #include directive cannot be used as host variables in SQL statements; the members of the unions can be used. Structures that contain the typedef structure cannot be used in SQL statements; the structure declared using the typedef can be used.

To retrieve the definition of the sample table DEPARTMENT described in [Db2 for i sample tables](#) in the SQL programming topic collection, you can code the following:

```
#pragma mapinc ("dept", "CORPDATA/DEPARTMENT(*ALL)", "both")
#include "dept"
CORPDATA_DEPARTMENT_DEPARTMENT_both_t Dept_Structure;
```

A host structure named Dept\_Structure is defined with the following elements: DEPTNO, DEPTNAME, MGRNO, and ADMRDEPT. These field names can be used as host variables in SQL statements.

**Note:** DATE, TIME, TIMESTAMP, and BOOLEAN columns generate character host variable definitions. They are treated by SQL with the same comparison and assignment rules as a DATE, TIME, TIMESTAMP, or

BOOLEAN column. For example, a date host variable can be compared only against a DATE column or a character string that is a valid representation of a date.

If the GRAPHIC or VARGRAPHIC column has a UCS-2 CCSID, the generated host variable will have the UCS-2 CCSID assigned to it. If the GRAPHIC or VARGRAPHIC column has a UTF-16 CCSID, the generated host variable will have the UTF-16 CCSID assigned to it.

Although zoned, binary (with nonzero scale fields), and, optionally, decimal are mapped to character fields in ILE C, SQL will treat these fields as numeric. By using the extended program model (EPM) routines, you can manipulate these fields to convert zoned and packed decimal data. For more information, see the [ILE C/C++ Language Reference](#) topic.

CLOB, BLOB, and DBCLOB columns in the external file are ignored. No host variable definition will be generated in the host structure for these types.

## Determining equivalent SQL and C or C++ data types

The precompiler determines the base SQLTYPE and SQLLEN of host variables based on the table. If a host variable appears with an indicator variable, the SQLTYPE is the base SQLTYPE plus one.

Table 1. C or C++ declarations mapped to typical SQL data types

C or C++ data type	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
short int	500	2	SMALLINT
long int	496	4	INTEGER
long long int	492	8	BIGINT
decimal(p,s)	484	p in byte 1, s in byte 2	DECIMAL (p,s)
_Decimal32	996	4	Treated as DECFLOAT(7) although SQL does not directly support this data type.
_Decimal64	996	8	DECFLOAT(16)
_Decimal128	996	16	DECFLOAT(34)
float	480	4	FLOAT (single precision)
double	480	8	FLOAT (double precision)
single-character form	452	1	CHAR(1)
NUL-terminated character form	460	length	VARCHAR (length - 1)
VARCHAR structured form	448	length	VARCHAR (length)
single-graphic form	468	1	GRAPHIC(1)
NUL-terminated single-graphic form	400	length	VARGRAPHIC (length - 1)
VARGRAPHIC structured form	464	length	VARGRAPHIC (length)

You can use the following table to determine the C or C++ data type that is equivalent to a given SQL data type.

Table 2. SQL data types mapped to typical C or C++ declarations

SQL data type	C or C++ data type	Notes
SMALLINT	short int	
INTEGER	long int	
BIGINT	long long int	
DECIMAL(p,s)	decimal(p,s)	p is a positive integer from 1 to 63, and s is a positive integer from 0 to 63.
NUMERIC(p,s) or nonzero scale binary	No exact equivalent	Use DECIMAL (p,s).
DECFLOAT(16)	_Decimal64	Only supported in C.
DECFLOAT(34)	_Decimal128	Only supported in C.
FLOAT (single precision)	float	
FLOAT (double precision)	double	
CHAR(1)	single-character form	
CHAR(n)	No exact equivalent	If $n > 1$ , use NUL-terminated character form.
VARCHAR(n)	NUL-terminated character form	Allow at least $n+1$ to accommodate the NUL-terminator. If data can contain character NULs (/0), use VARCHAR structured form or SQL VARCHAR.  $n$ is a positive integer. The maximum value of $n$ is 32740.
	VARCHAR structured form	The maximum value of $n$ is 32740. The SQL VARCHAR form may also be used.
CLOB	None	Use SQL TYPE IS to declare a CLOB in C or C++.
GRAPHIC (1)	single-graphic form	
GRAPHIC (n)	No exact equivalent	
VARGRAPHIC(n)	NUL-terminated graphic form	If $n > 1$ , use NUL-terminated graphic form.
	VARGRAPHIC structured form	If data can contain graphic NUL values (/0/0), use VARGRAPHIC structured form. Allow at least $n + 1$ to accommodate the NUL-terminator.  $n$ is a positive integer. The maximum value of $n$ is 16370.
DBCLOB	None	Use SQL TYPE IS to declare a DBCLOB in C or C++.

Table 2. SQL data types mapped to typical C or C++ declarations (continued)

SQL data type	C or C++ data type	Notes
BINARY	None	Use SQL TYPE IS to declare a BINARY in C or C++.
VARBINARY	None	Use SQL TYPE IS to declare a VARBINARY in C or C++.
BLOB	None	Use SQL TYPE IS to declare a BLOB in C or C++.
DATE	NUL-terminated character form	If the format is *USA, *ISO, *JIS, or *EUR, allow at least 11 characters to accommodate the NUL-terminator. If the format is *MDY, *YMD, or *DMY, allow at least 9 characters to accommodate the NUL-terminator. If the format is *JUL, allow at least 7 characters to accommodate the NUL-terminator.
	VARCHAR structured form	If the format is *USA, *ISO, *JIS, or *EUR, allow at least 10 characters. If the format is *MDY, *YMD, or *DMY, allow at least 8 characters. If the format is *JUL, allow at least 6 characters.
TIME	NUL-terminated character form	Allow at least 7 characters (9 to include seconds) to accommodate the NUL-terminator.
	VARCHAR structured form	Allow at least 6 characters; 8 to include seconds.
TIMESTAMP	NUL-terminated character form	Allow at least 20 characters (33 to include all fractional seconds) to accommodate the NUL-terminator. If n is less than 33, truncation occurs on the fractional seconds part.
	VARCHAR structured form	Allow at least 19 characters. To include all fractional seconds, allow 32 characters. If the number of characters is less than 32, truncation occurs on the fractional seconds part.
BOOLEAN	None	Use SQL TYPE IS to declare BOOLEAN in C or C++.
XML	None	Use SQL TYPE IS to declare XML in C or C++.
DATALINK	Not supported	

Table 2. SQL data types mapped to typical C or C++ declarations (continued)

SQL data type	C or C++ data type	Notes
ROWID	None	Use SQL TYPE IS to declare a ROWID in C or C++.
Result set locator	None	Use SQL TYPE IS to declare a result set locator in C or C++.

## Notes on C and C++ variable declaration and usage

Single quotation marks (') and quotation marks (") have different meanings in C, C++, and SQL.

C and C++ use quotation marks to delimit string constants and single quotation marks to delimit character constants. In contrast, SQL uses quotation marks for delimited identifiers and uses single quotation marks to delimit character string constants. Character data in SQL is distinct from integer data.

## Using indicator variables in C and C++ applications that use SQL

An indicator variable is a two-byte integer (short int).

You can also specify an indicator structure (defined as an array of halfword integer variables) to support a host structure.

Indicator variables are declared in the same way as host variables. The declarations of the two can be mixed in any way that seems appropriate to you.

### Example

Given the statement:

```
EXEC SQL FETCH CLS_CURSOR INTO :ClsCd,
                                :Day :DayInd,
                                :Bgn :BgnInd,
                                :End :EndInd;
```

Variables can be declared as follows:

```
EXEC SQL BEGIN DECLARE SECTION;
char   ClsCd[8];
char   Bgn[9];
char   End[9];
short  Day, DayInd, BgnInd, EndInd;
EXEC SQL END DECLARE SECTION;
```

### Related reference

[References to variables](#)

[Indicator variables in applications that use SQL](#)

An *indicator variable* is a halfword integer variable used to communicate additional information about its associated host variable.

## Coding SQL statements in COBOL applications

There are unique application and coding requirements for embedding SQL statements in a COBOL program. In this topic, requirements for host structures and host variables are defined.

The IBM i products support more than one COBOL compiler. The IBM Db2 Query Manager and SQL Development Kit for i licensed program only supports the OPM COBOL and ILE COBOL programming languages.

**Note:** By using the code examples, you agree to the terms of the [“Code license and disclaimer information”](#) on page 198.

## Related concepts

[Writing applications that use SQL](#)

You can create database applications in host languages that use Db2 for i SQL statements and functions.

## Related reference

[Example programs: Using Db2 for i statements](#)

Here is a sample application that shows how to code SQL statements in each of the languages that Db2 for i supports.

[Example: SQL statements in COBOL and ILE COBOL programs](#)

This example program is written in the COBOL programming language.

## Defining the SQL communication area in COBOL applications that use SQL

A COBOL program can be written to use the SQL communication area (SQLCA) to check return status for embedded SQL statements, or the program can use the SQL diagnostics area to check return status.

To use the SQL diagnostics area instead of the SQLCA, use the SET OPTION SQL statement with the option SQLCA = \*NO.

When using the SQLCA, a COBOL program that contains SQL statements must include one or both of the following:

- An SQLCODE variable declared as PICTURE S9(9) BINARY, PICTURE S9(9) COMP-4, or PICTURE S9(9) COMP.
- An SQLSTATE variable declared as PICTURE X(5).

Or,

- An SQLCA (which contains an SQLCODE and SQLSTATE variable).

The SQLCODE and SQLSTATE values are set by the database manager after each SQL statement is run. An application can check the SQLCODE or SQLSTATE value to determine whether the last SQL statement was successful.

The SQLCA can be coded in a COBOL program either directly or by using the SQL INCLUDE statement. When coding it directly, make sure it is initialized. Using the SQL INCLUDE statement requests the inclusion of a standard declaration:

```
EXEC SQL INCLUDE SQLCA END-EXEC.
```

The SQLCODE, SQLSTATE, and SQLCA variable declarations must appear in the WORKING-STORAGE SECTION or LINKAGE SECTION of your program and can be placed wherever a record description entry can be specified in those sections.

When you use the INCLUDE statement, the SQL COBOL precompiler includes COBOL source statements for the SQLCA:

```
01 SQLCA.  
  05 SQLCAID      PIC X(8). VALUE X"0000000000000000".  
  05 SQLCABC      PIC S9(9) BINARY.  
  05 SQLCODE      PIC S9(9) BINARY.  
  05 SQLERRM.  
    49 SQLERRML   PIC S9(4) BINARY.  
    49 SQLERRMC   PIC X(70).  
  05 SQLERRP      PIC X(8).  
  05 SQLERRD      OCCURS 6 TIMES  
                  PIC S9(9) BINARY.  
  05 SQLWARN.  
    10 SQLWARN0   PIC X.  
    10 SQLWARN1   PIC X.  
    10 SQLWARN2   PIC X.  
    10 SQLWARN3   PIC X.  
    10 SQLWARN4   PIC X.  
    10 SQLWARN5   PIC X.  
    10 SQLWARN6   PIC X.  
    10 SQLWARN7   PIC X.  
    10 SQLWARN8   PIC X.  
    10 SQLWARN9   PIC X.
```

```
10 SQLWARNA PIC X.  
05 SQLSTATE PIC X(5).
```

For ILE COBOL, the SQLCA is declared using the GLOBAL clause. SQLCODE is replaced with SQLCADE when a declaration for SQLCODE is found in the program and the SQLCA is provided by the precompiler. SQLSTATE is replaced with SQLSTOTE when a declaration for SQLSTATE is found in the program and the SQLCA is provided by the precompiler.

### Related concepts

[Using the SQL diagnostics area](#)

The SQL diagnostics area is used to keep the returned information for an SQL statement that has been run in a program. It contains all the information that is available to you as an application programmer through the SQLCA.

### Related reference

[SQL communication area](#)

## Defining SQL descriptor areas in COBOL applications that use SQL

There are two types of SQL descriptor areas (SQLDAs). One is defined with the ALLOCATE DESCRIPTOR statement. The other is defined using the SQLDA structure. In this topic, only the SQLDA form is discussed.

The following statements can use an SQLDA:

- EXECUTE...USING DESCRIPTOR *descriptor-name*
- FETCH...USING DESCRIPTOR *descriptor-name*
- OPEN...USING DESCRIPTOR *descriptor-name*
- CALL...USING DESCRIPTOR *descriptor-name*
- DESCRIBE *statement-name* INTO *descriptor-name*
- DESCRIBE CURSOR *cursor-name* INTO *descriptor-name*
- DESCRIBE INPUT *statement-name* INTO *descriptor-name*
- DESCRIBE PROCEDURE *procedure-name* INTO *descriptor-name*
- DESCRIBE TABLE *host-variable* INTO *descriptor-name*
- PREPARE *statement-name* INTO *descriptor-name*

Unlike the SQLCA, there can be more than one SQLDA in a program. The SQLDA can have any valid name. An SQLDA can be coded in a COBOL program directly or added with the INCLUDE statement. Using the SQL INCLUDE statement requests the inclusion of a standard SQLDA declaration:

```
EXEC SQL INCLUDE SQLDA END-EXEC.
```

The COBOL declarations included for the SQLDA are:

```

1 SQLDA.
05 SQLDAID      PIC X(8).
05 SQLDABC     PIC S9(9) BINARY.
05 SQLN       PIC S9(4) BINARY.
05 SQLD       PIC S9(4) BINARY.
05 SQLVAR OCCURS 0 TO 409 TIMES DEPENDING ON SQLD.
10 SQLVAR1.
15 SQLTYPE     PIC S9(4) BINARY.
15 SQLLEN     PIC S9(4) BINARY.
15 FILLER     REDEFINES SQLLEN.
20 SQLPRECISION PIC X.
20 SQLSCALE   PIC X.
15 SQLRES     PIC X(12).
15 SQLDATA    POINTER.
15 SQL-RESULT-SET-LOCATOR-R REDEFINES SQLDATA.
20 SQL-RESULT-SET-LOCATOR PIC S9(18) BINARY.
15 SQLIND     POINTER.
15 SQL-ROW-CHANGE-SQL-R REDEFINES SQLIND.
20 SQLD-ROW-CHANGE FIC S9(9) BINARY.
15 SQL-RESULT-SET-ROWS-R PIC REDEFINES SQLIND.
20 SQLD-RESULT-SET-ROWS PIC S9(9) BINARY.
15 SQLNAME.
49 SQLNAMEL PIC S9(4) BINARY.
49 SQLNAMEC PIC X(30).
10 SQLVAR2 REDEFINES SQLVAR1.
15 SQLVAR2-RESERVED-1 PIC S9(9) BINARY.
15 SQLLONGLEN REDEFINES SQLVAR2-RESERVED-1
PIC S9(9) BINARY.
15 SQLVAR2-RESERVED-2 PIC X(28).
15 SQLDATALEN POINTER.
15 SQLDATATYPE-NAME.
49 SQLDATATYPE_NAMEL PIC S9(4) BINARY.
49 SQLDATATYPE_NAMEC PIC X(30).

```

Figure 1. INCLUDE SQLDA declarations for COBOL

SQLDA declarations must appear in the WORKING-STORAGE SECTION or LINKAGE SECTION of your program and can be placed wherever a record description entry can be specified in those sections. For ILE COBOL, the SQLDA is declared using the GLOBAL clause.

Dynamic SQL is an advanced programming technique. With dynamic SQL, your program can develop and then run SQL statements while the program is running. A SELECT statement with a variable SELECT list (that is, a list of the data to be returned as part of the query) that runs dynamically requires an SQL descriptor area (SQLDA). This is because you cannot know in advance how many or what type of variables to allocate in order to receive the results of the SELECT.

#### Related concepts

[Dynamic SQL applications](#)

#### Related reference

[SQL descriptor area](#)

## Embedding SQL statements in COBOL applications that use SQL

SQL statements can be coded in COBOL program sections as in this table.

SQL statement	Program section
BEGIN DECLARE SECTION	WORKING-STORAGE SECTION or LINKAGE SECTION
END DECLARE SECTION	
DECLARE VARIABLE	
DECLARE STATEMENT	

SQL statement	Program section
INCLUDE SQLCA	WORKING-STORAGE SECTION or LINKAGE SECTION
INCLUDE SQLDA	
INCLUDE member-name	DATA DIVISION or PROCEDURE DIVISION
Other	PROCEDURE DIVISION

Each SQL statement in a COBOL program must begin with EXEC SQL and end with END-EXEC. If the SQL statement appears between two COBOL statements, the period is optional and might not be appropriate. The EXEC SQL keywords must appear all on one line, but the remainder of the statement can appear on the next and subsequent lines.

### Example

An UPDATE statement coded in a COBOL program might be coded as follows:

```
EXEC SQL
  UPDATE DEPARTMENT
  SET MGRNO = :MGR-NUM
  WHERE DEPTNO = :INT-DEPT
END-EXEC.
```

### Comments in COBOL applications that use SQL

In addition to SQL comments (--), you can include COBOL comment lines (\* or / in column 7) within embedded SQL statements except between the keywords EXEC and SQL. Single line comments (\*>) can also be used. COBOL debugging lines (D in column 7) are treated as comment lines by the precompiler.

### Continuation for SQL statements in COBOL applications that use SQL

The line continuation rules for SQL statements are the same as those for other COBOL statements, except that EXEC SQL must be specified within one line.

If you continue a string constant from one line to the next, the first nonblank character in the next line must be either an apostrophe or a quotation mark. If you continue a delimited identifier from one line to the next, the first nonblank character in the next line must be either an apostrophe or a quotation mark.

Constants containing DBCS data can be continued across multiple lines by placing the shift-in character in column 72 of the continued line and the shift-out after the first string delimiter of the continuation line.

This SQL statement has a valid graphic constant of G'<AABBCCDDEEFFGGHHIIJJKK>!. The redundant shifts are removed.

```
*...+...1...+...2...+...3...+...4...+...5...+...6...+...7...+...8
EXEC SQL
SELECT * FROM GRAPHTAB      WHERE GRAPHCOL = G'<AABB>
-   '<CCDDEEFFGGHHIIJJKK>'
END-EXEC.
```

### Including code in COBOL applications that use SQL

SQL statements or COBOL host variable declaration statements can be included by embedding the following SQL statement in the source code where the statements are to be embedded.

```
EXEC SQL INCLUDE member-name END-EXEC.
```

COBOL COPY statements cannot be used to include SQL statements or declarations of COBOL host variables that are referenced in SQL statements.

## Margins in COBOL applications that use SQL

You must code SQL statements in columns 12 through 72. If EXEC SQL starts before the specified margin (that is, before column 12), the SQL precompiler does not recognize the statement.

## Sequence numbers in COBOL applications that use SQL

The source statements generated by the SQL precompiler are generated with the same sequence number as the SQL statement.

## Names in COBOL applications that use SQL

Any valid COBOL variable name can be used for a host variable and is subject to the following restrictions:

Do not use host variable names or external entry names that begin with 'SQL', 'RDI', or 'DSN'. These names are reserved for the database manager.

Using structures that contain FILLER may not work as expected in an SQL statement. It is recommended that all fields within a COBOL structure be named to avoid unexpected results.

## COBOL compile-time options in COBOL applications that use SQL

The COBOL PROCESS statement can be used to specify the compile-time options for the COBOL compiler.

Although the PROCESS statement will be recognized by the COBOL compiler when it is called by the precompiler to create the program; the SQL precompiler itself does not recognize the PROCESS statement. Therefore, options that affect the syntax of the COBOL source such as APOST and QUOTE should not be specified in the PROCESS statement. Instead \*APOST and \*QUOTE should be specified in the OPTION parameter of the **CRTSQLCBL** and **CRTSQLCBLI** commands.

## Statement labels in COBOL applications that use SQL

Executable SQL statements in the PROCEDURE DIVISION can be preceded by a paragraph name.

## WHENEVER statement in COBOL applications that use SQL

The target for the GOTO or a DO PERFORM clause in an SQL WHENEVER statement must be a section name or unqualified paragraph name in the PROCEDURE DIVISION. The target for the DO clause must be a COBOL procedure name. The scope rules for procedures must be observed.

## Multiple source COBOL programs and the SQL COBOL precompiler

The SQL COBOL precompiler does not support precompiling multiple source programs separated with the PROCESS statement.

## Using host variables in COBOL applications that use SQL

All host variables used in SQL statements must be explicitly declared prior to their first use.

The COBOL statements that are used to define the host variables should be preceded by a BEGIN DECLARE SECTION statement and followed by an END DECLARE SECTION statement. If a BEGIN DECLARE SECTION and END DECLARE SECTION are specified, all host variable declarations used in SQL statements must be between the BEGIN DECLARE SECTION and the END DECLARE SECTION statements.

All host variables within an SQL statement must be preceded by a colon (:).

Host variables cannot be records or elements.

To accommodate using dashes within a COBOL host variable name, blanks must precede and follow a minus sign.

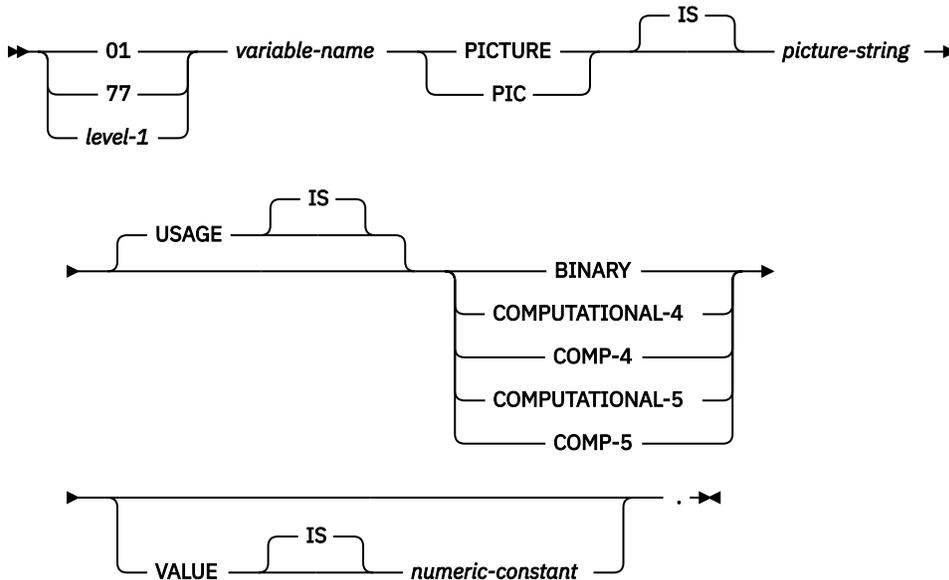
## Declaring host variables in COBOL applications that use SQL

The COBOL precompiler only recognizes a subset of valid COBOL declarations as valid host variable declarations.

### ***Numeric host variables in COBOL applications that use SQL***

This figure shows the syntax for valid integer host variable declarations.

#### **BIGINT and INTEGER and SMALLINT**

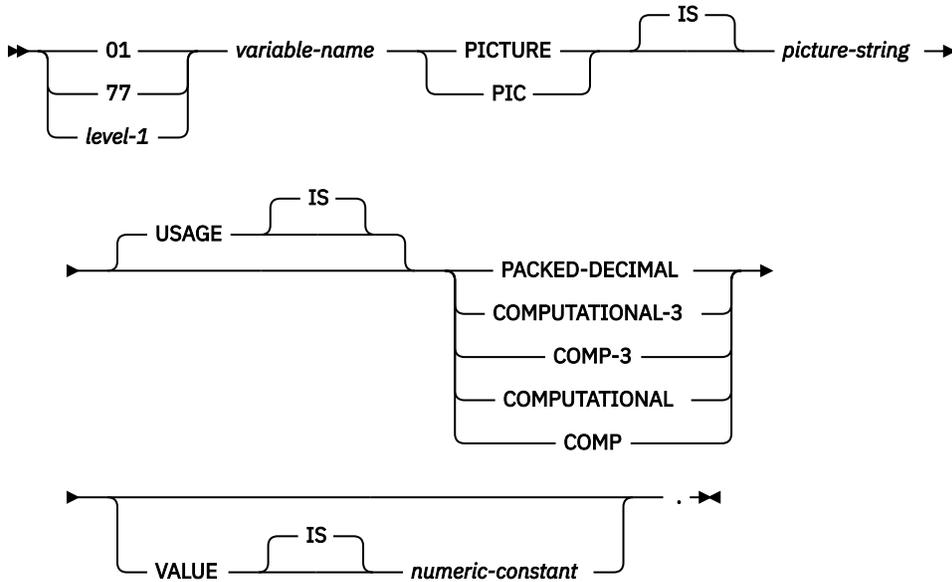


#### **Notes:**

1. BINARY, COMPUTATIONAL-4, COMP-4, COMPUTATIONAL-5, and COMP-5 are equivalent. A portable application should code BINARY, because COMPUTATIONAL-4, COMP-4, COMPUTATIONAL-5, and COMP-5 are IBM extensions that are not supported in International Organization for Standardization (ISO)/ANSI COBOL. The *picture-string* associated with these types must have the form S9(i)V9(d) (or S9...9V9...9, with *i* and *d* instances of 9).  $i + d$  must be less than or equal to 18.
2. *level-1* indicates a COBOL level between 2 and 48.
3. COMPUTATIONAL-5 and COMP-5 are only supported for ILE COBOL.

The following figure shows the syntax for valid decimal host variable declarations.

## DECIMAL

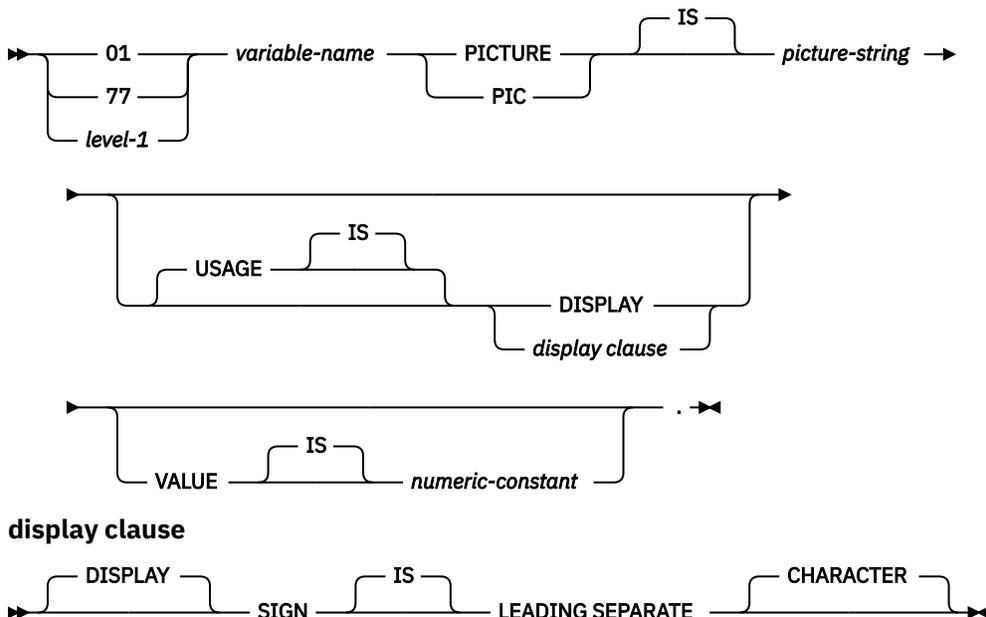


### Notes:

1. PACKED-DECIMAL, COMPUTATIONAL-3, and COMP-3 are equivalent. A portable application should code PACKED-DECIMAL, because COMPUTATIONAL-3 and COMP-3 are IBM extensions that are not supported in ISO/ANS COBOL. The *picture-string* associated with these types must have the form S9(i)V9(d) (or S9...9V9...9, with *i* and *d* instances of 9).  $i + d$  must be less than or equal to 63.
2. COMPUTATIONAL and COMP are equivalent. The picture strings associated with these and the data types they represent are product-specific. Therefore, COMP and COMPUTATIONAL should not be used in a portable application. In an OPM COBOL program, the *picture-string* associated with these types must have the form S9(i)V9(d) (or S9...9V9...9, with *i* and *d* instances of 9).  $i + d$  must be less than or equal to 63.
3. *level-1* indicates a COBOL level between 2 and 48.

The following figure shows the syntax for valid numeric host variable declarations.

## Numeric



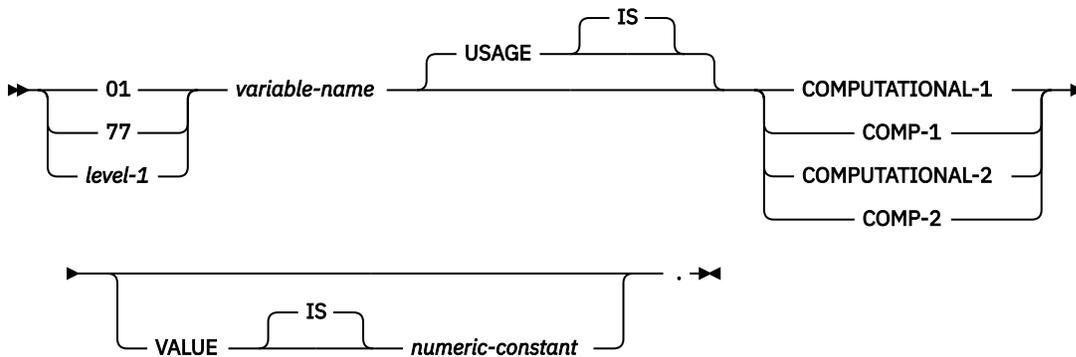
**Notes:**

1. The *picture-string* associated with SIGN LEADING SEPARATE and DISPLAY must have the form S9(i)V9(d) (or S9...9V9...9, with *i* and *d* instances of 9). *i* + *d* must be less than or equal to 18.
2. *level-1* indicates a COBOL level between 2 and 48.

**Floating-point host variables in COBOL applications that use SQL**

This figure shows the syntax for valid floating-point host variable declarations. Floating-point host variables are only supported for ILE COBOL.

**Floating-point**



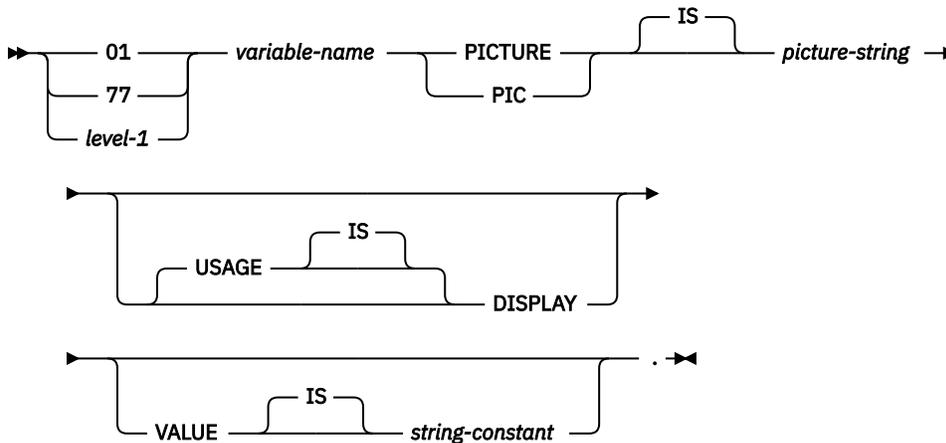
**Notes:**

1. COMPUTATIONAL-1 and COMP-1 are equivalent. COMPUTATIONAL-2 and COMP-2 are equivalent.
2. *level-1* indicates a COBOL level between 2 and 48.

**Character host variables in COBOL applications that use SQL**

There are two valid forms of character host variables: fixed-length strings and varying-length strings.

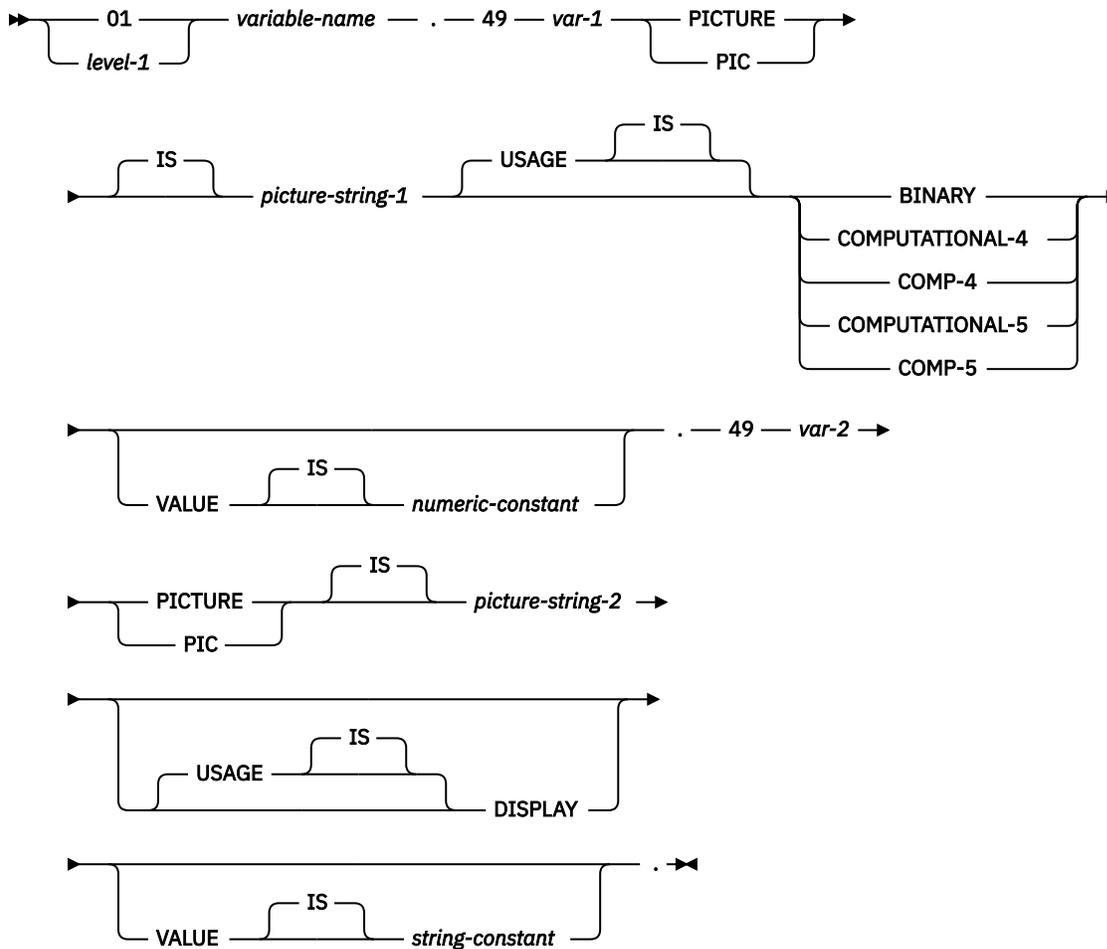
**Fixed-length character strings**



**Notes:**

1. The *picture-string* associated with these forms must be X(*m*) (or XXX...X, with *m* instances of X) with  $1 \leq m \leq 32\,766$ .
2. *level-1* indicates a COBOL level between 2 and 48.

## Varying-length character strings



### Notes:

1. The *picture-string-1* associated with these forms must be S9(*m*) or S9...9 with *m* instances of 9. *m* must be from 1 to 4.

Note that the database manager uses the full size of the S9(*m*) variable even though OPM COBOL only recognizes values up to the specified precision. This can cause data truncation errors when COBOL statements are being run, and might effectively limit the maximum length of variable-length character strings to the specified precision.

2. The *picture-string-2* associated with these forms must be either X(*m*), or XX...X, with *m* instances of X, and with  $1 \leq m \leq 32\,740$ .
3. *var-1* and *var-2* cannot be used as host variables.
4. *level-1* indicates a COBOL level between 2 and 48.
5. COMPUTATIONAL-5 and COMP-5 are only supported for ILE COBOL.

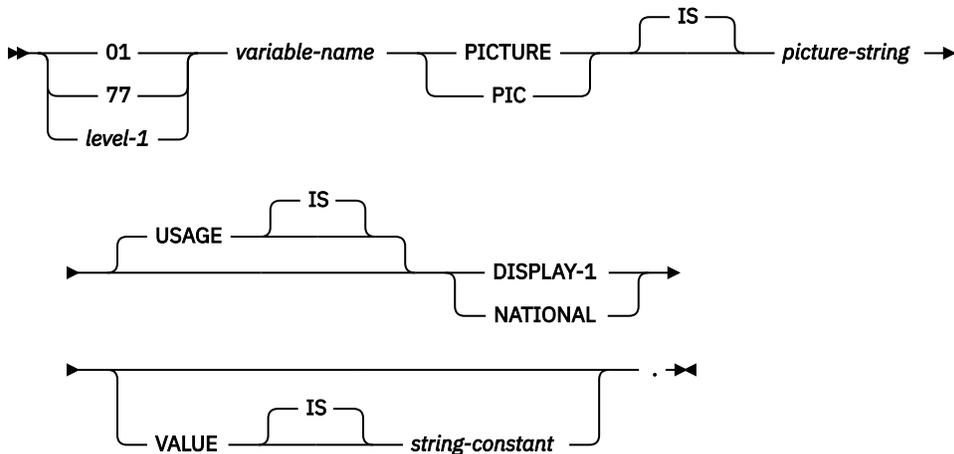
### **Graphic host variables in COBOL applications that use SQL**

Graphic host variables are only supported in ILE COBOL.

There are two valid forms of graphic host variables:

- Fixed-length graphic strings
- Varying-length graphic strings

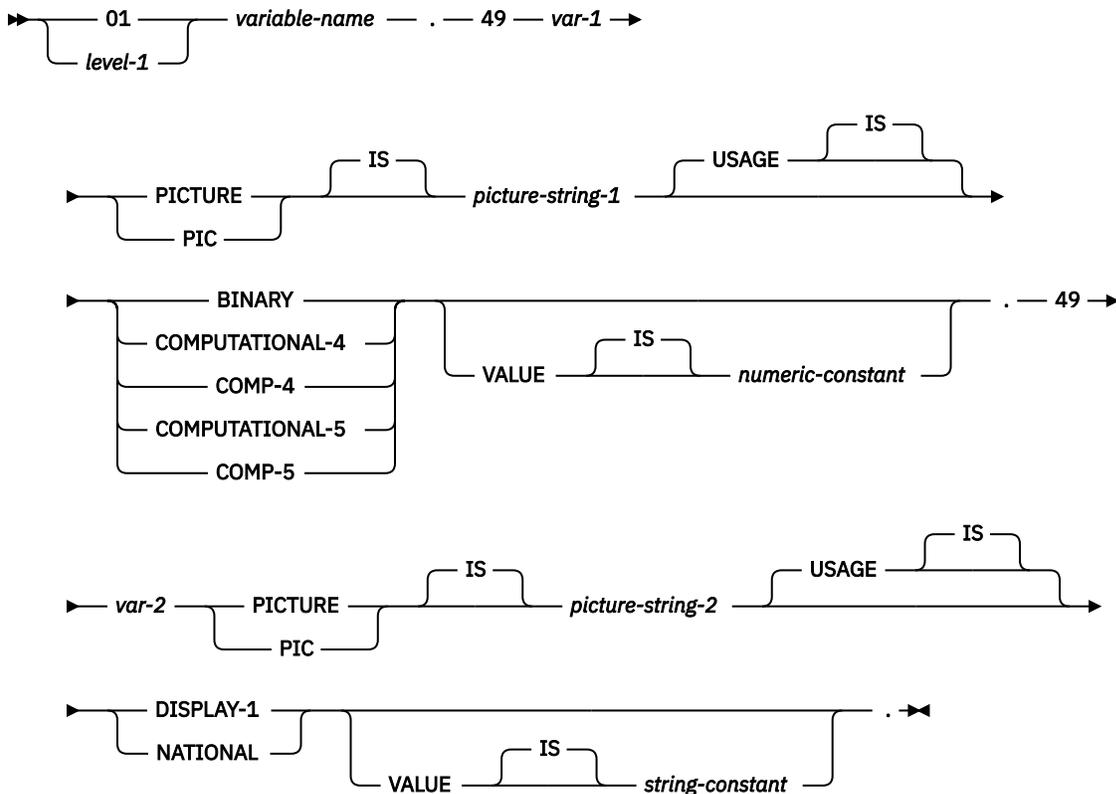
## Fixed-length graphic strings



### Notes:

1. The *picture-string* associated with the DISPLAY-1 form must be G(*m*) (or GGG...G, with *m* instances of G) or N(*m*) (or NNN...N, with *m* instances of N) with  $1 \leq m \leq 16\,383$ .
2. The *picture-string* associated with the NATIONAL form must be N(*m*) (or NNN...N, with *m* instances of N) with  $1 \leq m \leq 16\,383$ . NATIONAL is only supported for ILE COBOL. The CCSID is always 1200. You cannot specify a variable that is declared as NATIONAL on the DECLARE VARIABLE statement.
3. *level-1* indicates a COBOL level between 2 and 48.

## Varying-length graphic strings



### Notes:

1. The *picture-string-1* associated with these forms must be S9(*m*) or S9...9 with *m* instances of 9. *m* must be from 1 to 4.

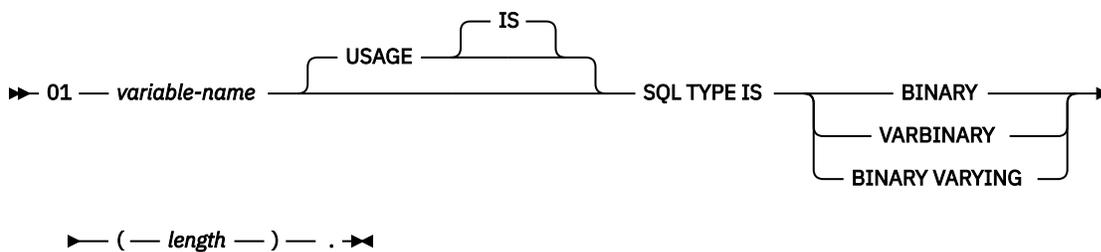
Note that the database manager uses the full size of the S9(*m*) variable even though OPM COBOL only recognizes values up to the specified precision. This can cause data truncation errors when COBOL statements are being run, and might effectively limit the maximum length of variable-length graphic strings to the specified precision.

2. The *picture-string-2* associated with the DISPLAY-1 form must be G(*m*), GG...G with *m* instances of G, N(*m*), or NN...N with *m* instances of N, and with  $1 \leq m \leq 16\ 370$ .
3. The *picture-string-2* associated with the NATIONAL form must be N(*m*) (or NNN...N, with *m* instances of N) with  $1 \leq m \leq 16\ 383$ . NATIONAL is only supported for ILE COBOL. The CCSID is always 1200. You cannot specify a variable that is declared as NATIONAL on the DECLARE VARIABLE statement.
4. The variables *var-1* and *var-2* cannot be used as host variables.
5. *level-1* indicates a COBOL level between 2 and 48.
6. COMPUTATIONAL-5 and COMP-5 are only supported for ILE COBOL.

### Binary host variables in COBOL applications that use SQL

COBOL does not have variables that correspond to the SQL binary data types. To create host variables that can be used with these data types, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a COBOL language structure in the output source member.

### BINARY and VARBINARY



#### Notes:

1. For BINARY host variables, the length must be in the range 1 to 32766.
2. For VARBINARY or BINARY VARYING host variables, the length must be in the range 1 to 32740.
3. SQL TYPE IS, BINARY, VARBINARY, and BINARY VARYING can be in mixed case.

### BINARY Example

The following declaration:

```
01 MY-BINARY SQL TYPE IS BINARY(200).
```

Results in the generation of the following code:

```
01 MY-BINARY PIC X(200).
```

### VARBINARY Example

The following declaration:

```
01 MY-VARBINARY SQL TYPE IS VARBINARY(250).
```

Results in the generation of the following structure:

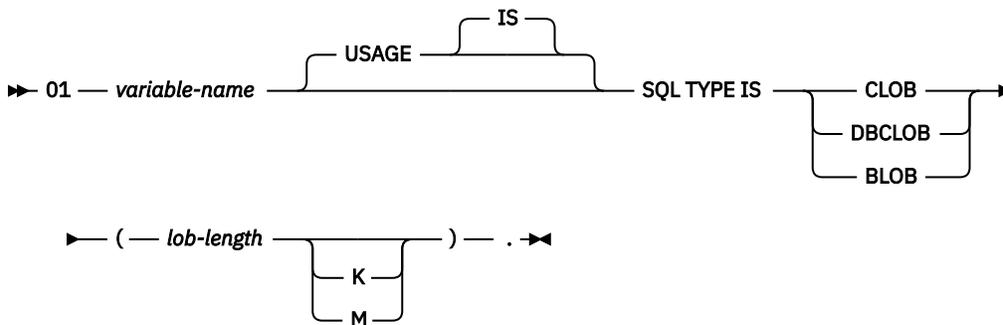
```
01 MY-VARBINARY.  
49 MY-VARBINARY-LENGTH PIC 9(5) BINARY.  
49 MY-VARBINARY-DATA PIC X(250).
```

### **LOB host variables in COBOL applications that use SQL**

COBOL does not have variables that correspond to the SQL data types for LOBs (large objects). To create host variables that can be used with these data types, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a COBOL language structure in the output source member.

LOB host variables are only supported in ILE COBOL.

### **LOB host variables**



#### **Notes:**

1. For BLOB and CLOB,  $1 \leq \text{lob-length} \leq 15,728,640$
2. For DBCLOB,  $1 \leq \text{lob-length} \leq 7,864,320$
3. SQL TYPE IS, BLOB, CLOB, DBCLOB can be in mixed case.

### **CLOB example**

The following declaration:

```
01 MY-CLOB SQL TYPE IS CLOB(16384).
```

Results in the generation of the following structure:

```
01 MY-CLOB.  
49 MY-CLOB-LENGTH PIC 9(9) BINARY.  
49 MY-CLOB-DATA PIC X(16384).
```

### **DBCLOB example**

The following declaration:

```
01 MY-DBCLOB SQL TYPE IS DBCLOB(8192).
```

Results in the generation of the following structure:

```
01 MY-DBCLOB.  
49 MY-DBCLOB-LENGTH PIC 9(9) BINARY.  
49 MY-DBCLOB-DATA PIC G(8192) DISPLAY-1.
```

## BLOB example

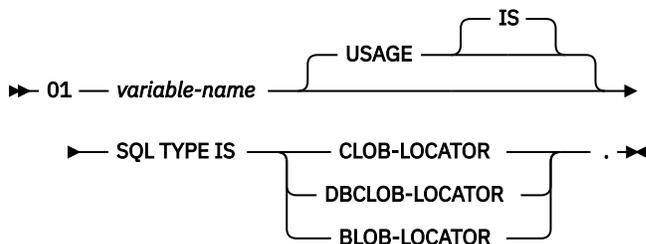
The following declaration:

```
01 MY-BLOB SQL TYPE IS BLOB(16384).
```

Results in the generation of the following structure:

```
01 MY-BLOB.  
  49 MY-BLOB-LENGTH PIC 9(9) BINARY.  
  49 MY-BLOB-DATA PIC X(16384).
```

## LOB locator



### Notes:

1. SQL TYPE IS, BLOB-LOCATOR, CLOB-LOCATOR, DBCLOB-LOCATOR can be in mixed case.
2. LOB locators cannot be initialized in the SQL TYPE IS statement.

CLOB and DBCLOB locators have similar syntax.

## BLOB locator example

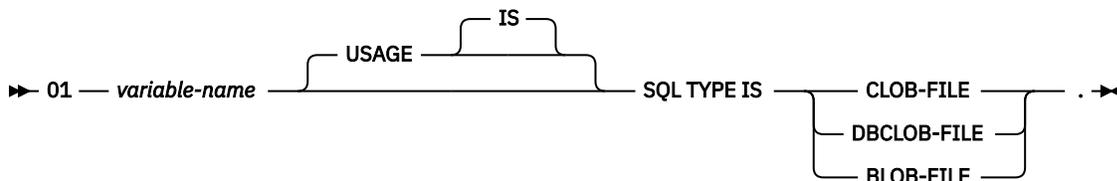
The following declaration:

```
01 MY-LOCATOR SQL TYPE IS BLOB_LOCATOR.
```

Results in the following generation:

```
01 MY-LOCATOR PIC 9(9) BINARY.
```

## LOB file reference variable



**Note:** SQL TYPE IS, BLOB-FILE, CLOB-FILE, DBCLOB-FILE can be in mixed case.

## BLOB file reference example

The following declaration:

```
01 MY-FILE SQL TYPE IS BLOB-FILE.
```

Results in the generation of the following structure:

```
01 MY-FILE.  
  49 MY-FILE-NAME-LENGTH PIC S9(9) COMP-5.
```

```

49 MY-FILE-DATA-LENGTH PIC S9(9) COMP-5.
49 MY-FILE-FILE-OPTIONS PIC S9(9) COMP-5.
49 MY-FILE-NAME PIC X(255).

```

CLOB and DBCLOB file reference variables have similar syntax.

The precompiler generates declarations for the following file option constants. You can use these constants to set the xxx-FILE-OPTIONS variable when you use file reference host variables.

- SQL\_FILE\_READ (2)
- SQL\_FILE\_CREATE (8)
- SQL\_FILE\_OVERWRITE (16)
- SQL\_FILE\_APPEND (32)

### Related reference

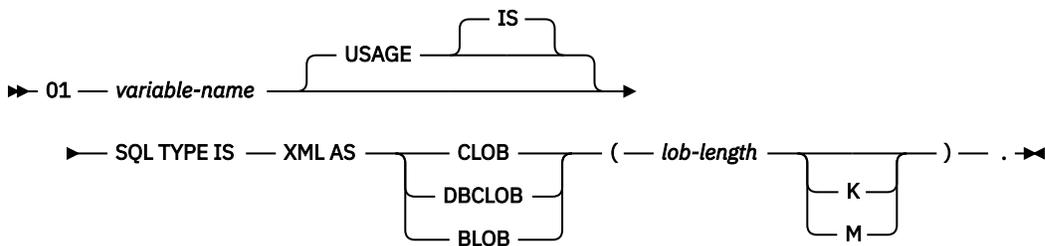
[LOB file reference variables](#)

### XML host variables in COBOL applications that use SQL

COBOL does not have variables that correspond to the SQL data type for XML. To create host variables that can be used with this data type, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a COBOL language structure in the output source member.

XML host variables are only supported in ILE COBOL.

### XML host variables



### Notes:

1. For BLOB and CLOB,  $1 \leq \text{lob-length} \leq 15,728,640$
2. For DBCLOB,  $1 \leq \text{lob-length} \leq 7,864,320$
3. SQL TYPE IS, XML AS, BLOB, CLOB, DBCLOB can be in mixed case.
4. The CCSID value for an XML host variable can be explicitly set by the DECLARE VARIABLE statement. Otherwise, the value specified by the SQL\_XML\_DATA\_CCSDI QAQQINI option will be used. The default for this QAQQINI option is CCSID 1208.

### XML example

The following declaration:

```
01 MY-XML SQL TYPE IS CLOB(5000).
```

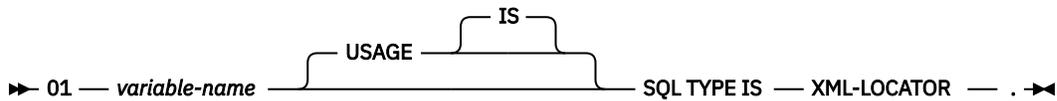
Results in the generation of the following structure:

```

01 MY-XML.
  49 MY-XML-LENGTH PIC 9(9) BINARY.
  49 MY-XML-DATA PIC X(5000).

```

## XML locator



### Notes:

1. SQL TYPE IS, XML AS, XML-LOCATOR can be in mixed case.
2. LOB locators cannot be initialized in the SQL TYPE IS statement.

## XML locator example

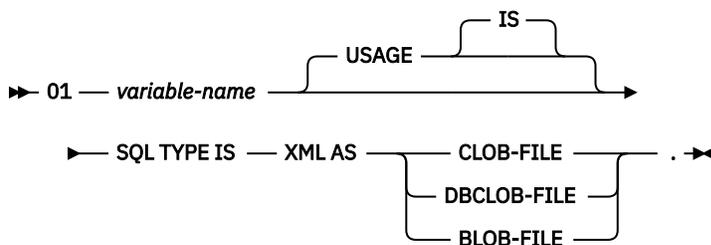
The following declaration:

```
01 MY-LOCATOR SQL TYPE IS XML-LOCATOR.
```

Results in the following generation:

```
01 MY-LOCATOR PIC 9(9) BINARY.
```

## XML file reference variable



**Note:** SQL TYPE IS, XML AS, BLOB-FILE, CLOB-FILE, DBCLOB-FILE can be in mixed case.

## XML file reference example

The following declaration:

```
01 MY-FILE SQL TYPE IS XML AS CLOB-FILE.
```

Results in the generation of the following structure:

```
01 MY-FILE.  
  49 MY-FILE-NAME-LENGTH PIC S9(9) COMP-5.  
  49 MY-FILE-DATA-LENGTH PIC S9(9) COMP-5.  
  49 MY-FILE-FILE-OPTIONS PIC S9(9) COMP-5.  
  49 MY-FILE-NAME PIC X(255).
```

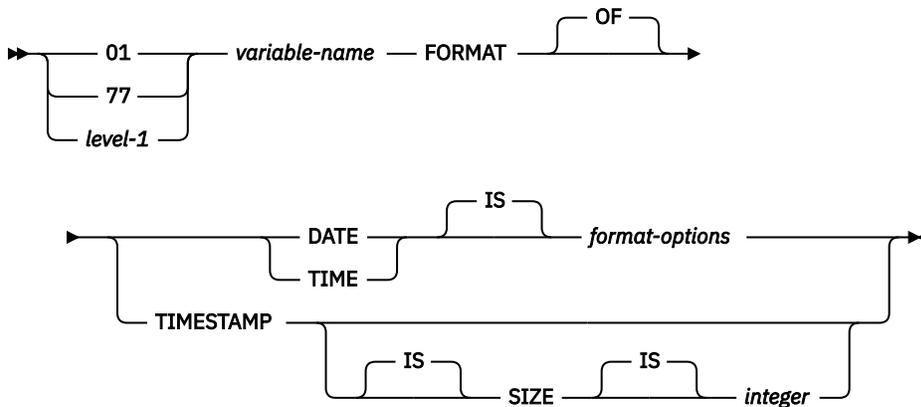
The precompiler generates declarations for the following file option constants. You can use these constants to set the xxx-FILE-OPTIONS variable when you use file reference host variables.

- SQL\_FILE\_READ (2)
- SQL\_FILE\_CREATE (8)
- SQL\_FILE\_OVERWRITE (16)
- SQL\_FILE\_APPEND (32)

## Datetime host variables in COBOL applications that use SQL

This figure shows the syntax for valid date, time, and timestamp host variable declarations. Datetime host variables are supported only for ILE COBOL.

### Datetime host variable



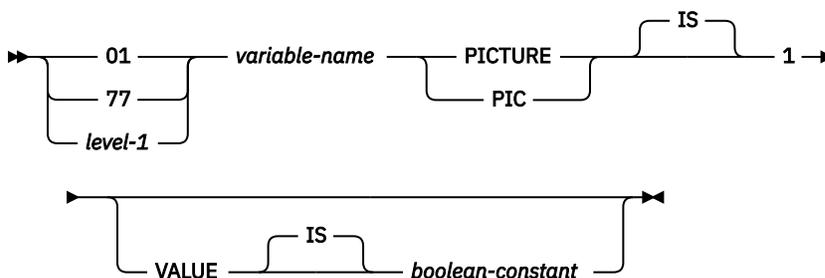
#### Notes:

1. *level-1* indicates a COBOL level between 2 and 48.
2. *format-options* indicates valid datetime options that are supported by the COBOL compiler. See the [ILE COBOL Language Reference](#) manual for details.
3. The value for the `TIMESTAMP SIZE` integer must be 19 to 32.

## Boolean host variables in COBOL applications that use SQL

This figure shows the syntax for valid Boolean host variable declarations. Boolean host variables are supported only for ILE COBOL.

### Boolean host variable



#### Notes:

1. *level-1* indicates a COBOL level between 2 and 48.

## ROWID host variables in COBOL applications that use SQL

COBOL does not have a variable that corresponds to the SQL data type ROWID. To create host variables that can be used with this data type, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a COBOL language structure in the output source member.

### ROWID

```

    ┌── 01 ──┐
    │       │
    └── variable-name ── SQL TYPE IS ROWID ── . ──>
  
```

**Note:** SQL TYPE IS ROWID can be in mixed case.

## ROWID example

The following declaration:

```
01 MY-ROWID SQL TYPE IS ROWID.
```

Results in the generation of the following structure:

```
01 MY-ROWID.  
  49 MY-ROWID-LENGTH PIC 9(2) BINARY.  
  49 MY-ROWID-DATA PIC X(40).
```

## Result set locator host variables in COBOL applications that use SQL

COBOL does not have a variable that corresponds to the SQL result set locator data type. To create host variables that can be used with this data type, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a COBOL language structure in the output source member.

### Result set locator

```
►► 01 — variable-name — USAGE — IS — RESULT_SET_LOCATOR — . ►►
```

**Note:** SQL TYPE IS RESULT\_SET\_LOCATOR can be in mixed case.

## Result set locator example

The following declaration:

```
01 RSL0C1 SQL TYPE IS RESULT_SET_LOCATOR.
```

Results in the generation of the following structure:

```
01 RSL0C1 PIC 9(18) BINARY.
```

## Using host structures in COBOL applications that use SQL

A *host structure* is a named set of host variables that is defined in your program's DATA DIVISION.

Host structures have a maximum of two levels, even though the host structure might itself occur within a multilevel structure. An exception is the declaration of a varying-length character string, which requires another level that must be level 49.

A host structure name can be a group name whose subordinate levels name basic data items. For example:

```
01 A  
  02 B  
    03 C1 PICTURE ...  
    03 C2 PICTURE ...
```

In this example, B is the name of a host structure consisting of the basic items C1 and C2.

When writing an SQL statement using a qualified host variable name (for example, to identify a field within a structure), use the name of the structure followed by a period and the name of the field. For example, specify B.C1 rather than C1 OF B or C1 IN B. However, this guideline applies only to qualified names within SQL statements; you cannot use this technique for writing qualified names in COBOL statements.

A host structure is considered complete if any of the following items are found:

- A COBOL item that must begin in area A
- Any SQL statement (except SQL INCLUDE)

After the host structure is defined, you can refer to it in an SQL statement instead of listing the several host variables (that is, the names of the data items that comprise the host structure).

For example, you can retrieve all column values from selected rows of the table CORPDATA.EMPLOYEE with:

```

01 PEMPL.
  10 EMPNO          PIC X(6).
  10 FIRSTNME.
     49 FIRSTNME-LEN PIC S9(4) USAGE BINARY.
     49 FIRSTNME-TEXT PIC X(12).
  10 MIDINIT       PIC X(1).
  10 LASTNAME.
     49 LASTNAME-LEN PIC S9(4) USAGE BINARY.
     49 LASTNAME-TEXT PIC X(15).
  10 WORKDEPT      PIC X(3).
...
MOVE "000220" TO EMPNO.
...
EXEC SQL
  SELECT *
  INTO :PEMPL
  FROM CORPDATA.EMPLOYEE
  WHERE EMPNO = :EMPNO
END-EXEC.

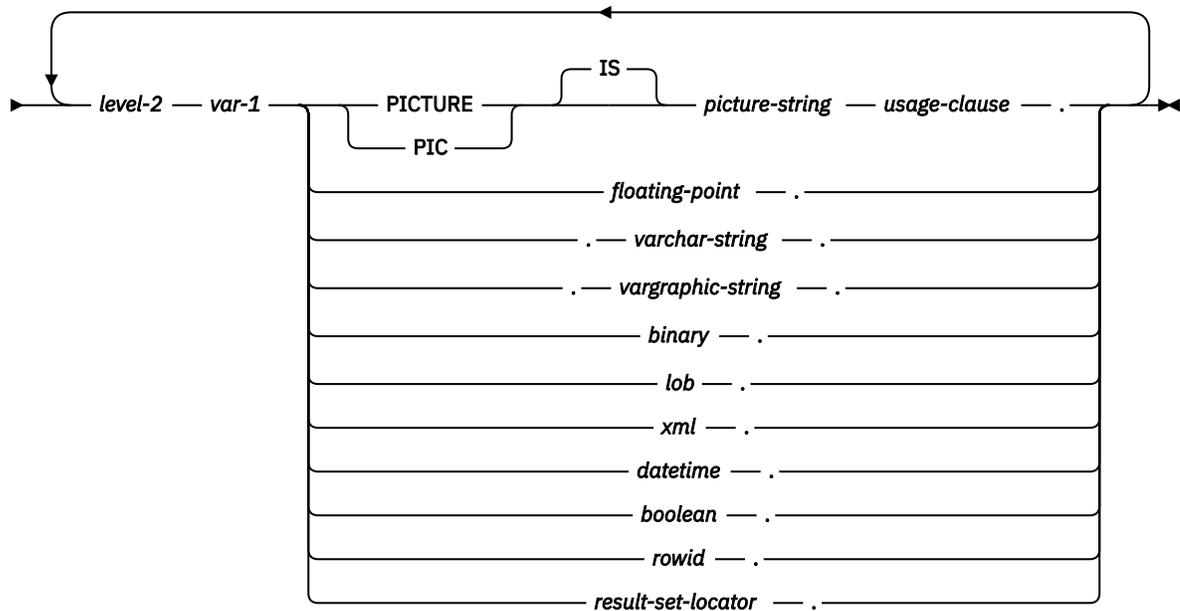
```

Notice that in the declaration of PEMPL, two varying-length string elements are included in the structure: FIRSTNME and LASTNAME.

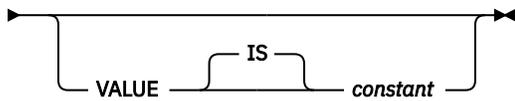
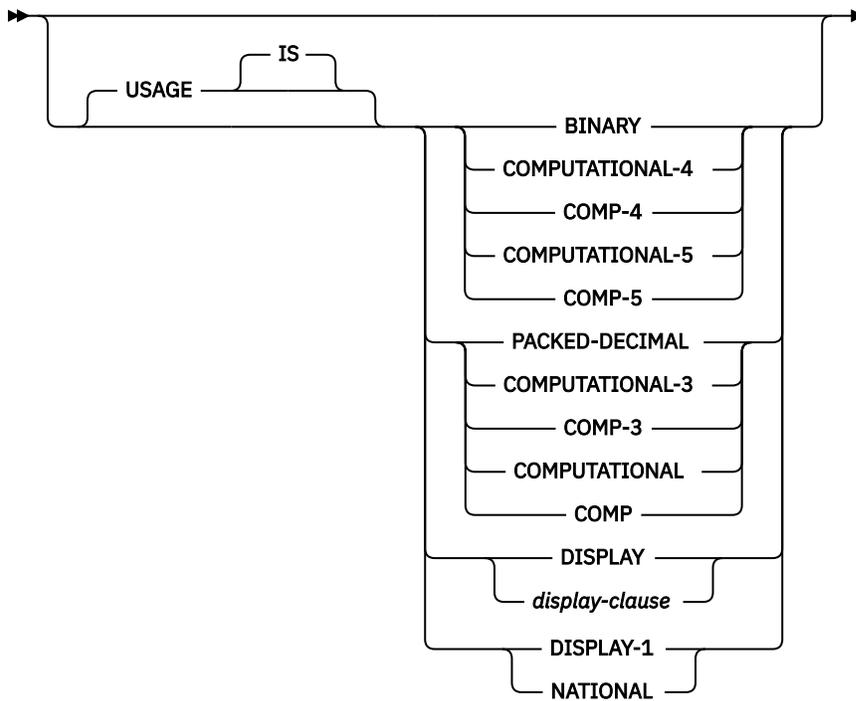
## Host structure in COBOL applications that use SQL

This figure shows the syntax for the valid host structure.

► *level-1* — *variable-name* — . — ►



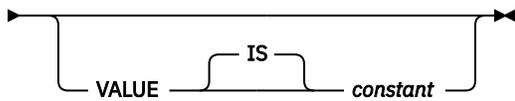
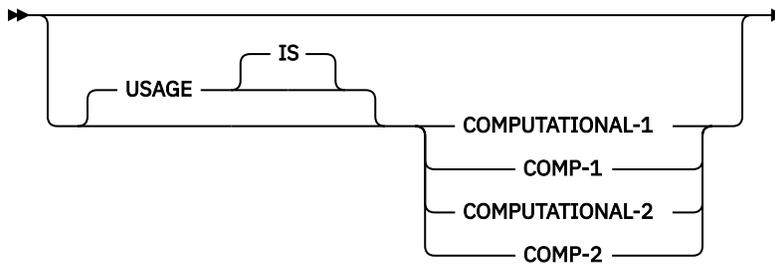
**usage-clause**



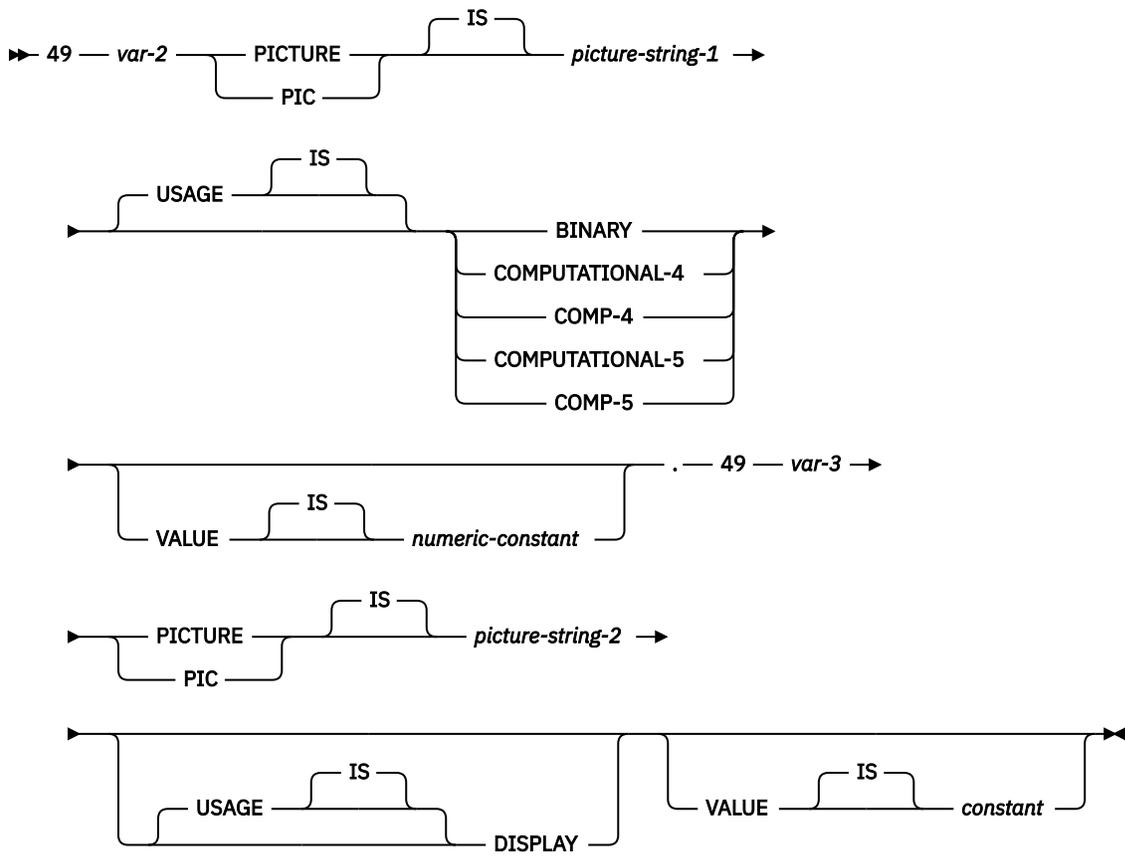
**display-clause**



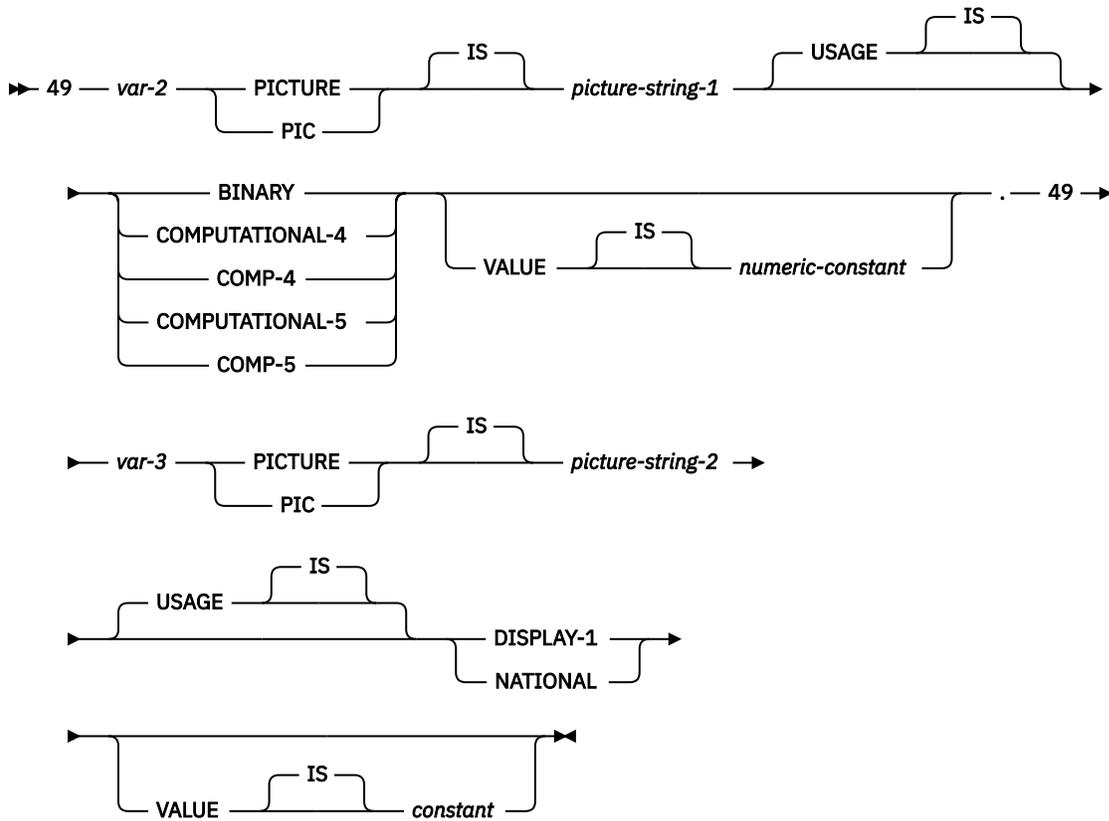
**floating-point**



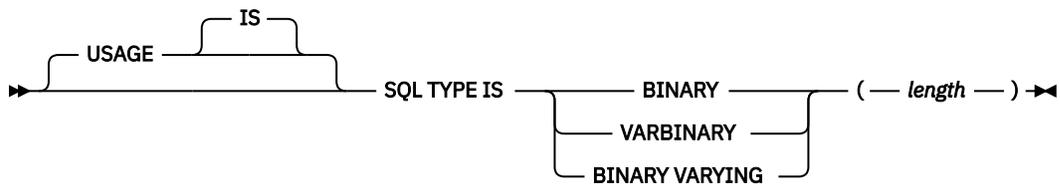
**varchar-string**



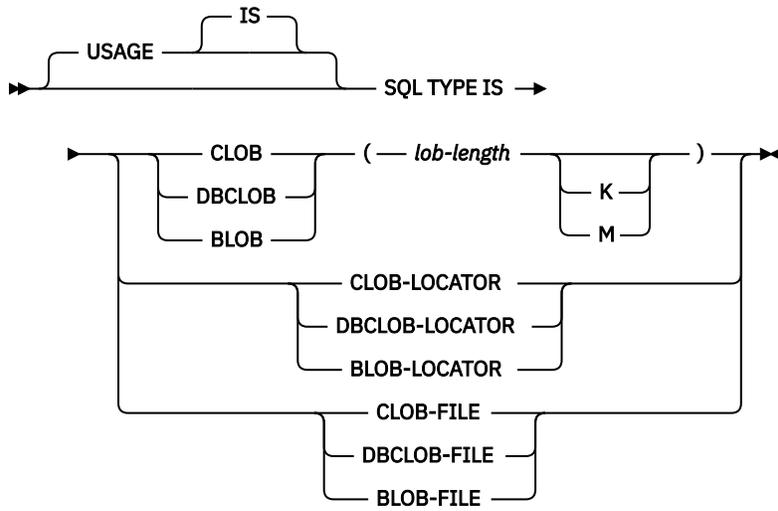
**vargraphic-string**



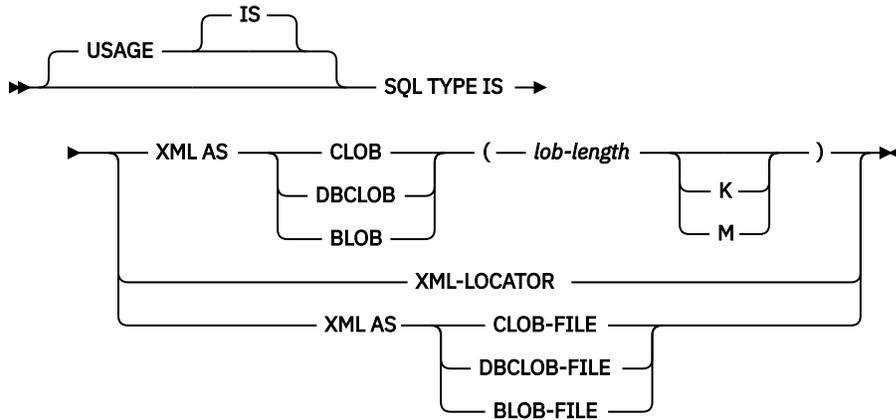
**binary**



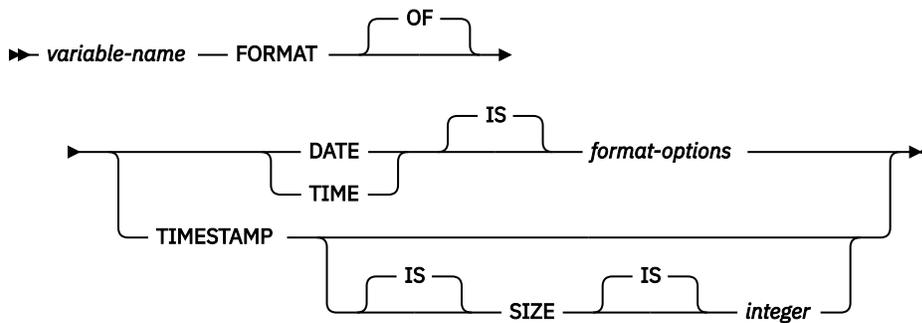
**lob**



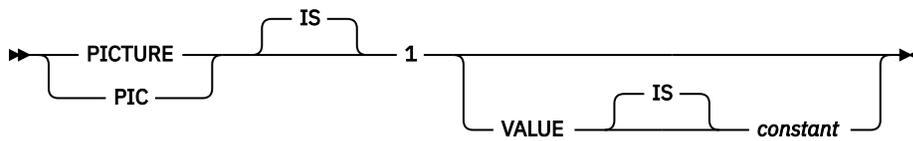
**xml**



**datetime**



**boolean**



**rowid**

▶▶ SQL TYPE IS ROWID ▶▶

**result-set-locator**

▶▶ SQL TYPE IS RESULT\_SET\_LOCATOR ▶▶

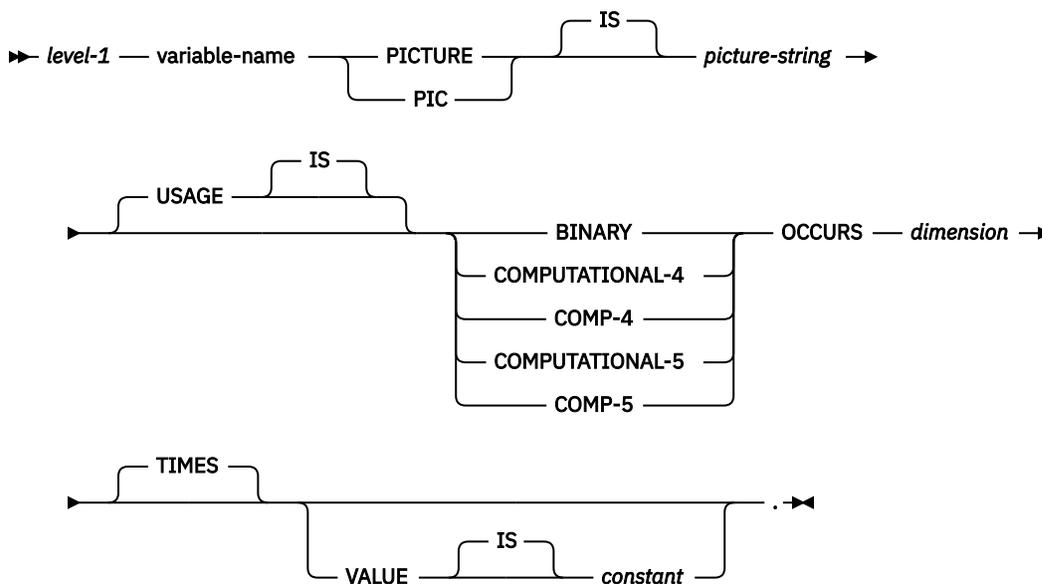
**Notes:**

1. *level-1* indicates a COBOL level between 1 and 47.
2. *level-2* indicates a COBOL level between 2 and 48 where *level-2* > *level-1*.
3. Graphic host variables, LOB host variables, Boolean host variables, XML host variables, floating-point host variables, and COMP-5 host variables are only supported for ILE COBOL.
4. For details on declaring numeric, character, graphic, binary, LOB, Boolean, XML, ROWID, and result set locator host variables, see the notes under numeric-host variables, character-host variables, graphic-host variables, binary host variables, LOB host variables, Boolean host variables, XML host variables, ROWID, and result set locator host variables.
5. The variable *format-options* indicates valid datetime options that are supported by the COBOL compiler. See the [ILE COBOL Language Reference](#) manual for details.
6. The value for the *TIMESTAMP SIZE* integer must be 19 to 32.

**Host structure indicator array in COBOL applications that use SQL**

This figure shows the syntax for valid host structure indicator array declarations.

**Host structure indicator array**



**Notes:**

1. *level-1* must be an integer between 2 and 48.
2. BINARY, COMPUTATIONAL-4, COMP-4, COMPUTATIONAL-5, and COMP-5 are equivalent. A portable application should code BINARY because COMPUTATIONAL-4, COMP-4, COMPUTATIONAL-5, and

COMP-5 are IBM extensions that are not supported in ISO/ANSI COBOL. The *picture-string* associated with these types must have the form S9(*i*) (or S9...9, with *i* instances of 9). *i* must be less than or equal to 4.

## Using host structure arrays in COBOL applications that use SQL

A host structure array is a named set of host variables that is defined in the program's Data Division and has an OCCURS clause.

Host structure arrays have a maximum of two levels, even though the host structure can occur within a multiple level structure. A varying-length string requires another level, level 49. A host structure array name can be a group name whose subordinate levels name basic data items.

In these examples, the following are true:

- All members in B-ARRAY must be valid.
- B-ARRAY cannot be qualified.
- B-ARRAY can only be used on the blocked form of the FETCH and INSERT statements.
- B-ARRAY is the name of an array of host structures containing items C1-VAR and C2-VAR.
- The SYNCHRONIZED attribute must not be specified.
- C1-VAR and C2-VAR are not valid host variables in any SQL statement. A structure cannot contain an intermediate level structure.

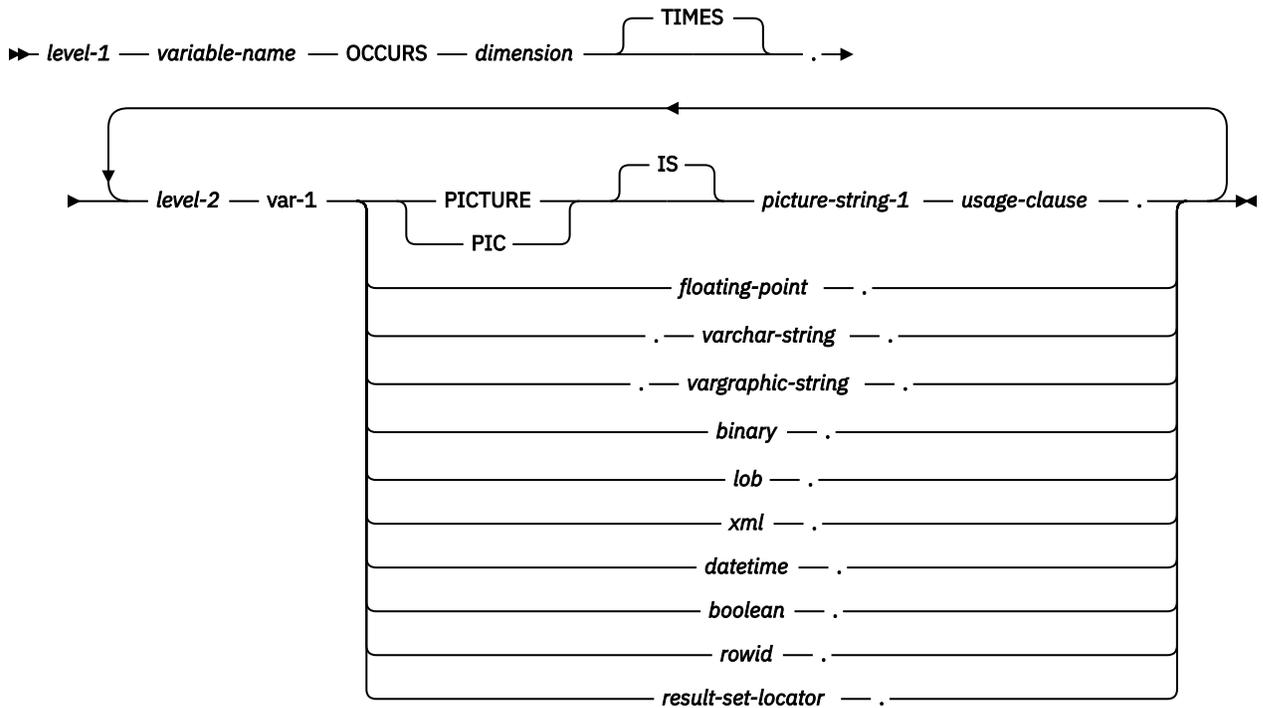
```
01 A-STRUCT.  
  02 B-ARRAY OCCURS 10 TIMES.  
    03 C1-VAR PIC X(20).  
    03 C2-VAR PIC S9(4).
```

To retrieve 10 rows from the CORPDATA.DEPARTMENT table, use the following example:

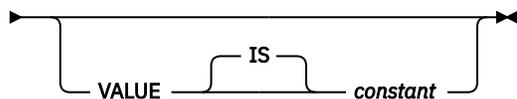
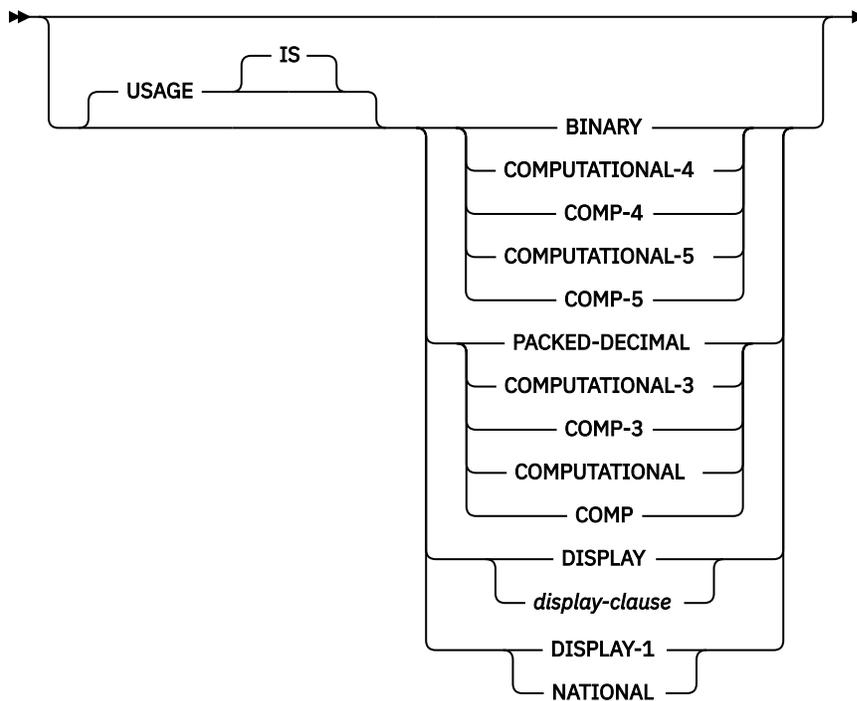
```
01 TABLE-1.  
  02 DEPT OCCURS 10 TIMES.  
    05 DEPTNO PIC X(3).  
    05 DEPTNAME.  
      49 DEPTNAME-LEN PIC S9(4) BINARY.  
      49 DEPTNAME-TEXT PIC X(29).  
    05 MGRNO PIC X(6).  
    05 ADMRDEPT PIC X(3).  
01 TABLE-2.  
  02 IND-ARRAY OCCURS 10 TIMES.  
    05 INDS PIC S9(4) BINARY OCCURS 4 TIMES.  
  
....  
EXEC SQL  
  DECLARE C1 CURSOR FOR  
  SELECT *  
  FROM CORPDATA.DEPARTMENT  
END-EXEC.  
  
....  
EXEC SQL  
  FETCH C1 FOR 10 ROWS INTO :DEPT :IND-ARRAY  
END-EXEC.
```

# Host structure array in COBOL applications that use SQL

These figures show the syntax for valid host structure array declarations.



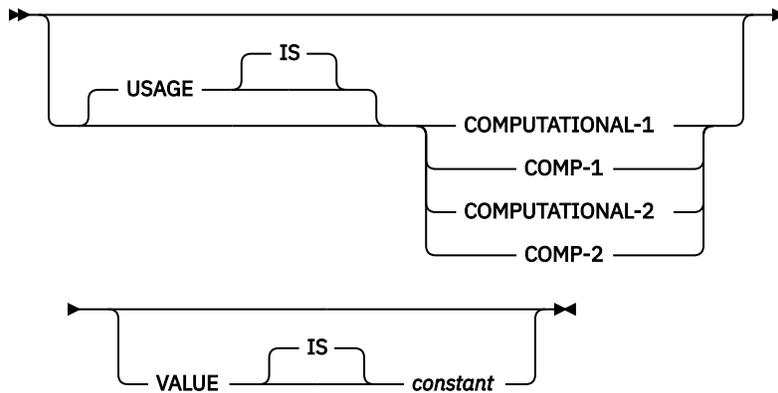
## usage-clause



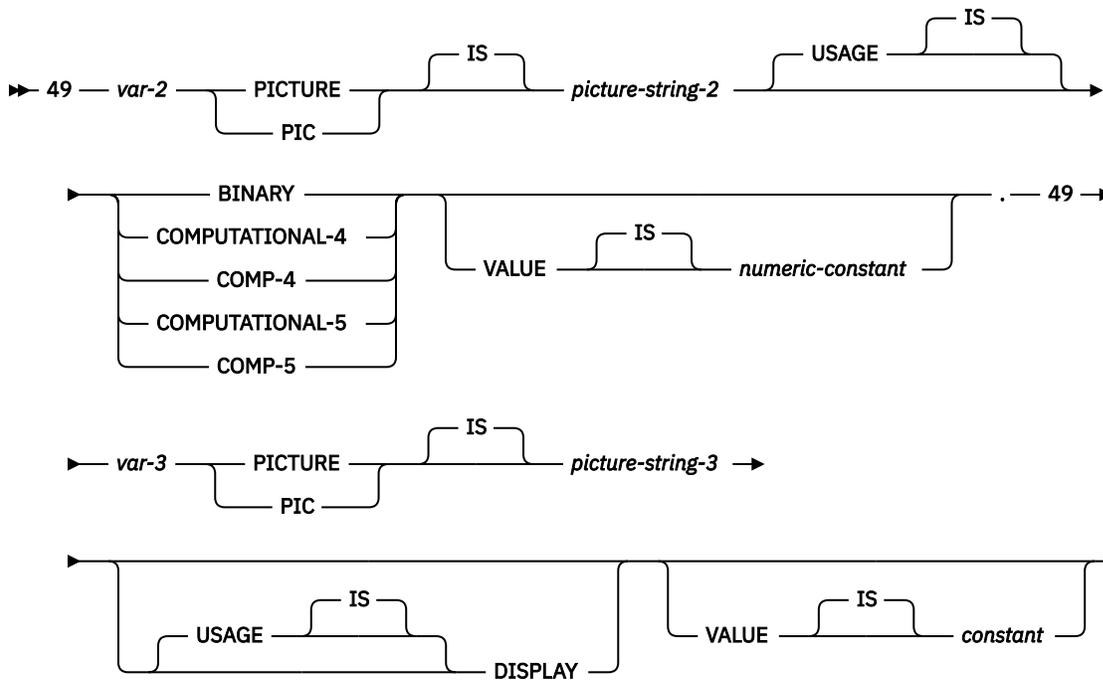
## display-clause



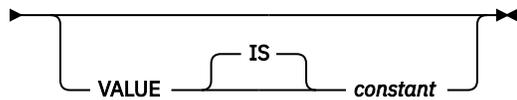
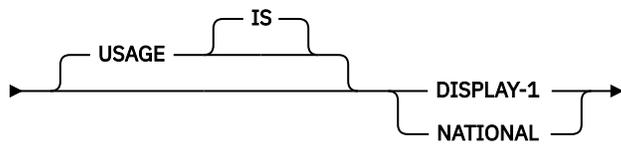
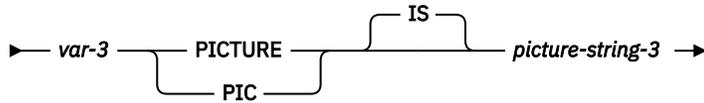
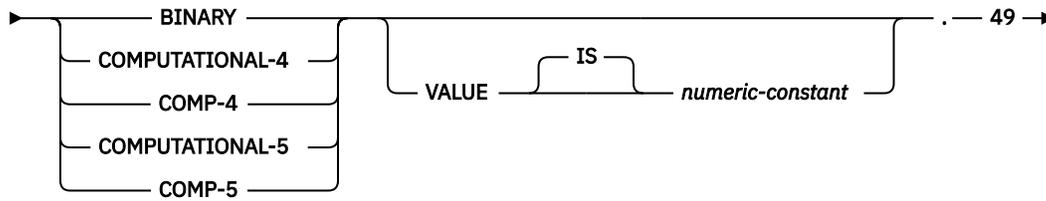
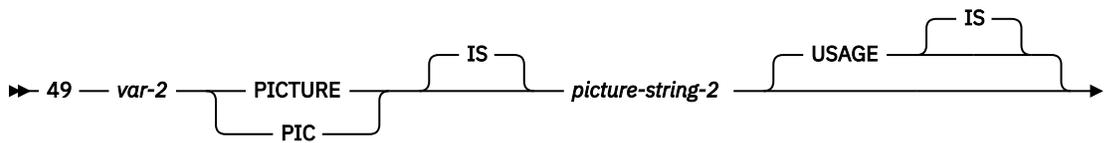
**floating-point**



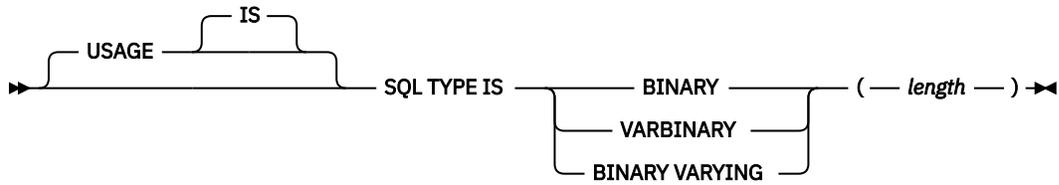
**varchar-string**



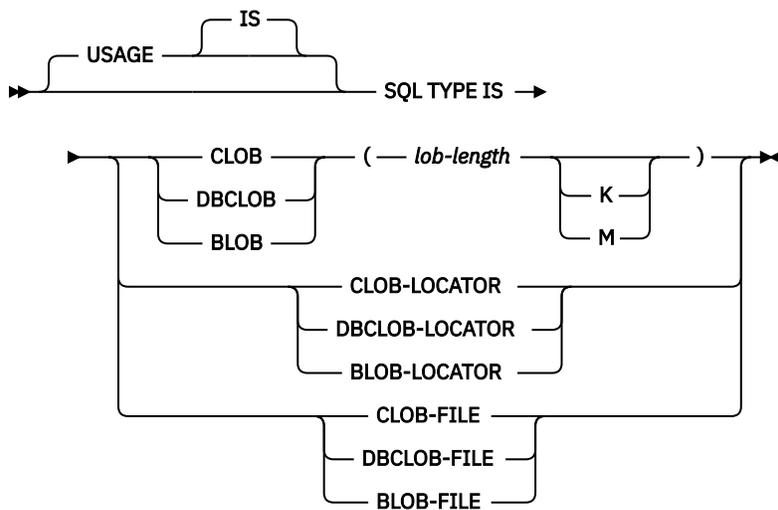
**vargraphic-string**



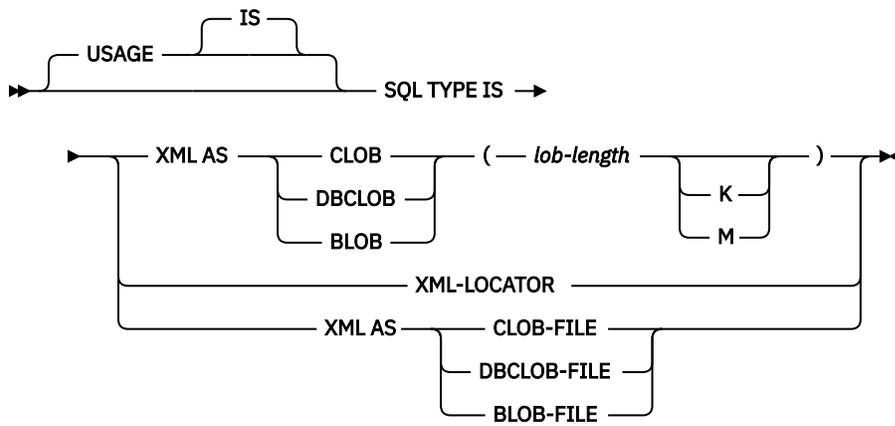
**binary**



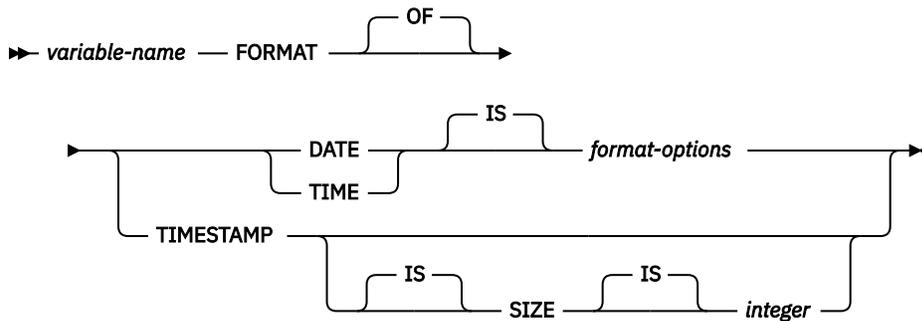
**lob**



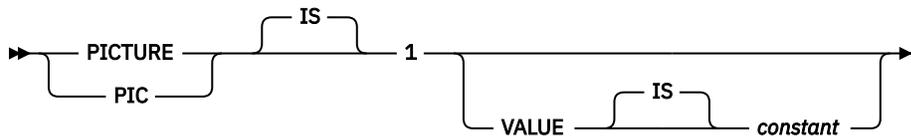
**xml**



### datetime



### boolean



### rowid

SQL TYPE IS ROWID →

### result set locator

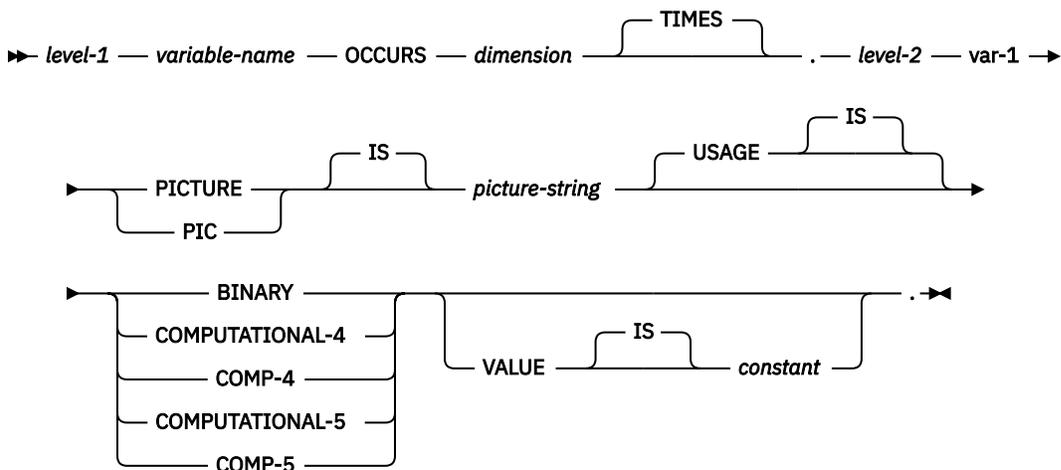
SQL TYPE IS RESULT\_SET\_LOCATOR →

### Notes:

1. *level-1* indicates a COBOL level between 2 and 47.
2. *level-2* indicates a COBOL level between 3 and 48 where *level-2* > *level-1*.
3. Graphic host variables, LOB host variables, Boolean host variables, XML host variables, and floating-point host variables are only supported for ILE COBOL.
4. For details on declaring numeric, character, graphic, binary, LOB, Boolean, XML, ROWID, and result set locator host variables, see the notes under numeric-host variables, character-host variables, graphic-host variables, binary host variables, LOB, Boolean, XML, ROWID, and result set locator host variables.
5. The variable *format-options* indicates valid datetime options that are supported by the COBOL compiler. See the [ILE COBOL Language Reference](#) manual for details.
6. The value for the `TIMESTAMP SIZE` integer must be 19 to 32.

## Host array indicator structure in COBOL applications that use SQL

This figure shows the valid syntax for host structure array indicators.



### Notes:

1. *level-1* indicates a COBOL level between 2 and 48.
2. *level-2* indicates a COBOL level between 3 and 48 where *level-2* > *level-1*.
3. BINARY, COMPUTATIONAL-4, COMP-4, COMPUTATIONAL-5, and COMP-5 are equivalent. A portable application should code BINARY, because COMPUTATIONAL-4, COMP-4, COMPUTATIONAL-5, and COMP-5 are IBM extensions that are not supported in ISO/ANSI COBOL. The *picture-string* associated with these types must have the form S9(*i*) (or S9...9, with *i* instances of 9). *i* must be less than or equal to 4.

## Using external file descriptions in COBOL applications that use SQL

SQL uses the COPY DD-format-name, COPY DD-ALL-FORMATS, COPY DDS-format-name, COPY DDR-format-name, COPY DDR-ALL-FORMATS, COPY DDSR-format-name, COPY DDS-ALL-FORMATS, and COPY DDSR-ALL-FORMATS to retrieve host variables from the file definitions.

If the REPLACING option is specified, only complete name replacing is done. Var-1 is compared against the format name and the field name. If they are equal, var-2 is used as the new name.

**Note:** You cannot retrieve host variables from file definitions that have field names which are COBOL reserved words. You must place the COPY DDx-format statement within a COBOL host structure.

To retrieve the definition of the sample table DEPARTMENT described in [Db2 for i sample tables](#) in the SQL programming concepts topic collection, you can code the following:

```
01 DEPARTMENT-STRUCTURE.
   COPY DDS-ALL-FORMATS OF DEPARTMENT.
```

A host structure named DEPARTMENT-STRUCTURE is defined with an 05 level field named DEPARTMENT-RECORD that contains four 06 level fields named DEPTNO, DEPTNAME, MGRNO, and ADMRDEPT. These field names can be used as host variables in SQL statements.

For more information about the COBOL COPY verb, see the [ILE COBOL Language Reference](#)  and COBOL/400 User's Guide at [IBM Publications Center](#) .

CLOB, BLOB, and DBCLOB columns in the external file are ignored. No host variable definition will be generated in the host structure for these types.

## Using external file descriptions for host structure arrays in COBOL applications that use SQL

Because COBOL creates an extra level when including externally described data, the OCCURS clause must be placed on the preceding 04 level. The structure cannot contain any additional declares at the 05 level.

If the file contains fields that are generated as FILLER, the structure cannot be used as a host structure array.

For device files, if INDARA is not specified and the file contains indicators, the declaration cannot be used as a host structure array. The indicator area is included in the generated structure and causes the storage for records to not be contiguous.

For example, the following shows how to use COPY-DDS to generate a host structure array and fetch 10 rows into the host structure array:

```
01 DEPT.
   04 DEPT-ARRAY OCCURS 10 TIMES.
   COPY DDS-ALL-FORMATS OF DEPARTMENT.
   ...

EXEC SQL DECLARE C1 CURSOR FOR
      SELECT * FROM CORPDATA.DEPARTMENT
END EXEC.

EXEC SQL OPEN C1
END-EXEC.

EXEC SQL FETCH C1 FOR 10 ROWS INTO :DEPARTMENT
END-EXEC.
```

**Note:** DATE, TIME, TIMESTAMP, and BOOLEAN columns will generate character host variable definitions that are treated by SQL with the same comparison and assignment rules as the DATE, TIME, TIMESTAMP, or BOOLEAN column. For example, a date host variable can only be compared against a DATE column or a string which is a valid representation of a date.

Although GRAPHIC and VARGRAPHIC are mapped to character variables in OPM COBOL, SQL considers these GRAPHIC and VARGRAPHIC variables. If the GRAPHIC or VARGRAPHIC column has a UCS-2 CCSID, the generated host variable has the UCS-2 CCSID assigned to it. If the GRAPHIC or VARGRAPHIC column has a UTF-16 CCSID, the generated host variable has the UTF-16 CCSID assigned to it.

## Determining equivalent SQL and COBOL data types

The precompiler determines the base SQLTYPE and SQLLEN of host variables based on this table. If a host variable appears with an indicator variable, the SQLTYPE is the base SQLTYPE plus one.

Table 3. COBOL declarations mapped to typical SQL data types

COBOL data type	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
S9(i)V9(d) COMP-3 or S9(i)V9(d) COMP or S9(i)V9(d) PACKED-DECIMAL	484	i+d in byte 1, d in byte 2	DECIMAL(i+d,d)
S9(i)V9(d) DISPLAY SIGN LEADING SEPARATE	504	i+d in byte 1, d in byte 2	No exact equivalent use DECIMAL(i+d,d) or NUMERIC (i+d,d)
S9(i)V9(d)DISPLAY	488	i+d in byte 1, d in byte 2	NUMERIC(i+d,d)
S9(i) BINARY or S9(i) COMP-4 or S9(i) COMP-5 where i is from 1 to 4	500	2	SMALLINT

Table 3. COBOL declarations mapped to typical SQL data types (continued)

COBOL data type	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
S9(i) BINARY or S9(i) COMP-4 or S9(i) COMP-5 where i is from 5 to 9	496	4	INTEGER
S9(i) BINARY or S9(i) COMP-4 or S9(i) COMP-5 where i is from 10 to 18.	492	8	BIGINT
Not supported by OPM COBOL.			
S9(i)V9(d) BINARY or S9(i)V9(d) COMP-4 or S9(i)V9(d) COMP-5 where $i+d \leq 4$	500	i+d in byte 1, d in byte 2	No exact equivalent use DECIMAL(i+d,d) or NUMERIC (i+d,d)
S9(i)V9(d) BINARY or S9(i)V9(d) COMP-4 or S9(i)V9(d) COMP-5 where $4 < i+d \leq 9$	496	i+d in byte 1, d in byte 2	No exact equivalent use DECIMAL(i+d,d) or NUMERIC (i+d,d)
COMP-1	480	4	FLOAT(single precision)
Not supported by OPM COBOL.			
COMP-2	480	8	FLOAT(double precision)
Not supported by OPM COBOL.			
Fixed-length character data	452	m	CHAR(m)
Varying-length character data	448	m	VARCHAR(m)
Fixed-length graphic data	468	m	GRAPHIC(m)
Not supported by OPM COBOL.			
Varying-length graphic data	464	m	VARGRAPHIC(m)
Not supported by OPM COBOL.			
DATE	384		DATE
Not supported by OPM COBOL.			
TIME	388		TIME
Not supported by OPM COBOL.			
TIMESTAMP SIZE n	392	n	TIMESTAMP(0) when n = 19. TIMESTAMP(n-20) when n > 20
Not supported by OPM COBOL.			
Boolean (PIC 1)	2436	1	BOOLEAN
Not supported by OPM COBOL.			

The following table can be used to determine the COBOL data type that is equivalent to a given SQL data type.

Table 4. SQL data types mapped to typical COBOL declarations

SQL data type	COBOL data type	Notes
SMALLINT	S9(m) COMP-4 or S9(m) COMP-5	m is from 1 to 4
INTEGER	S9(m) COMP-4 or S9(m) COMP-5	m is from 5 to 9
BIGINT	S9(m) COMP-4 or S9(m) COMP-5 for ILE COBOL.  Not supported by OPM COBOL.	m is from 10 to 18
DECIMAL(p,s)	If p<64: S9(p-s)V9(s) PACKED-DECIMAL or S9(p-s)V9(s) COMP or S9(p-s)V9(s) COMP-3. If p>63: Not supported	p is precision; s is scale. 0<=s<=p<=63. If s=0, use S9(p) or S9(p)V. If s=p, use SV9(s).
NUMERIC(p,s)	If p<19: S9(p-s)V9(s) DISPLAY If p>18: Not supported	p is precision; s is scale. 0<=s<=p<=18. If s=0, use S9(p) or S9(p)V. If s=p, use SV9(s).
DECFLOAT	Not supported	
FLOAT(single precision)	COMP-1 for ILE COBOL.  Not supported by OPM COBOL.	
FLOAT(double precision)	COMP-2 for ILE COBOL.  Not supported by OPM COBOL.	
CHAR(n)	Fixed-length character string	32766≥n≥1
VARCHAR(n)	Varying-length character string	32740≥n≥1
CLOB	None	Use SQL TYPE IS to declare a CLOB for ILE COBOL.  Not supported by OPM COBOL.
GRAPHIC(n)	Fixed-length graphic string for ILE COBOL.  Not supported by OPM COBOL.	16383≥n≥1
VARGRAPHIC(n)	Varying-length graphic string for ILE COBOL.  Not supported by OPM COBOL.	16370≥n≥1
DBCLOB	None	Use SQL TYPE IS to declare a DBCLOB for ILE COBOL.  Not supported by OPM COBOL.
BINARY	None	Use SQL TYPE IS to declare a BINARY.
VARBINARY	None	Use SQL TYPE IS to declare a VARBINARY.

Table 4. SQL data types mapped to typical COBOL declarations (continued)

SQL data type	COBOL data type	Notes
BLOB	None	Use SQL TYPE IS to declare a BLOB.  Not supported by OPM COBOL.
DATE	Fixed-length character string or DATE for ILE COBOL.	If the format is *USA, *JIS, *EUR, or *ISO, allow at least 10 characters. If the format is *YMD, *DMY, or *MDY, allow at least 8 characters. If the format is *JUL, allow at least 6 characters.
TIME	Fixed-length character string or TIME for ILE COBOL.	Allow at least 6 characters; 8 to include seconds.
TIMESTAMP(n)	Fixed-length character string or TIMESTAMP(19) when n = 0, TIMESTAMP(20+n) when n > 0 for ILE COBOL.	To include all fractional seconds, n must be 12. If n is less than 12, truncation occurs on the fractional seconds part.
BOOLEAN	Boolean (PIC 1)	Not supported by OPM COBOL.
XML	None	Use SQL TYPE IS to declare an XML.  Not supported by OPM COBOL.
DATALINK	Not supported	
ROWID	None	Use SQL TYPE IS to declare a ROWID.
Result set locator	None	Use SQL TYPE IS to declare a result set locator.

### Notes on COBOL variable declaration and usage

Any level 77 data description entry can be followed by one or more REDEFINES entries. However, the names in these entries cannot be used in SQL statements.

Unpredictable results may occur when a structure contains levels defined below a FILLER item.

The COBOL declarations for SMALLINT, INTEGER, and BIGINT data types are expressed as a number of decimal digits. The database manager uses the full size of the integers and can place larger values in the host variable than would be allowed in the specified number of digits in the COBOL declaration. However, this can cause data truncation or size errors when COBOL statements are being run. Ensure that the size of numbers in your application is within the declared number of digits.

### Using indicator variables in COBOL applications that use SQL

An *indicator variable* is a two-byte integer (PIC S9(m) USAGE BINARY, where m is from 1 to 4).

You can also specify an indicator structure (defined as an array of halfword integer variables) to support a host structure.

Indicator variables are declared in the same way as host variables, and the declarations of the two can be mixed in any way that seems appropriate to the programmer.

## Example

Given the statement:

```
EXEC SQL FETCH CLS_CURSOR INTO :CLS-CD,  
                                     :NUMDAY :NUMDAY-IND,  
                                     :BGN :BGN-IND,  
                                     :ENDCLS :ENDCLS-IND  
  
END-EXEC.
```

The variables can be declared as follows:

```
EXEC SQL BEGIN DECLARE SECTION END-EXEC.  
77 CLS-CD      PIC X(7).  
77 NUMDAY     PIC S9(4) BINARY.  
77 BGN        PIC X(8).  
77 ENDCLS     PIC X(8).  
77 NUMDAY-IND PIC S9(4) BINARY.  
77 BGN-IND    PIC S9(4) BINARY.  
77 ENDCLS-IND PIC S9(4) BINARY.  
EXEC SQL END DECLARE SECTION END-EXEC.
```

### Related reference

[References to variables](#)

[Indicator variables in applications that use SQL](#)

An *indicator variable* is a halfword integer variable used to communicate additional information about its associated host variable.

## Coding SQL statements in PL/I applications

There are some unique application and coding requirements for embedding SQL statements in a PL/I program. In this topic, requirements for host structures and host variables are defined.

**Note:** By using the code examples, you agree to the terms of the [“Code license and disclaimer information”](#) on page 198.

### Related concepts

[Writing applications that use SQL](#)

You can create database applications in host languages that use Db2 for i SQL statements and functions.

### Related reference

[Example programs: Using Db2 for i statements](#)

Here is a sample application that shows how to code SQL statements in each of the languages that Db2 for i supports.

Example: SQL statements in PL/I programs

This example program is written in the PL/I programming language.

## Defining the SQL communication area in PL/I applications that use SQL

A PL/I program that contains SQL statements must include one or both of these fields.

- An SQLCODE variable declared as FIXED BINARY(31)
- An SQLSTATE variable declared as CHAR(5)

Or,

- An SQLCA (which contains an SQLCODE and SQLSTATE variable).

The SQLCODE and SQLSTATE values are set by the database manager after each SQL statement is run. An application can check the SQLCODE or SQLSTATE value to determine whether the last SQL statement was successful.

The SQLCA can be coded in a PL/I program either directly or by using the SQL INCLUDE statement. Using the SQL INCLUDE statement requests the inclusion of a standard SQLCA declaration:

```
EXEC SQL INCLUDE SQLCA ;
```

The scope of the SQLCODE, SQLSTATE, and SQLCA variables must include the scope of all SQL statements in the program.

The included PL/I source statements for the SQLCA are:

```
DCL 1 SQLCA,
  2 SQLCAID      CHAR(8),
  2 SQLCABC      FIXED(31) BINARY,
  2 SQLCODE      FIXED(31) BINARY,
  2 SQLERRM      CHAR(70) VAR,
  2 SQLERRP      CHAR(8),
  2 SQLERRD(6)   FIXED(31) BINARY,
  2 SQLWARN,
  3 SQLWARN0     CHAR(1),
  3 SQLWARN1     CHAR(1),
  3 SQLWARN2     CHAR(1),
  3 SQLWARN3     CHAR(1),
  3 SQLWARN4     CHAR(1),
  3 SQLWARN5     CHAR(1),
  3 SQLWARN6     CHAR(1),
  3 SQLWARN7     CHAR(1),
  3 SQLWARN8     CHAR(1),
  3 SQLWARN9     CHAR(1),
  3 SQLWARNA     CHAR(1),
  2 SQLSTATE     CHAR(5);
```

SQLCODE is replaced with SQLCADE when a declare for SQLCODE is found in the program and the SQLCA is provided by the precompiler. SQLSTATE is replaced with SQLSTOTE when a declare for SQLSTATE is found in the program and the SQLCA is provided by the precompiler.

### Related reference

[SQL communication area](#)

## Defining SQL descriptor areas in PL/I applications that use SQL

There are two types of SQL descriptor areas. One is defined with the ALLOCATE DESCRIPTOR statement. The other is defined using the SQLDA structure. In this topic, only the SQLDA form is discussed.

The following statements can use an SQLDA:

- EXECUTE...USING DESCRIPTOR *descriptor-name*
- FETCH...USING DESCRIPTOR *descriptor-name*
- OPEN...USING DESCRIPTOR *descriptor-name*
- CALL...USING DESCRIPTOR *descriptor-name*
- DESCRIBE *statement-name* INTO *descriptor-name*
- DESCRIBE CURSOR *cursor-name* INTO *descriptor-name*
- DESCRIBE INPUT *statement-name* INTO *descriptor-name*
- DESCRIBE PROCEDURE *procedure-name* INTO *descriptor-name*
- DESCRIBE TABLE *host-variable* INTO *descriptor-name*
- PREPARE *statement-name* INTO *descriptor-name*

Unlike the SQLCA, there can be more than one SQLDA in a program, and an SQLDA can have any valid name. An SQLDA can be coded in a PL/I program either program directly or by using the SQL INCLUDE statement. Using the SQL INCLUDE statement requests the inclusion of a standard SQLDA declaration:

```
EXEC SQL INCLUDE SQLDA ;
```

The included PL/I source statements for the SQLDA are:

```
DCL 1 SQLDA BASED(SQLDAPTR),
  2 SQLDAID      CHAR(8),
  2 SQLDABC      FIXED(31) BINARY,
  2 SQLN         FIXED(15) BINARY,
  2 SQLD         FIXED(15) BINARY,
  2 SQLVAR(99),
  3 SQLTYPE      FIXED(15) BINARY,
  3 SQLLEN       FIXED(15) BINARY,
  3 SQLRES       CHAR(12),
  3 SQLDATA      PTR,
  3 SQLIND       PTR,
  3 SQLNAME      CHAR(30) VAR;
DCL SQLDAPTR PTR;
```

Dynamic SQL is an advanced programming technique. With dynamic SQL, your program can develop and then run SQL statements while the program is running. A SELECT statement with a variable SELECT list (that is, a list of the data to be returned as part of the query) that runs dynamically requires an SQL descriptor area (SQLDA). This is because you cannot know in advance how many or what type of variables to allocate in order to receive the results of the SELECT.

### Related concepts

[Dynamic SQL applications](#)

### Related reference

[SQL descriptor area](#)

## Embedding SQL statements in PL/I applications that use SQL

The first statement of the PL/I program must be a PROCEDURE statement. SQL statements can be coded in a PL/I program wherever executable statements can appear.

Each SQL statement in a PL/I program must begin with EXEC SQL and end with a semicolon (;). The key words EXEC SQL must appear all on one line, but the remainder of the statement can appear on the next and subsequent lines.

### Example: Embedding SQL statements in PL/I applications that use SQL

You can code an UPDATE statement in a PL/I program as in this example.

```
EXEC SQL UPDATE DEPARTMENT
        SET MGRNO = :MGR_NUM
        WHERE DEPTNO = :INT_DEPT ;
```

### Comments in PL/I applications that use SQL

In addition to SQL comments (--), you can include PL/I comments (/...\*/) in embedded SQL statements wherever a blank is allowed, except between the keywords EXEC and SQL.

### Continuation for SQL statements in PL/I applications that use SQL

The line continuation rules for SQL statements are the same as those for other PL/I statements, except that EXEC SQL must be specified within one line.

Constants containing DBCS data can be continued across multiple lines by placing the shift-in and shift-out characters outside of the margins. This example assumes margins of 2 and 72. This SQL statement has a valid graphic constant of G'<AABBCCDDEEFFGGHHIIJJKK>'.

```
*(..+...1...+...2...+...3...+...4...+...5...+...6...+...7.)..
EXEC SQL SELECT * FROM GRAPH TAB          WHERE GRAPHCOL = G'<AABBCCDD>
<EEFFGGHHIIJJKK>';
```

## Including code in PL/I applications that use SQL

SQL statements or PL/I host variable declaration statements can be included by placing the following SQL statement at the point in the source code where the statements are to be embedded.

```
EXEC SQL INCLUDE member-name ;
```

No PL/I preprocessor directives are permitted within SQL statements. PL/I %INCLUDE statements cannot be used to include SQL statements or declarations of PL/I host variables that are referenced in SQL statements.

## Margins in PL/I applications that use SQL

You must code SQL statements within the margins specified by the MARGINS parameter on the CRTSQLPLI command. If EXEC SQL does not start within the specified margins, the SQL precompiler will not recognize the SQL statement.

### Related concepts

[CL command descriptions for host language precompilers](#)

The IBM Db2 Query Manager and SQL Development Kit for i licensed program provides commands for precompiling programs coded in these programming languages.

## Names in PL/I applications that use SQL

Any valid PL/I variable name can be used for a host variable and is subject to these restrictions.

Do not use host variable names or external entry names that begin with 'SQL', 'RDI', or 'DSN'. These names are reserved for the database manager.

## Statement labels in PL/I applications that use SQL

All executable SQL statements, like PL/I statements, can have a label prefix.

## WHENEVER statement in PL/I applications that use SQL

The target for the GOTO clause in an SQL WHENEVER statement must be a label in the PL/I source code and must be within the scope of any SQL statements affected by the WHENEVER statement.

## Using host variables in PL/I applications that use SQL

All host variables used in SQL statements must be explicitly declared.

The PL/I statements that are used to define the host variables should be preceded by a BEGIN DECLARE SECTION statement and followed by an END DECLARE SECTION statement. If a BEGIN DECLARE SECTION and END DECLARE SECTION are specified, all host variable declarations used in SQL statements must be between the BEGIN DECLARE SECTION and the END DECLARE SECTION statements.

All host variables within an SQL statement must be preceded by a colon (:).

The names of host variables must be unique within the program, even if the host variables are in different blocks or procedures.

An SQL statement that uses a host variable must be within the scope of the statement in which the variable was declared.

Host variables must be scalar variables. They cannot be elements of an array.

## Declaring host variables in PL/I applications that use SQL

The PL/I precompiler only recognizes a subset of valid PL/I declarations as valid host variable declarations.

Only the names and data attributes of the variables are used by the precompilers; the alignment, scope, and storage attributes are ignored. Even though alignment, scope, and storage are ignored, there are

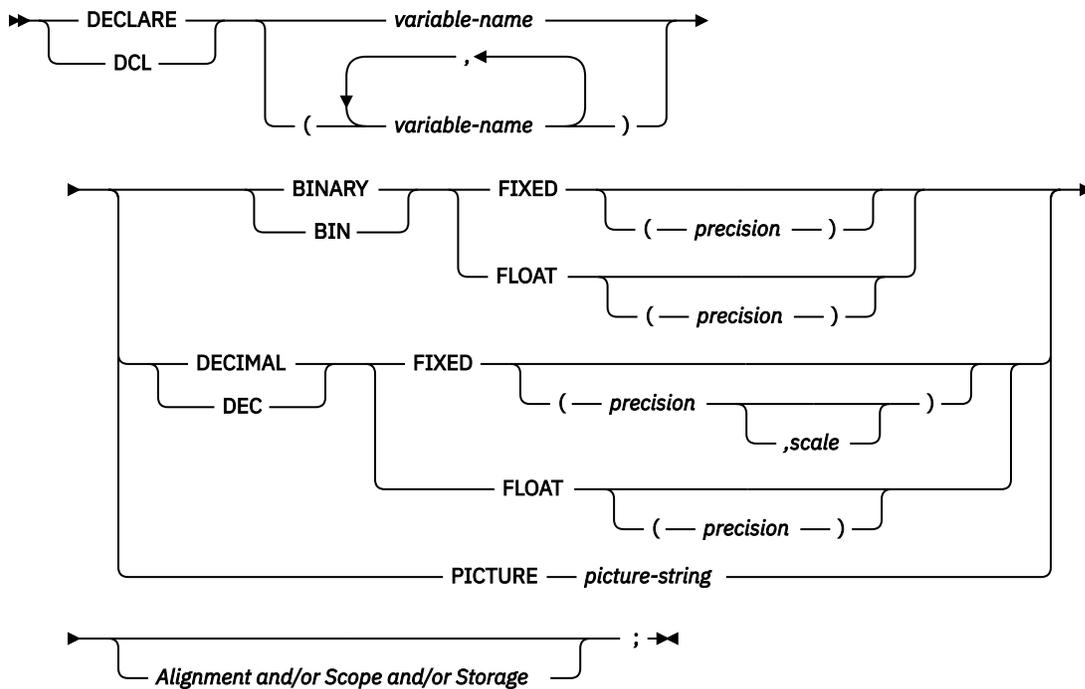
some restrictions on their use that, if ignored, may result in problems when compiling PL/I source code that is created by the precompiler. These restrictions are:

- A declaration with the EXTERNAL scope attribute and the STATIC storage attribute must also have the INITIAL storage attribute.
- If the BASED storage attribute is coded, it must be followed by a PL/I element-locator-expression.

### ***Numeric-host variables in PL/I applications that use SQL***

This figure shows the syntax for valid scalar numeric-host variable declarations.

#### **Numeric**



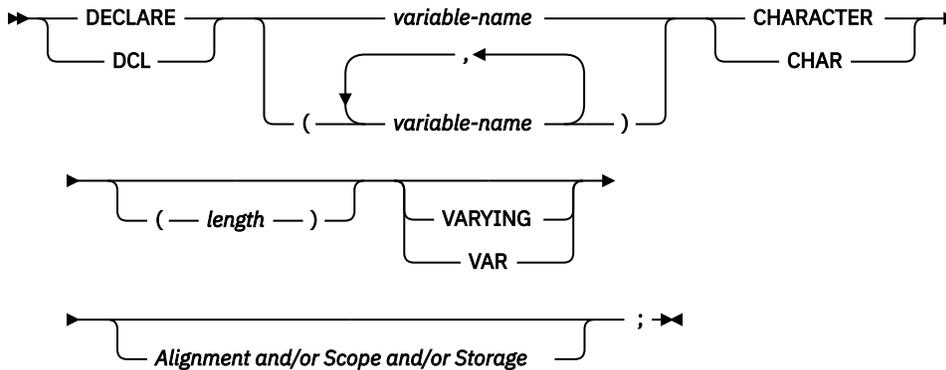
#### **Notes:**

1. (BINARY, BIN, DECIMAL, or DEC) and (FIXED or FLOAT) and (precision, scale) can be specified in any order.
2. A picture-string in the form '9...9V9...R' indicates a numeric host variable. The R is required. The optional V indicates the implied decimal point.
3. A picture-string in the form 'S9...9V9...9' indicates a sign leading separate host variable. The S is required. The optional V indicates the implied decimal point.

## Character-host variables in PL/I applications that use SQL

This figure shows the syntax for valid scalar character-host variables.

### Character



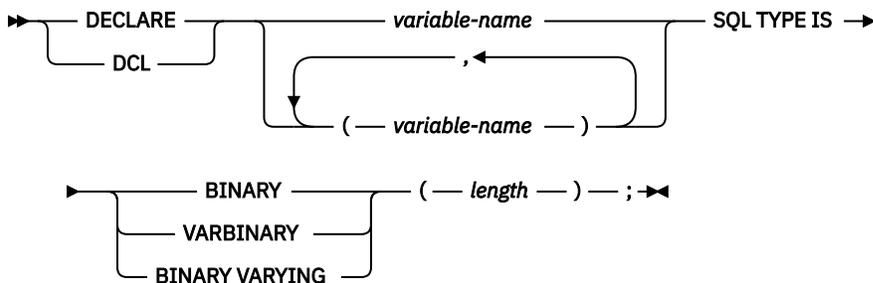
### Notes:

1. The variable *length* must be an integer constant not greater than 32766 if VARYING or VAR is not specified.
2. If VARYING or VAR is specified, *length* must be a constant no greater than 32740.

## Binary host variables in PL/I applications that use SQL

PL/I does not have variables that correspond to the SQL binary data types. To create host variables that can be used with these data types, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a PL/I language structure in the output source member.

### BINARY and VARBINARY



### Notes:

1. For BINARY host variables, the length must be in the range 1 to 32766.
2. For VARBINARY and BINARY VARYING host variables, the length must be in the range 1 to 32740.
3. SQL TYPE IS, BINARY, VARBINARY, BINARY VARYING can be in mixed case.

### BINARY example

The following declaration:

```
DCL MY_BINARY SQL TYPE IS BINARY(100);
```

Results in the generation of the following code:

```
DCL MY_BINARY CHARACTER(100);
```

## VARBINARY example

The following declaration:

```
DCL MY_VARBINARY SQL TYPE IS VARBINARY(250);
```

Results in the generation of the following code:

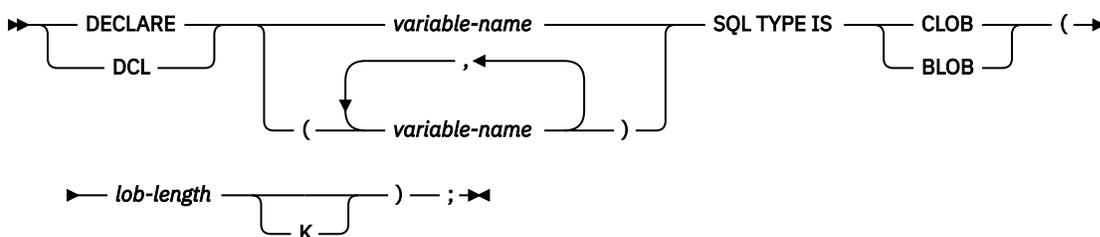
```
DCL MY_VARBINARY CHARACTER(250) VARYING;
```

## LOB host variables in PL/I applications that use SQL

PL/I does not have variables that correspond to the SQL data types for LOBs (large objects). To create host variables that can be used with these data types, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a PL/I language structure in the output source member.

The following figure shows the syntax for valid LOB host variables.

### LOB



### Notes:

1. For BLOB and CLOB,  $1 \leq \text{lob-length} \leq 32,766$
2. SQL TYPE IS, BLOB, CLOB can be in mixed case.

## CLOB example

The following declaration:

```
DCL MY_CLOB SQL TYPE IS CLOB(16384);
```

Results in the generation of the following structure:

```
DCL 1 MY_CLOB,  
    3 MY_CLOB_LENGTH BINARY FIXED (31) UNALIGNED,  
    3 MY_CLOB_DATA CHARACTER (16384);
```

## BLOB example

The following declaration:

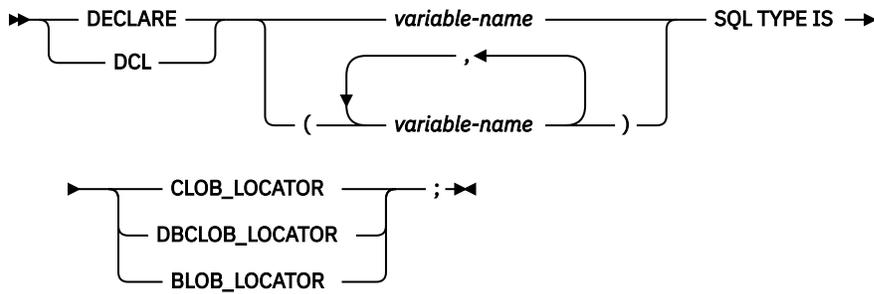
```
DCL MY_BLOB SQL TYPE IS BLOB(16384);
```

Results in the generation of the following structure:

```
DCL 1 MY_BLOB,  
    3 MY_BLOB_LENGTH BINARY FIXED (31) UNALIGNED,  
    3 MY_BLOB_DATA CHARACTER (16384);
```

The following figure shows the syntax for valid LOB locators.

## LOB locator



**Note:** SQL TYPE IS, BLOB\_LOCATOR, CLOB\_LOCATOR, DBCLOB\_LOCATOR can be in mixed case.

## CLOB locator example

The following declaration:

```
DCL MY_LOCATOR SQL TYPE IS CLOB_LOCATOR;
```

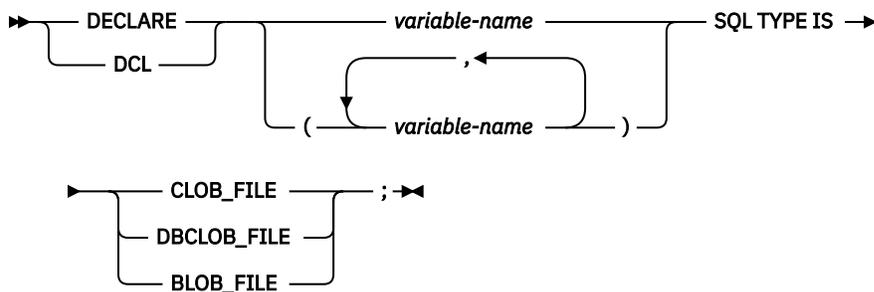
Results in the following generation:

```
DCL MY_LOCATOR BINARY FIXED(31) UNALIGNED;
```

BLOB and DBCLOB locators have similar syntax.

The following figure shows the syntax for valid LOB file reference variables.

## LOB file reference variable



**Note:** SQL TYPE IS, BLOB\_FILE, CLOB\_FILE, and DBCLOB\_FILE can be in mixed case.

## CLOB file reference example

The following declaration:

```
DCL MY_FILE SQL TYPE IS CLOB_FILE;
```

Results in the generation of the following structure:

```
DCL 1 MY_FILE,  
  3 MY_FILE_NAME_LENGTH BINARY FIXED(31) UNALIGNED,  
  3 MY_FILE_DATA_LENGTH BINARY FIXED(31) UNALIGNED,  
  3 MY_FILE_FILE_OPTIONS BINARY FIXED(31) UNALIGNED,  
  3 MY_FILE_NAME CHAR(255);
```

BLOB and DBCLOB file reference variables have similar syntax.

The pre-compiler will generate declarations for the following file option constants:

- SQL\_FILE\_READ (2)

- SQL\_FILE\_CREATE (8)
- SQL\_FILE\_OVERWRITE (16)
- SQL\_FILE\_APPEND (32)

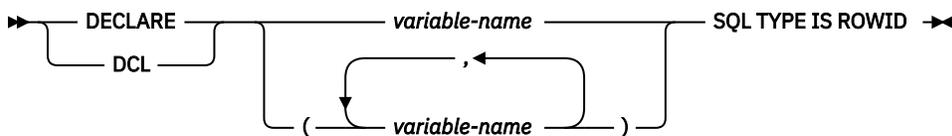
### Related reference

[LOB file reference variables](#)

### **ROWID host variables in PL/I applications that use SQL**

PL/I does not have a variable that corresponds to the SQL data type ROWID. To create host variables that can be used with this data type, use the SQL TYPE IS clause. The SQL precompiler replaces this declaration with a PL/I language structure in the output source member.

### ROWID



**Note:** SQL TYPE IS ROWID can be in mixed case.

### **ROWID example**

The following declaration:

```
DCL MY_ROWID SQL TYPE IS ROWID;
```

Results in the following generation:

```
DCL MY_ROWID CHARACTER(40) VARYING;
```

## Using host structures in PL/I applications that use SQL

In PL/I programs, you can define a host structure, which is a named set of elementary PL/I variables. A host structure name can be a group name whose subordinate levels name elementary PL/I variables.

For example:

```
DCL 1 A,
    2 B,
    3 C1 CHAR(...),
    3 C2 CHAR(...);
```

In this example, B is the name of a host structure consisting of the elementary items C1 and C2.

You can use the structure name as shorthand notation for a list of scalars. You can qualify a host variable with a structure name (for example, STRUCTURE.FIELD). Host structures are limited to two levels. (For example, in the above host structure example, the A cannot be referred to in SQL.) A structure cannot contain an intermediate level structure. In the previous example, A could not be used as a host variable or referred to in an SQL statement. However, B is the first level structure. B can be referred to in an SQL statement. A host structure for SQL data is two levels deep and can be thought of as a named set of host variables. After the host structure is defined, you can refer to it in an SQL statement instead of listing the several host variables (that is, the names of the host variables that make up the host structure).

For example, you can retrieve all column values from selected rows of the table CORPDATA.EMPLOYEE with:

```
DCL 1 PEMPL,
    5 EMPNO    CHAR(6),
    5 FIRSTNME CHAR(12) VAR,
    5 MIDINIT  CHAR(1),
```

```

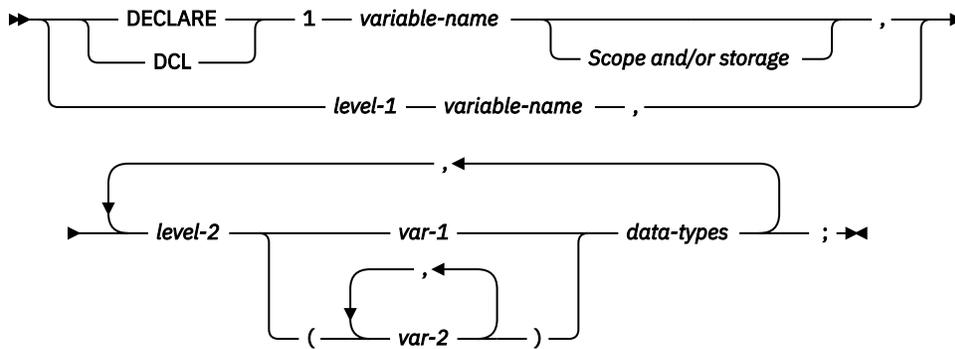
5 LASTNAME CHAR(15) VAR,
5 WORKDEPT CHAR(3);
...
EMPID = '000220';
...
EXEC SQL
  SELECT *
  INTO :PEMPL
  FROM CORPDATA.EMPLOYEE
  WHERE EMPNO = :EMPID;

```

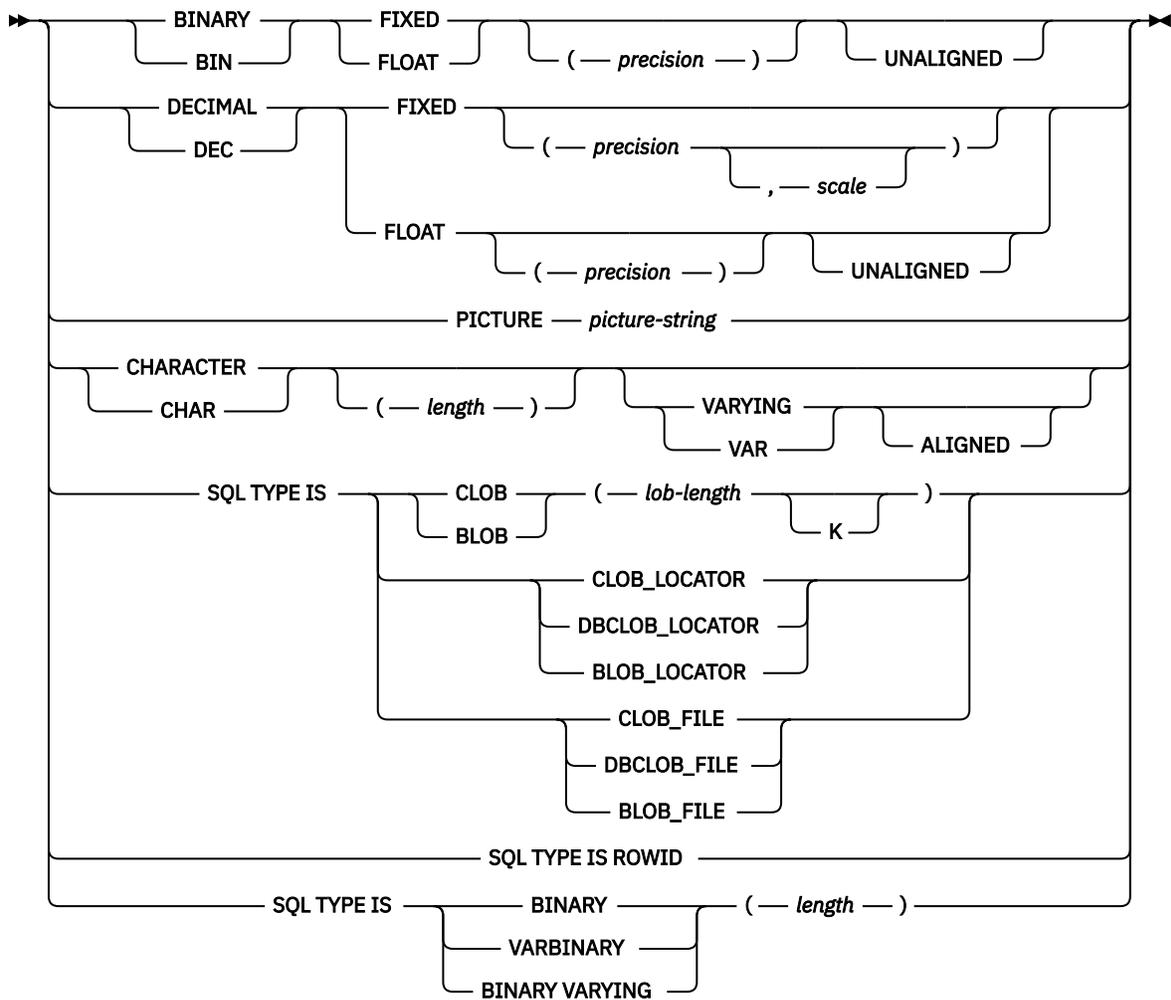
## Host structures in PL/I applications that use SQL

This figure shows the syntax for valid host structure declarations.

### Host structures



### data-types



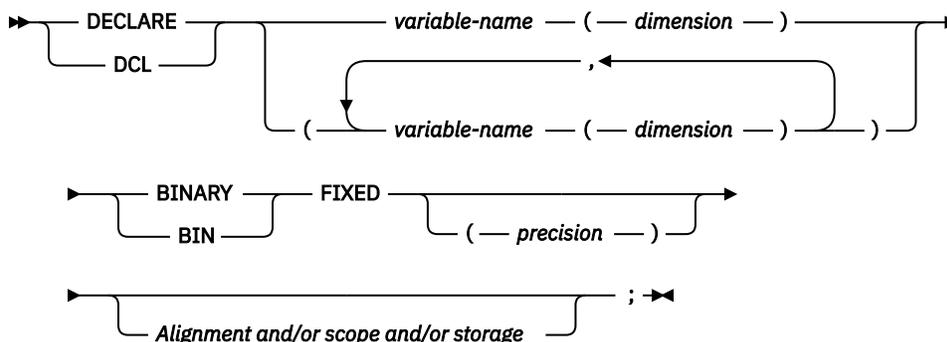
**Notes:**

1. *level-1* indicates that there is an intermediate level structure.
2. *level-1* must be an integer constant between 1 and 254.
3. *level-2* must be an integer constant between 2 and 255.
4. For details on declaring numeric, character, LOB, ROWID, and binary host variables, see the notes under numeric-host variables, character-host variables, LOB host variables, ROWID host variables, and binary host variables.

## Host structure indicator arrays in PL/I applications that use SQL

This figure shows the syntax for valid host structure indicator array declarations.

### Host structure indicator array



**Note:** Dimension must be an integer constant between 1 and 32766.

## Using host structure arrays in PL/I applications that use SQL

In PL/I programs, you can define a host structure array.

In these examples, the following are true:

- B\_ARRAY is the name of a host structure array that contains the items C1\_VAR and C2\_VAR.
- B\_ARRAY cannot be qualified.
- B\_ARRAY can only be used with the blocked forms of the FETCH and INSERT statements.
- All items in B\_ARRAY must be valid host variables.
- C1\_VAR and C2\_VAR are not valid host variables in any SQL statement. A structure cannot contain an intermediate level structure. A\_STRUCT cannot contain the dimension attribute.

```
DCL 1 A_STRUCT,  
    2 B_ARRAY(10),  
    3 C1_VAR CHAR(20),  
    3 C2_FIXED BIN(15) UNALIGNED;
```

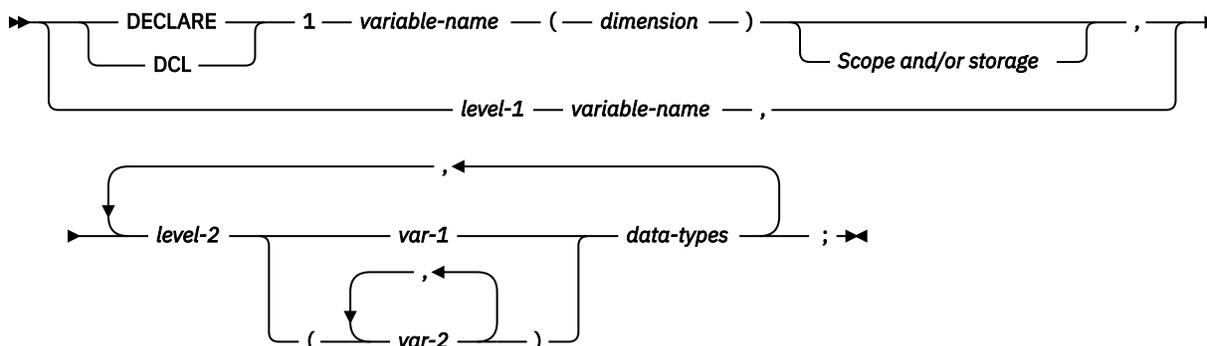
To retrieve 10 rows from the CORPDATA.DEPARTMENT table, do the following:

```
DCL 1 DEPT(10),  
    5 DEPTNO CHAR(3),  
    5 DEPTNAME CHAR(29) VAR,  
    5 MGRNO CHAR(6),  
    5 ADMRDEPT CHAR(3);  
DCL 1 IND_ARRAY(10),  
    5 INDS(4) FIXED BIN(15);  
EXEC SQL  
  DECLARE C1 CURSOR FOR  
  SELECT *  
  FROM CORPDATA.DEPARTMENT;  
  
EXEC SQL  
  FETCH C1 FOR 10 ROWS INTO :DEPT :IND_ARRAY;
```

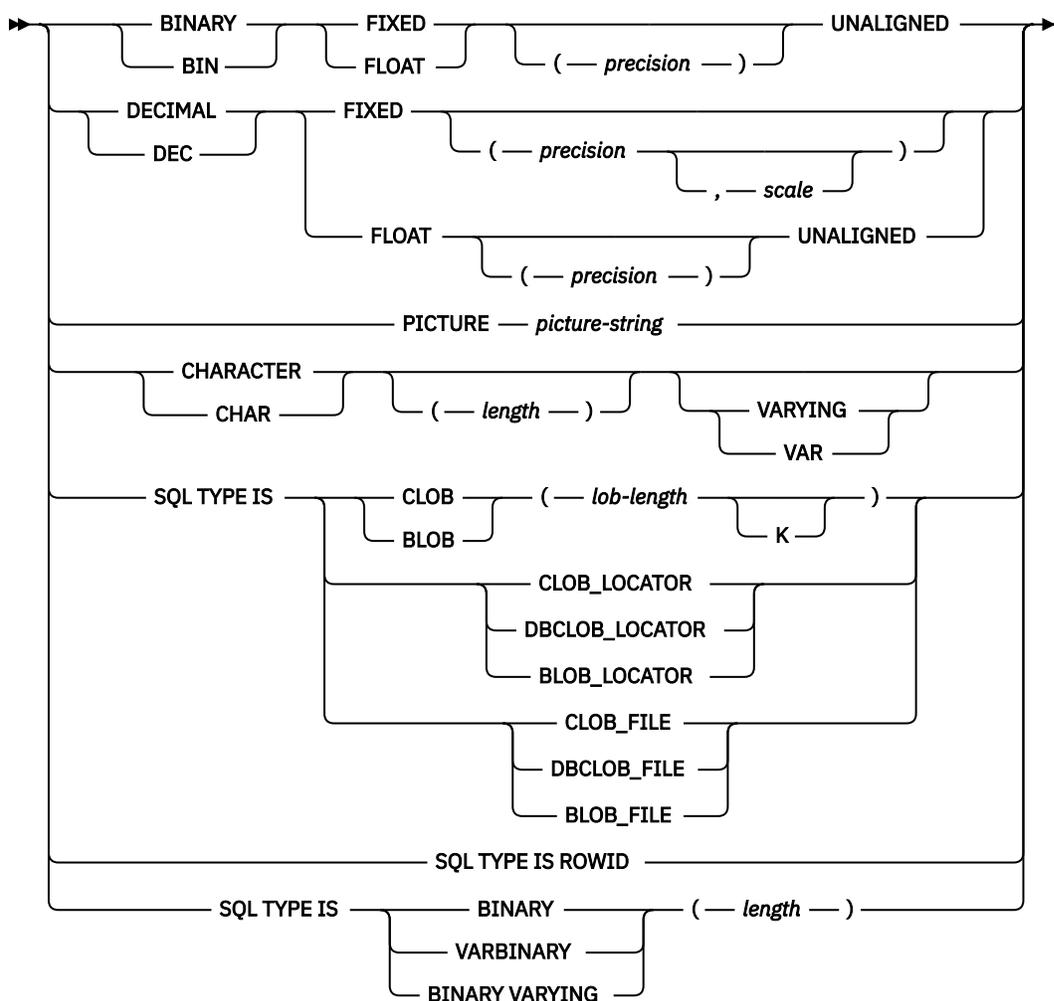
## Host structure array in PL/I applications that use SQL

This syntax diagram shows the syntax for valid host structure array declarations.

### Host structure array



### data-types



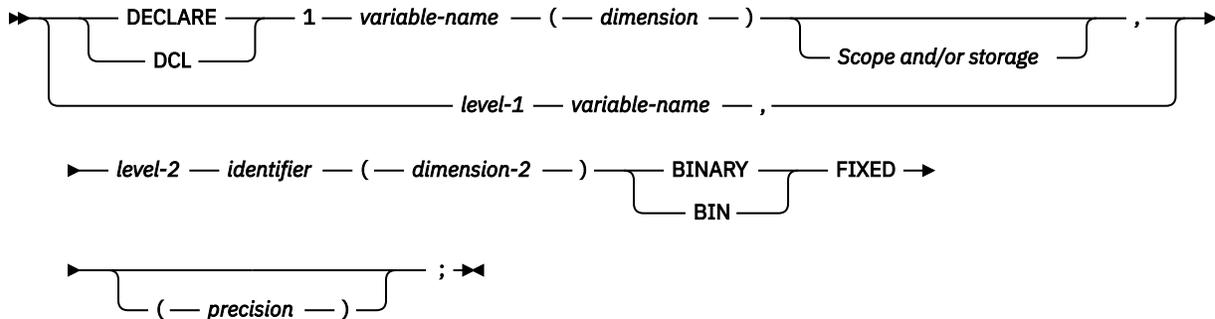
### Notes:

1. *level-1* indicates that there is an intermediate level structure.
2. *level-1* must be an integer constant between 1 and 254.
3. *level-2* must be an integer constant between 2 and 255.

4. For details on declaring numeric, character, LOB, ROWID, and binary host variables, see the notes under numeric-host variables, character-host variables, LOB host variables, ROWID, and binary host variables.
5. Dimension must be an integer constant between 1 and 32 767.

### Host structure array indicator in PL/I applications that use SQL

This figure shows the syntax diagram for the declaration of a valid host structure array indicator.



#### Notes:

1. *level-1* indicates that there is an intermediate level structure.
2. *level-1* must be an integer constant between 1 and 254.
3. *level-2* must be an integer constant between 2 and 255.
4. Dimension-1 and dimension-2 must be integer constants between 1 and 32 767.

## Using external file descriptions in PL/I applications that use SQL

You can use the PL/I %INCLUDE directive to include the definitions of externally described files in a source program.

When used with SQL, only a particular format of the %INCLUDE directive is recognized by the SQL precompiler. That directive format must have the following three elements or parameter values, otherwise the precompiler ignores the directive. The required elements are *file name*, *format name*, and *element type*. There are two optional elements supported by the SQL precompiler: prefix name and COMMA.

The structure is ended normally by the last data element of the record or key structure. However, if in the %INCLUDE directive the COMMA element is specified, then the structure is not ended.

To include the definition of the sample table DEPARTMENT described in [Db2 for i sample tables](#) in the SQL programming topic collection, you can code:

```
DCL 1 TDEPT_STRUCTURE,
  %INCLUDE DEPARTMENT(DEPARTMENT,RECORD);
```

In the above example, a host structure named TDEPT\_STRUCTURE would be defined having four fields. The fields would be DEPTNO, DEPTNAME, MGRNO, and ADMRDEPT.

For device files, if INDARA is not specified and the file contains indicators, the declaration cannot be used as a host structure array. The indicator area is included in the generated structure and causes the storage to not be contiguous.

```
DCL 1 DEPT_REC(10),
  %INCLUDE DEPARTMENT(DEPARTMENT,RECORD);

EXEC SQL DECLARE C1 CURSOR FOR
  SELECT * FROM CORPDATA.DEPARTMENT;

EXEC SQL OPEN C1;

EXEC SQL FETCH C1 FOR 10 ROWS INTO :DEPT_REC;
```

**Note:** DATE, TIME, and TIMESTAMP columns will generate host variable definitions that are treated by SQL with the same comparison and assignment rules as a DATE, TIME, and TIMESTAMP column. For example, a date host variable can only be compared with a DATE column or a character string that is a valid representation of a date.

Although decimal and zoned fields with precision greater than 15 and binary with nonzero scale fields are mapped to character field variables in PL/I, SQL considers these fields to be numeric.

Although GRAPHIC and VARGRAPHIC are mapped to character variables in PL/I, SQL considers these to be GRAPHIC and VARGRAPHIC host variables. If the GRAPHIC or VARGRAPHIC column has a UCS-2 CCSID, the generated host variable will have the UCS-2 CCSID assigned to it. If the GRAPHIC or VARGRAPHIC column has a UTF-16 CCSID, the generated host variable will have the UTF-16 CCSID assigned to it.

CLOB, BLOB, and DBCLOB columns in the external file are ignored. No host variable definition will be generated in the host structure for these types.

## Determining equivalent SQL and PL/I data types

The precompiler determines the base SQLTYPE and SQLLEN of host variables based on this table.

If a host variable appears with an indicator variable, the SQLTYPE is the base SQLTYPE plus one.

*Table 5. PL/I declarations mapped to typical SQL data types*

PL/I data type	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
BIN FIXED(p) where p is in the range 1 to 15	500	2	SMALLINT
BIN FIXED(p) where p is in the range 16 to 31	496	4	INTEGER
DEC FIXED(p,s)	484	p in byte 1, s in byte 2	DECIMAL(p,s)
BIN FLOAT(p) p is in the range 1 to 24	480	4	FLOAT (single precision)
BIN FLOAT(p) p is in the range 25 to 53	480	8	FLOAT (double precision)
DEC FLOAT(m) m is in the range 1 to 7	480	4	FLOAT (single precision)
DEC FLOAT(m) m is in the range 8 to 16	480	8	FLOAT (double precision)
PICTURE picture string (numeric)	488	p in byte 1, s in byte 2	NUMERIC (p,s)
PICTURE picture string (sign leading separate)	504	p in byte 1, s in byte 2	No exact equivalent, use NUMERIC(p,s).
CHAR(n)	452	n	CHAR(n)
CHAR(n) VARYING	448	n	VARCHAR(n)

The following table can be used to determine the PL/I data type that is equivalent to a given SQL data type.

Table 6. SQL data types mapped to typical PL/I declarations

SQL data type	PL/I equivalent	Notes
SMALLINT	BIN FIXED(p)	p is a positive integer from 1 to 15.
INTEGER	BIN FIXED(p)	p is a positive integer from 16 to 31.
BIGINT	No exact equivalent	Use DEC FIXED(18).
DECIMAL(p,s) or NUMERIC(p,s)	DEC FIXED(p) or DEC FIXED(p,s) or PICTURE picture-string	s (the scale factor) and p (the precision) are positive integers. p is a positive integer from 1 to 31. s is a positive integer from 0 to p.
DECFLOAT	Not supported	Not supported.
FLOAT (single precision)	BIN FLOAT(p) or DEC FLOAT(m)	p is a positive integer from 1 to 24. m is a positive integer from 1 to 7.
FLOAT (double precision)	BIN FLOAT(p) or DEC FLOAT(m)	p is a positive integer from 25 to 53. m is a positive integer from 8 to 16.
CHAR(n)	CHAR(n)	n is a positive integer from 1 to 32766.
VARCHAR(n)	CHAR(n) VARYING	n is a positive integer from 1 to 32740.
CLOB	None	Use SQL TYPE IS to declare a CLOB.
GRAPHIC(n)	Not supported	Not supported.
VARGRAPHIC(n)	Not supported	Not supported.
DBCLOB	Not supported	Not supported.
BINARY	None	Use SQL TYPE IS to declare a BINARY.
VARBINARY	None	Use SQL TYPE IS to declare a VARBINARY.
BLOB	None	Use SQL TYPE IS to declare a BLOB.
DATE	CHAR(n)	If the format is *USA, *JIS, *EUR, or *ISO, n must be at least 10 characters. If the format is *YMD, *DMY, or *MDY, n must be at least 8 characters. If the format is *JUL, n must be at least 6 characters.
TIME	CHAR(n)	n must be at least 6; to include seconds, n must be at least 8.

Table 6. SQL data types mapped to typical PL/I declarations (continued)

SQL data type	PL/I equivalent	Notes
TIMESTAMP	CHAR(n)	<i>n</i> must be at least 19. To include microseconds at full precision, <i>n</i> must be 26; if <i>n</i> is less than 26, truncation occurs on the microseconds part.
BOOLEAN	Not supported	Not supported.
XML	Not supported	Not supported.
DATALINK	Not supported	Not supported.
ROWID	None	Use SQL TYPE IS to declare a ROWID.
Result set locator	Not supported	Not supported.

## Using indicator variables in PL/I applications that use SQL

An *indicator variable* is a two-byte integer (BIN FIXED(p), where p is 1 to 15).

You can also specify an indicator structure (defined as an array of halfword integer variables) to support a host structure.

Indicator variables are declared in the same way as host variables and the declarations of the two can be mixed in any way that seems appropriate to the programmer.

### Example

Given the statement:

```
EXEC SQL FETCH CLS_CURSOR INTO :CLS_CD,
                                :DAY :DAY_IND,
                                :BGN :BGN_IND,
                                :END :END_IND;
```

Variables can be declared as follows:

```
EXEC SQL BEGIN DECLARE SECTION;
DCL CLS_CD CHAR(7);
DCL DAY BIN FIXED(15);
DCL BGN CHAR(8);
DCL END CHAR(8);
DCL (DAY_IND, BGN_IND, END_IND) BIN FIXED(15);
EXEC SQL END DECLARE SECTION;
```

### Related reference

[References to variables](#)

[Indicator variables in applications that use SQL](#)

An *indicator variable* is a halfword integer variable used to communicate additional information about its associated host variable.

## Differences in PL/I because of structure parameter passing techniques

The PL/I precompiler attempts to use the structure parameter passing technique, if possible. This structure parameter passing technique provides better performance for most PL/I programs using SQL.

The precompiler generates code where each host variable is a separate parameter when the following conditions are true:

- A PL/I %INCLUDE compiler directive is found that copies external text into the source program.

- The data length of the host variables referred to in the statement is greater than 32 703. Because SQL uses 64 bytes of the structure,  $32703 + 64 = 32767$ , the maximum length of a data structure.
- The PL/I precompiler estimates that it could possibly exceed the PL/I limit for user-defined names.
- A sign leading separate host variable is found in the host variable list for the SQL statement.

### Related concepts

[Application design tips for database performance](#)

## Coding SQL statements in RPG/400 applications

The RPG/400 licensed program supports both RPG II and RPG III programs.

SQL statements can only be used in RPG III programs. RPG II and AutoReport are NOT supported. All referrals to RPG in this guide apply to RPG III or ILE RPG only.

This topic describes the unique application and coding requirements for embedding SQL statements in a RPG/400 program. Requirements for host variables are defined.

**Note:** By using the code examples, you agree to the terms of the [“Code license and disclaimer information”](#) on page 198.

For more information about programming using RPG, see the manuals *RPG/400 User's Guide* and *RPG/400 Reference* at [IBM Publications Center](#) .

### Related concepts

[Writing applications that use SQL](#)

You can create database applications in host languages that use Db2 for i SQL statements and functions.

### Related reference

[Example programs: Using Db2 for i statements](#)

Here is a sample application that shows how to code SQL statements in each of the languages that Db2 for i supports.

[Example: SQL statements in RPG/400 programs](#)

This example program is written in the RPG programming language.

## Defining the SQL communication area in RPG/400 applications that use SQL

The SQL precompiler automatically places the SQLCA in the input specifications of the RPG/400 program prior to the first calculation specification.

INCLUDE SQLCA should not be coded in the source program. If the source program specifies INCLUDE SQLCA, the statement will be accepted, but it is redundant. The SQLCA, as defined for RPG/400:

```
ISQLCA      DS
I*          SQL COMMUNICATION AREA
I I          X'0000000000000000'
I           1   8  SQLAID
I           B   9  120SQLABC
I           B  13  160SQLCOD
I           B  17  180SQLERL
I           19  88  SQLERM
I           89  96  SQLERP
I           97  120 SQLERR
I           B  97  1000SQLER1
I           B 101  1040SQLER2
I           B 105  1080SQLER3
I           B 109  1120SQLER4
I           B 113  1160SQLER5
I           B 117  1200SQLER6
I           121  131  SQLWRN
I           121  121  SQLWN0
I           122  122  SQLWN1
I           123  123  SQLWN2
I           124  124  SQLWN3
I           125  125  SQLWN4
I           126  126  SQLWN5
I           127  127  SQLWN6
I           128  128  SQLWN7
I           SQL
```

I	129	129	SQLWN8	SQL
I	130	130	SQLWN9	SQL
I	131	131	SQLWNA	SQL
I	132	136	SQLSTT	SQL
I*	END OF SQLCA			SQL

**Note:** Variable names in RPG/400 are limited to 6 characters. The standard SQLCA names have been changed to a length of 6. RPG/400 does not have a way of defining arrays in a data structure without also defining them in the extension specification. SQLERR is defined as character with SQLER1 through 6 used as the names of the elements.

#### Related reference

[SQL communication area](#)

## Defining SQL descriptor areas in RPG/400 applications that use SQL

There are two types of SQL descriptor areas. One is defined with the ALLOCATE DESCRIPTOR statement. The other is defined using the SQLDA structure. In this topic, only the SQLDA form is discussed.

The following statements can use an SQLDA:

- EXECUTE...USING DESCRIPTOR *descriptor-name*
- FETCH...USING DESCRIPTOR *descriptor-name*
- OPEN...USING DESCRIPTOR *descriptor-name*
- CALL...USING DESCRIPTOR *descriptor-name*
- DESCRIBE *statement-name* INTO *descriptor-name*
- DESCRIBE CURSOR *cursor-name* INTO *descriptor-name*
- DESCRIBE INPUT *statement-name* INTO *descriptor-name*
- DESCRIBE PROCEDURE *procedure-name* INTO *descriptor-name*
- DESCRIBE TABLE *host-variable* INTO *descriptor-name*
- PREPARE *statement-name* INTO *descriptor-name*

Unlike the SQLCA, there can be more than one SQLDA in a program and an SQLDA can have any valid name.

Dynamic SQL is an advanced programming technique. With dynamic SQL, your program can develop and then run SQL statements while the program is running. A SELECT statement with a variable SELECT list (that is, a list of the data to be returned as part of the query) that runs dynamically requires an SQL descriptor area (SQLDA). This is because you cannot know in advance how many or what type of variables to allocate in order to receive the results of the SELECT.

Because the SQLDA uses pointer variables that are not supported by RPG/400, an INCLUDE SQLDA statement cannot be specified in an RPG/400 program. An SQLDA must be set up by a C, C++, COBOL, PL/I, or ILE RPG program and passed to the RPG program in order to use it.

#### Related concepts

[Dynamic SQL applications](#)

#### Related reference

[SQL descriptor area](#)

## Embedding SQL statements in RPG/400 applications that use SQL

SQL statements coded in an RPG/400 program must be placed in the calculation section. This requires that a C be placed in position 6.

SQL statements can be placed in detail calculations, in total calculations, or in an RPG/400 subroutine. The SQL statements are run based on the logic of the RPG/400 statements.

The keywords EXEC SQL indicate the beginning of an SQL statement. EXEC SQL must occupy positions 8 through 16 of the source statement, preceded by a / in position 7. The SQL statement may start in position 17 and continue through position 74.

The keyword END-EXEC ends the SQL statement. END-EXEC must occupy positions 8 through 16 of the source statement, preceded by a slash (/) in position 7. Positions 17 through 74 must be blank.

Both uppercase and lowercase letters are acceptable in SQL statements.

## Example: Embedding SQL statements in RPG/400 applications that use SQL

An UPDATE statement coded in an RPG/400 program might be coded as this example shows.

```
*...1...+...2...+...3...+...4...+...5...+...6...+...7...*  
C/EXEC SQL UPDATE DEPARTMENT  
C+ SET MANAGER = :MGRNUM  
C+ WHERE DEPTNO = :INTDEP  
C/END-EXEC
```

## Comments in RPG/400 applications that use SQL

In addition to SQL comments (--), RPG/400 comments can be included within SQL statements wherever a blank is allowed, except between the keywords EXEC and SQL.

To embed an RPG/400 comment within the SQL statement, place an asterisk (\*) in position 7.

## Continuation for SQL statements in RPG/400 applications that use SQL

When additional records are needed to contain the SQL statement, positions 9 through 74 can be used. Position 7 must be a + (plus sign), and position 8 must be blank.

Constants containing DBCS data can be continued across multiple lines by placing the shift-in character in position 75 of the continued line and placing the shift-out character in position 8 of the continuation line. This SQL statement has a valid graphic constant of G'<AABBCCDDEEFFGGHHIIJJKK>'.

```
*...1...+...2...+...3...+...4...+...5...+...6...+...7...+...8  
C/EXEC SQL SELECT * FROM GRAPHTAB WHERE GRAPHCOL = G'<AABB>  
C+<CCDDEEFFGGHHIIJJKK>'  
C/END-EXEC
```

## Including code in RPG/400 applications that use SQL

SQL statements and RPG/400 calculation specifications can be included by embedding the SQL statement.

```
*...1...+...2...+...3...+...4...+...5...+...6...+...7...+...8  
C/EXEC SQL INCLUDE member-name  
C/END-EXEC
```

The /COPY statement can be used to include SQL statements or RPG/400 specifications.

## Sequence numbers in RPG/400 applications that use SQL

The sequence numbers of the source statements generated by the SQL precompiler are based on the \*NOSEQSRC/\*SEQSRC keywords of the OPTION parameter on the CRTSQLRPG command.

When \*NOSEQSRC is specified, the sequence number from the input source member is used. For \*SEQSRC, the sequence numbers start at 000001 and are incremented by 1.

## **Names in RPG/400 applications that use SQL**

Any valid RPG variable name can be used for a host variable and is subject to these restrictions.

Do not use host variable names or external entry names that begin with 'SQ', 'SQL', 'RDI', or 'DSN'. These names are reserved for the database manager.

## **Statement labels in RPG/400 applications that use SQL**

A TAG statement can precede any SQL statement. Code the TAG statement on the line preceding EXEC SQL.

## **WHENEVER statement in RPG/400 applications that use SQL**

The target for the GOTO clause must be the label of the TAG statement. The scope rules for the GOTO/TAG must be observed.

## **Using host variables in RPG/400 applications that use SQL**

All host variables used in SQL statements must be explicitly declared. LOB, XML, ROWID, result set locator, and binary host variables are not supported in RPG/400.

SQL embedded in RPG/400 does not use the SQL BEGIN DECLARE SECTION and END DECLARE SECTION statements to identify host variables. Do not put these statements in the source program.

All host variables within an SQL statement must be preceded by a colon (:).

The names of host variables must be unique within the program.

## **Declaring host variables in RPG/400 applications that use SQL**

The SQL RPG/400 precompiler only recognizes a subset of RPG/400 declarations as valid host variable declarations.

Most variables defined in RPG/400 can be used in SQL statements. A partial listing of variables that are not supported includes the following:

- Indicator field names (\*INxx)
- Tables
- UDATE
- UDAY
- UMONTH
- UYEAR
- Look-ahead fields
- Named constants

Fields used as host variables are passed to SQL, using the CALL/PARM functions of RPG/400. If a field cannot be used in the result field of the PARM, it cannot be used as a host variable.

## **Using host structures in RPG/400 applications that use SQL**

The RPG/400 data structure name can be used as a host structure name if subfields exist in the data structure. The use of the data structure name in an SQL statement implies that it is the list of subfield names that make up the data structure.

When subfields are not present for the data structure, then the data structure name is a host variable of character type. This allows character variables larger than 256, because data structures can be up to 9999.

In the following example, BIGCHR is an RPG/400 data structure without subfields. SQL treats any referrals to BIGCHR as a character string with a length of 642.

```
*...1....+...2....+...3....+...4....+...5....+...6....+...7...*
IBIGCHR      DS                      642
```

In the next example, PEMPL is the name of the host structure consisting of the subfields EMPNO, FIRSTN, MIDINT, LASTNAME, and DEPTNO. The referral to PEMPL uses the subfields. For example, the first column of EMPLOYEE is placed in *EMPNO*, the second column is placed in *FIRSTN*, and so on.

```
*...1....+...2....+...3....+...4....+...5....+...6....+...7. ...*
IPEMPL      DS
I           01 06 EMPNO
I           07 18 FIRSTN
I           19 19 MIDINT
I           20 34 LASTNA
I           35 37 DEPTNO
...
C           MOVE '000220' EMPNO
...
C/EXEC SQL
C+ SELECT * INTO :PEMPL
C+ FROM CORPDATA.EMPLOYEE
C+ WHERE EMPNO = :EMPNO
C/END-EXEC
```

When writing an SQL statement, referrals to subfields can be qualified. Use the name of the data structure, followed by a period and the name of the subfield. For example, PEMPL.MIDINT is the same as specifying only MIDINT.

## Using host structure arrays in RPG/400 applications that use SQL

A host structure array is defined as an occurrence data structure. An occurrence data structure can be used on the SQL FETCH statement when fetching multiple rows.

In these examples, the following are true:

- All items in BARRAY must be valid host variables.
- All items in BARRAY must be contiguous. The first FROM position must be 1 and there cannot be overlaps in the TO and FROM positions.
- For all statements other than the multiple-row FETCH and blocked INSERT, if an occurrence data structure is used, the current occurrence is used. For the multiple-row FETCH and blocked INSERT, the occurrence is set to 1.

```
*...1....+...2....+...3....+...4....+...5....+...6....+...7. ...*
IBARRAY     DS                      10
I           01 20 C1VAR
I           B 21 220C2VAR
```

The following example uses a host structure array called DEPT and a multiple-row FETCH statement to retrieve 10 rows from the DEPARTMENT table.

```
*...1....+...2....+...3....+...4....+...5....+...6....+...7...*
E           INDS          4 4 0
IDEPT      DS          10
I           01 03 DEPTNO
I           04 32 DEPTNM
I           33 38 MGRNO
I           39 41 ADMRD
IINDARR    DS          10
I           B 1 80INDS
...
C/EXEC SQL
C+ DECLARE C1 CURSOR FOR
C+ SELECT *
C+ FROM CORPDATA.DEPARTMENT
```

```

C/END-EXEC
C/EXEC SQL
C+ OPEN C1
C/END-EXEC
C/EXEC SQL
C+ FETCH C1 FOR 10 ROWS INTO :DEPT:INDARR
C/END-EXEC

```

## Using external file descriptions in RPG/400 applications that use SQL

The SQL precompiler processes the RPG/400 source in much the same manner as the ILE RPG compiler. This means that the precompiler processes the /COPY statement for definitions of host variables.

Field definitions for externally described files are obtained and renamed, if different names are specified. The external definition form of the data structure can be used to obtain a copy of the column names to be used as host variables.

In the following example, the sample table DEPARTMENT is used as a file in an RPG/400 program. The SQL precompiler retrieves the field (column) definitions for DEPARTMENT for use as host variables.

```

*...1...+...2...+...3...+...4...+...5...+...6...+...7...*
FTDEPT  IP  E          DISK
F          TDEPT          KRENAMEDEPTREC
I
I DEPTREC
I          DEPTNAME      DEPTN
I          ADMRDEPT      ADMRD

```

**Note:** Code an F-spec for a file in your RPG program only if you use RPG/400 statements to do I/O operations to the file. If you use only SQL statements to do I/O operations to the file, you can include the external definition by using an external data structure.

In the following example, the sample table is specified as an external data structure. The SQL precompiler retrieves the field (column) definitions as subfields of the data structure. Subfield names can be used as host variable names, and the data structure name TDEPT can be used as a host structure name. The field names must be changed because they are greater than six characters.

```

*...1...+...2...+...3...+...4...+...5...+...6...+...7...*
ITDEPT  E DSDEPARTMENT
I          DEPTNAME      DEPTN
I          ADMRDEPT      ADMRD

```

**Note:** DATE, TIME, and TIMESTAMP columns will generate host variable definitions that are treated by SQL with the same comparison and assignment rules as a DATE, TIME, and TIMESTAMP column. For example, a date host variable can only be compared against a DATE column or a character string that is a valid representation of a date.

Although varying-length columns generate fixed-length character-host variable definitions, to SQL they are varying-length character variables.

Although GRAPHIC and VARGRAPHIC columns are mapped to character variables in RPG/400, SQL considers these GRAPHIC and VARGRAPHIC variables. If the GRAPHIC or VARGRAPHIC column has a UCS-2 CCSID, the generated host variable will have the UCS-2 CCSID assigned to it. If the GRAPHIC or VARGRAPHIC column has a UTF-16 CCSID, the generated host variable will have the UTF-16 CCSID assigned to it.

CLOB, BLOB, and DBCLOB columns in the external file are ignored. No host variable definition will be generated in the host structure for these types.

## External file description considerations for host structure arrays in RPG/400 applications that use SQL

Field definitions for externally described files, including renaming of fields, are recognized by the SQL precompiler.

The external definition form of the data structure can be used to obtain a copy of the column names to be used as host variables.

In the following example, the DEPARTMENT table is included in the RPG/400 program and is used to declare a host structure array. A multiple-row FETCH statement is then used to retrieve 10 rows into the host structure array.

```

*...1...+...2...+...3...+...4...+...5...+...6...*
ITDEPT      E DSDEPARTMENT          10
I           DEPARTMENT              DEPTN
I           ADMRDEPT                ADMRD

...

C/EXEC SQL
C+  DECLARE C1 CURSOR FOR
C+  SELECT *
C+  FROM CORPDATA.DEPARTMENT
C/END-EXEC

...

C/EXEC SQL
C+  FETCH C1 FOR 10 ROWS INTO :TDEPT
C/END-EXEC

```

## Determining equivalent SQL and RPG/400 data types

The precompiler determines the base SQLTYPE and SQLLEN of host variables based on the table. If a host variable appears with an indicator variable, the SQLTYPE is the base SQLTYPE plus one.

Table 7. RPG/400 declarations mapped to typical SQL data types

RPG/400 data type	Col 43	Col 52	Other RPG/400 coding	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
Data Structure subfield	blank	blank	Length = n where n ≤ 256	452	n	CHAR(n)
Data structure (without subfields)	n/a	n/a	Length = n where n ≤ 9999	452	n	CHAR(n)
Input field	blank	blank	Length = n where n ≤ 256	452	n	CHAR(n)
Calculation result field	n/a	blank	Length = n where n ≤ 256	452	n	CHAR(n)
Data Structure subfield	B	0	Length = 2	500	2	SMALLINT
Data Structure subfield	B	0	Length = 4	496	4	INTEGER
Data Structure subfield	B	1-4	Length = 2	500	2	DECIMAL(4,s) where s=column 52
Data Structure subfield	B	1-9	Length = 4	496	4	DECIMAL(9,s) where s=column 52
Data Structure subfield	P	0 to 9	Length = n where n is 1 to 16	484	p in byte 1, s in byte 2	DECIMAL(p,s) where p = n*2-1 and s = column 52

Table 7. RPG/400 declarations mapped to typical SQL data types (continued)

RPG/400 data type	Col 43	Col 52	Other RPG/400 coding	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
Input field	P	0 to 9	Length = n where n is 1 to 16	484	p in byte 1, s in byte 2	DECIMAL(p,s) where p = n*2-1 and s = column 52
Input field	blank	0 to 9	Length = n where n is 1 to 30	484	p in byte 1, s in byte 2	DECIMAL(p,s) where p = n and s = column 52
Input field	B	0 to 4 if n = 2; 0 to 9 if n = 4	Length = 2 or 4	484	p in byte 1, s in byte 2	DECIMAL(p,s) where p=4 if n=2 or 9 if n=4 and s = column 52
Calculation result field	n/a	0 to 9	Length = n where n is 1 to 30	484	p in byte 1, s in byte 2	DECIMAL(p,s) where p = n and s = column 52
Data Structure subfield	blank	0 to 9	Length = n where n is 1 to 30	488	p in byte 1, s in byte 2	NUMERIC(p,s) where p = n and s = column 52

Use the information in the following table to determine the RPG/400 data type that is equivalent to a given SQL data type.

Table 8. SQL data types mapped to typical RPG/400 declarations

SQL data type	RPG/400 data type	Notes
SMALLINT	Subfield of a data structure. B in position 43, length must be 2 and 0 in position 52 of the subfield specification.	
INTEGER	Subfield of a data structure. B in position 43, length must be 4 and 0 in position 52 of the subfield specification.	
BIGINT	No exact equivalent	Use P in position 43 and 0 in position 52 of the subfield specification.
DECIMAL	Subfield of a data structure. P in position 43 and 0 through 9 in position 52 of the subfield specification.  OR Defined as numeric and not a subfield of a data structure.	Maximum length of 16 (precision 30) and maximum scale of 9.
NUMERIC	Subfield of the data structure. Blank in position 43 and 0 through 9 in position 52 of the subfield	Maximum length of 30 (precision 30) and maximum scale of 9.

Table 8. SQL data types mapped to typical RPG/400 declarations (continued)

SQL data type	RPG/400 data type	Notes
DECFLOAT	Not supported	Not supported
FLOAT (single precision)	No exact equivalent	Use one of the alternative numeric data types described above.
FLOAT (double precision)	No exact equivalent	Use one of the alternative numeric data types described above.
CHAR(n)	Subfield of a data structure or input field. Blank in positions 43 and 52 of the specification. OR Calculation result field defined without decimal places.	n can be from 1 to 256.
CHAR(n)	Data structure name with no subfields in the data structure.	n can be from 1 to 9999.
VARCHAR(n)	No exact equivalent	Use a character host variable large enough to contain the largest expected VARCHAR value.
CLOB	Not supported	Not supported
GRAPHIC(n)	Not supported	Not supported
VARGRAPHIC(n)	Not supported	Not supported
DBCLOB	Not supported	Not supported
BINARY	Not supported	Not supported
VARBINARY	Not supported	Not supported
BLOB	Not supported	Not supported
DATE	Subfield of a data structure. Blank in position 52 of the subfield specification. OR Field defined without decimal places.	If the format is *USA, *JIS, *EUR, or *ISO, the length must be at least 10. If the format is *YMD, *DMY, or *MDY, the length must be at least 8. If the format is *JUL, the length must be at least 6.
TIME	Subfield of a data structure. Blank in position 52 of the subfield specification. OR Field defined without decimal places.	Length must be at least 6; to include seconds, length must be at least 8.
TIMESTAMP	Subfield of a data structure. Blank in position 52 of the subfield specification. OR Field defined without decimal places.	Length must be at least 19. To include microseconds at full precision, length must be 26. If length is less than 26, truncation occurs on the microseconds part.
BOOLEAN	Not supported	Not supported.
XML	Not supported	Not supported
DATALINK	Not supported	Not supported

Table 8. SQL data types mapped to typical RPG/400 declarations (continued)

SQL data type	RPG/400 data type	Notes
ROWID	Not supported	Not supported
Result set locator	Not supported	Not supported

## Assignment rules in RPG/400 applications that use SQL

RPG/400 associates precision and scale with all numeric types.

RPG/400 defines numeric operations, assuming the data is in packed format. This means that operations involving binary variables include an implicit conversion to packed format before the operation is performed (and back to binary, if necessary). Data is aligned to the implied decimal point when SQL operations are performed.

## Using indicator variables in RPG/400 applications that use SQL

An indicator variable is a two-byte integer.

See the entry for the SMALLINT SQL data type in [Table 7 on page 101](#).

An indicator structure can be defined by declaring the variable as an array with an element length of 4,0 and declaring the array name as a subfield of a data structure with B in position 43.

Indicator variables are declared in the same way as host variables and the declarations of the two can be mixed in any way that seems appropriate to the programmer.

### Related reference

[References to variables](#)

[Indicator variables in applications that use SQL](#)

An *indicator variable* is a halfword integer variable used to communicate additional information about its associated host variable.

## Example: Using indicator variables in RPG/400 applications that use SQL

This example shows declaring indicator variables in RPG.

Given the statement:

```
*...1...+...2...+...3...+...4...+...5...+...6...+...7...*
C/EXEC SQL FETCH CLS_CURSOR INTO :CLSCD,
C+           :DAY :DAYIND,
C+           :BGN :BGNIND,
C+           :END :ENDIND
C/END-EXEC
```

variables can be declared as follows:

```
*...1...+...2...+...3...+...4...+...5...+...6...+...7...*
I           DS
I           1  7 CLSCD
I           B  8  90DAY
I           B 10 110DAYIND
I           12 19 BGN
I           B 20 210BGNIND
I           22 29 END
I           B 30 310ENDIND
```

## Differences in RPG/400 because of structure parameter passing techniques

The SQL RPG/400 precompiler attempts to use the structure parameter passing technique, if possible.

The precompiler generates code where each host variable is a separate parameter when the following conditions are true:

- The data length of the host variables, referred to in the statement, is greater than 9935. Because SQL uses 64 bytes of the structure,  $9935 + 64 = 9999$ , the maximum length of a data structure.
- An indicator is specified on the statement where the length of the indexed indicator name plus the required index value is greater than six characters. The precompiler must generate an assignment statement for the indicator with the indicator name in the result field that is limited to six characters ("INDIC,1" requires seven characters).
- The length of a host variable is greater than 256. This can happen when a data structure without subfields is used as a host variable, and its length exceeds 256. Subfields cannot be defined with a length greater than 256.

### Related concepts

[Application design tips for database performance](#)

## Correctly ending a called RPG/400 program that uses SQL

SQL run time builds and maintains data areas (internal SQLDAs) for each SQL statement that contains host variables.

These internal SQLDAs are built the first time the statement is run and then reused on subsequent executions of the statement to increase performance. The internal SQLDAs can be reused as long as there is at least one SQL program active. The SQL precompiler allocates static storage used by SQL run time to manage the internal SQLDAs properly.

If an RPG/400 program containing SQL is called from another program that also contains SQL, the RPG/400 program should not set the Last Record (LR) indicator on. Setting the LR indicator on causes the static storage to be re-initialized the next time the RPG/400 program is run. Re-initializing the static storage causes the internal SQLDAs to be rebuilt, thus causing a performance degradation.

An RPG/400 program containing SQL statements that is called by a program that also contains SQL statements, should be ended one of two ways:

- By the RETRN statement
- By setting the RT indicator on.

This allows the internal SQLDAs to be used again and reduces the total run time.

## Coding SQL statements in ILE RPG applications

You need to be aware of the unique application and coding requirements for embedding SQL statements in an ILE RPG program. In this topic, the coding requirements for host variables are defined.

Not all features implemented by the ILE RPG compiler are supported by the SQL precompiler.

- If a control specification is not present in the program source, the RPG compiler searches for a data area containing control specification keywords. This feature is not supported by the SQL precompiler.

**Note:** By using the code examples, you agree to the terms of the [“Code license and disclaimer information”](#) on page 198.

For more information about programming using ILE RPG, see the [ILE RPG Programmer's Guide](#)  topic and the [ILE RPG Language Reference](#)  topic.

### Related concepts

[Writing applications that use SQL](#)

You can create database applications in host languages that use Db2 for i SQL statements and functions.

### Related reference

[Example programs: Using Db2 for i statements](#)

Here is a sample application that shows how to code SQL statements in each of the languages that Db2 for i supports.

[Example: SQL statements in ILE RPG programs](#)

This example program is written in the ILE RPG programming language.

## Defining the SQL communication area in ILE RPG applications that use SQL

The SQL precompiler automatically places the SQL communication area (SQLCA) in the definition specifications of the ILE RPG program before the first calculation specification, unless a SET OPTION SQLCA = \*NO statement is found.

INCLUDE SQLCA should not be coded in the source program. If the source program specifies INCLUDE SQLCA, the statement will be accepted, but it is redundant. The SQLCA source statements for ILE RPG are:

```
// SQL COMMUNICATION AREA
DCL-DS SQLCA;
  SQLCAID CHAR(8) INZ('0000000000000000');
  SQLAID CHAR(8) OVERLAY(SQLCAID);
  SQLCABC INT(10);
  SQLABC BINDEC(9) OVERLAY(SQLCABC);
  SQLCODE INT(10);
  SQLCOD BINDEC(9) OVERLAY(SQLCODE);
  SQLERRML INT(5);
  SQLERL BINDEC(4) OVERLAY(SQLERRML);
  SQLERRMC CHAR(70);
  SQLERM CHAR(70) OVERLAY(SQLERRMC);
  SQLERRP CHAR(8);
  SQLERP CHAR(8) OVERLAY(SQLERRP);
  SQLERR CHAR(24);
  SQLER1 BINDEC(9) OVERLAY(SQLERR:*NEXT);
  SQLER2 BINDEC(9) OVERLAY(SQLERR:*NEXT);
  SQLER3 BINDEC(9) OVERLAY(SQLERR:*NEXT);
  SQLER4 BINDEC(9) OVERLAY(SQLERR:*NEXT);
  SQLER5 BINDEC(9) OVERLAY(SQLERR:*NEXT);
  SQLER6 BINDEC(9) OVERLAY(SQLERR:*NEXT);
  SQLERRD INT(10) DIM(6) OVERLAY(SQLERR);
  SQLWRN CHAR(11);
  SQLWN0 CHAR(1) OVERLAY(SQLWRN:*NEXT);
  SQLWN1 CHAR(1) OVERLAY(SQLWRN:*NEXT);
  SQLWN2 CHAR(1) OVERLAY(SQLWRN:*NEXT);
  SQLWN3 CHAR(1) OVERLAY(SQLWRN:*NEXT);
  SQLWN4 CHAR(1) OVERLAY(SQLWRN:*NEXT);
  SQLWN5 CHAR(1) OVERLAY(SQLWRN:*NEXT);
  SQLWN6 CHAR(1) OVERLAY(SQLWRN:*NEXT);
  SQLWN7 CHAR(1) OVERLAY(SQLWRN:*NEXT);
  SQLWN8 CHAR(1) OVERLAY(SQLWRN:*NEXT);
  SQLWN9 CHAR(1) OVERLAY(SQLWRN:*NEXT);
  SQLWNA CHAR(1) OVERLAY(SQLWRN:*NEXT);
  SQLWARN CHAR(1) DIM(11) OVERLAY(SQLWRN);
  SQLSTATE CHAR(5);
  SQLSTT CHAR(5) OVERLAY(SQLSTATE);
END-DS SQLCA;
```

If a SET OPTION SQLCA = \*NO statement is found, the SQL precompiler automatically places SQLCODE and SQLSTATE variables in the definition specification. They are defined as follows when the SQLCA is not included:

```
DCL-S SQLCODE INT(10);
DCL-S SQLSTATE CHAR(5);
```

### Related reference

[SQL communication area](#)

## Defining SQL descriptor areas in ILE RPG applications that use SQL

There are two types of SQL descriptor areas (SQLDAs). One is defined with the ALLOCATE DESCRIPTOR statement. The other is defined using the SQLDA structure. In this topic, only the SQLDA form is discussed.

The following statements can use an SQLDA:

- EXECUTE...USING DESCRIPTOR *descriptor-name*
- FETCH...USING DESCRIPTOR *descriptor-name*

- OPEN...USING DESCRIPTOR *descriptor-name*
- CALL...USING DESCRIPTOR *descriptor-name*
- DESCRIBE *statement-name* INTO *descriptor-name*
- DESCRIBE CURSOR *cursor-name* INTO *descriptor-name*
- DESCRIBE INPUT *statement-name* INTO *descriptor-name*
- DESCRIBE PROCEDURE *procedure-name* INTO *descriptor-name*
- DESCRIBE TABLE *host-variable* INTO *descriptor-name*
- PREPARE *statement-name* INTO *descriptor-name*

Unlike the SQLCA, there can be more than one SQLDA in a program and an SQLDA can have any valid name.

Dynamic SQL is a programming technique. With dynamic SQL, your program can develop and then run SQL statements while the program is running. A SELECT statement with a variable SELECT list (that is, a list of columns to be returned as part of the query) that runs dynamically requires an SQL descriptor area (SQLDA). This is because you cannot know in advance how many or what type of variables to allocate in order to receive the results of the SELECT.

You can specify an INCLUDE SQLDA statement in an ILE RPG program. If an INCLUDE SQLDA statement is found anywhere in your program, the SQLDA structure is generated one time as part of the global definitions in your program.

```
EXEC SQL INCLUDE SQLDA;
```

The INCLUDE SQLDA generates the following data structure.

```
// SQL DESCRIPTOR AREA
DCL-DS SQLDA;
  SQLDAID CHAR(8);
  SQLDABC INT(10);
  SQLN INT(5);
  SQLD INT(5);
  SQL_VAR CHAR(80) DIM(SQL_NUM);
  *N POINTER OVERLAY(SQL_VAR:17);
  *N POINTER OVERLAY(SQL_VAR:33);
END-DS SQLDA;
DCL-DS SQLVAR;
  SQLTYPE INT(5);
  SQLLEN INT(5);
  SQLRES CHAR(12);
  SQLINF01 CHAR(16);
  SQLDATA POINTER OVERLAY(SQLINF01);
  SQL_RESULT_SET_LOCATOR INT(20) OVERLAY(SQLINF01);
  SQLINF02 CHAR(16);
  SQLIND POINTER OVERLAY(SQLINF02);
  SQL_ROW_CHANGE INT(10) OVERLAY(SQLINF02);
  SQL_RESULT_SET_ROWS INT(10) OVERLAY(SQLINF02);
  SQLNAMELEN INT(5);
  SQLNAME CHAR(30);
END-DS SQLVAR;
// EXTENDED SQLDA
DCL-DS SQLVAR2;
  SQLLONGL INT(10);
  SQLRSVDL CHAR(28);
  SQLDATAL POINTER;
  SQLTNAMELN INT(5);
  SQLTNAME CHAR(30);
END-DS SQLVAR2;
```

The user is responsible for the definition of SQL\_NUM. SQL\_NUM must be defined as a numeric constant with the dimension required for SQL\_VAR.

The INCLUDE SQLDA generates two data structures. The second data structure is used to setup and reference the part of the SQLDA that contains the field descriptions.

To set the field descriptions of the SQLDA the program sets up the field description in the subfields of SQLVAR and then assigns SQLVAR to SQL\_VAR(n), where n is the number of the field in the SQLDA. This is repeated until all the field descriptions are set.

When the SQLDA field descriptions are to be referenced the user assigns SQLVAR(n) to SQL\_VAR where n is the number of the field description to be processed.

### Related concepts

[Dynamic SQL applications](#)

### Related reference

[SQL descriptor area](#)

## Embedding SQL statements in ILE RPG applications that use SQL

SQL statements coded in an ILE RPG program can be placed in the calculation section or in a free-form calculation block.

SQL statements can be placed in detail calculations, in total calculations, or in RPG subroutines. The SQL statements are run based on the logic of the RPG statements.

Both uppercase and lowercase letters are acceptable in SQL statements.

### Fixed-form RPG

The keywords EXEC SQL indicate the beginning of an SQL statement. EXEC SQL must occupy positions 8 through 16 of the source statement, preceded by a / in position 7. The SQL statement may start in position 17 and continue through position 80.

The keyword END-EXEC ends the SQL statement. END-EXEC must occupy positions 8 through 16 of the source statement, preceded by a slash (/) in position 7. Positions 17 through 80 must be blank.

An UPDATE statement coded in an ILE RPG program might be coded as follows:

```
C/EXEC SQL UPDATE DEPARTMENT
C+          SET  MANAGER = :MGRNUM
C+          WHERE DEPTNO = :INTDEP
C/END-EXEC
```

### Free-form RPG

Each SQL statement must begin with EXEC SQL and end with a semicolon (;). The EXEC SQL keywords must be on one line. The remaining part of the SQL statement can be on more than one line. Each SQL statement should start on a new line. No other statement should be on the same line as the SQL statement.

An UPDATE statement coded in free form might be coded in the following way:

```
EXEC SQL UPDATE DEPARTMENT
SET MGRNO = :MGR_NUM
WHERE DEPTNO = :INT_DEP;
```

## Comments in ILE RPG applications that use SQL

In addition to SQL comments (--), ILE RPG comments can be included within SQL statements wherever SQL allows a blank character.

### Fixed-form RPG

To embed an ILE RPG comment within the SQL statement, place an asterisk (\*) in position 7.

## Free-form RPG

Bracketed comments (*/\*...\*/*) are allowed within embedded SQL statements whenever a blank is allowed, except between the keywords EXEC and SQL. Comments can span any number of lines. Single-line comments (*//*) can also be used.

## Continuation for SQL statements in ILE RPG applications that use SQL

SQL statements can be continued across many records in ILE RPG.

## Fixed-form RPG

When additional records are needed to contain the SQL statement, positions 9 through 80 can be used. Position 7 must be a plus sign (+), and position 8 must be blank. Position 80 of the continued line is concatenated with position 9 of the continuation line.

Constants containing DBCS data can be continued across multiple lines by placing the shift-in character in position 81 of the continued line and placing the shift-out character in position 8 of the continuation line.

In this example, the SQL statement has a valid graphic constant of G'<AABBCCDDEEFFGGHHIIJJKK>'.

```
C/EXEC SQL      SELECT * FROM GRAPHTAB WHERE GRAPHCOL = G'<AABBCCDDEE>  
C+<FFGGHHIIJJKK>'  
C/END-EXEC
```

## Free-form RPG

SQL statements can be contained on one or more lines. To continue an SQL statement across multiple lines, the SQL statement can be split wherever a blank is allowed. The plus sign (+) can be used to indicate a continuation of a string constant. The literal continues with the first nonblank character on the next line.

## Including code in ILE RPG applications that use SQL

To include SQL statements and RPG specifications in ILE RPG applications, use the SQL INCLUDE statement.

```
C/EXEC SQL INCLUDE member-name  
C/END-EXEC
```

RPG directives are handled by the SQL precompiler according to the value of the RPG preprocessor options parameter (RPGPPOPT).

### Related reference

[Using directives in ILE RPG applications that use SQL](#)

RPG directives are handled by the SQL precompiler according to the value of the RPG preprocessor options parameter (RPGPPOPT). If the RPG preprocessor is used, the SQL precompile will run using the expanded preprocessed source.

## Using directives in ILE RPG applications that use SQL

RPG directives are handled by the SQL precompiler according to the value of the RPG preprocessor options parameter (RPGPPOPT). If the RPG preprocessor is used, the SQL precompile will run using the expanded preprocessed source.

- When the value is \*NONE, the RPG preprocessor is not called to preprocess the RPG source. When a source stream file is precompiled, no directives are recognized by SQL. When a source member is precompiled, the only directive that is handled by the SQL precompiler is /COPY. Nested /COPY statements are not handled. In fully free-form source mode, /COPY statements that start in any column are handled by the SQL precompiler. In column-limited source mode, only /COPY statements that

start in column 7 are handled by the SQL precompiler. All /COPY statements must reference a source member; they cannot reference a source stream file. All other directives are ignored until the RPG compiler is called. This means that all RPG and SQL statements within conditional logic blocks are processed unconditionally by the SQL precompiler.

- When the value is \*LVL1, the RPG preprocessor will be called to preprocess the RPG source. All /COPY statements are expanded, even nested /COPY statements, and the conditional compilation directives will be handled.
- When the value is \*LVL2, the RPG preprocessor will be called to preprocess the RPG source. All /COPY and /INCLUDE statements are expanded and the conditional compilation directives will be handled.
- When \*LVL1 or \*LVL2 is used, there is a possibility that the expanded source generated by the RPG preprocessor will become very large and reach a resource limit due to the expansion of the /COPY and /INCLUDE statements. If this happens you must either break up your source into smaller pieces, or not use the RPG preprocessor.

### **Related reference**

[Including code in ILE RPG applications that use SQL](#)

To include SQL statements and RPG specifications in ILE RPG applications, use the SQL INCLUDE statement.

## **Sequence numbers in ILE RPG applications that use SQL**

The sequence numbers of the source statements generated by the SQL precompiler are based on the \*NOSEQSRC/\*SEQSRC keywords of the OPTION parameter on the **CRTSQLRPGI** command.

When \*NOSEQSRC is specified, the sequence number from the input source member is used. For \*SEQSRC, the sequence numbers start at 000001 and are incremented by 1.

## **Names in ILE RPG applications that use SQL**

Any valid ILE RPG variable name can be used for a host variable with these restrictions.

- Do not use host variable names or external entry names that begin with the characters SQ, SQL, RDI, or DSN. These names are reserved for the database manager.
- The maximum length of host variable names is 64 characters.

## **Statement labels in ILE RPG applications that use SQL**

A TAG statement can precede any SQL statement. Code the TAG statement on the line preceding EXEC SQL.

## **WHENEVER statement in ILE RPG applications that use SQL**

The target for the GOTO clause must be the label of the TAG statement. The scope rules for the GOTO/TAG must be observed. The target for the DO EXSR clause must be a subroutine name. The scope rules for subroutine names must be observed. The target for the DO clause must be an RPG subroutine name. The scope rules for subroutines must be observed.

## **Using host variables in ILE RPG applications that use SQL**

All host variables used in SQL statements must be explicitly declared.

SQL embedded in ILE RPG does not use the SQL BEGIN DECLARE SECTION and END DECLARE SECTION statements to identify host variables. Do not put these statements in the source program.

All host variables within an SQL statement must be preceded by a colon (:). Names of host variables do not need to be unique within the program. The precompiler recognizes variables with the same name in different procedures and scopes them correctly.

An SQL statement that uses a host variable must be within the scope of the variable's declaration. A DECLARE CURSOR statement must be in the same scope as its OPEN statement to guarantee that any variables used by the DECLARE CURSOR will use the definition in the scope of the OPEN.

If an error stating that a host variable is not defined or not usable is issued, look at the cross-reference in the precompiler listing to see how the precompiler defined the variable. To generate a cross-reference in the listing, run the precompile command with \*XREF specified on the OPTIONS parameter.

## Declaring host variables in ILE RPG applications that use SQL

The SQL ILE RPG precompiler only recognizes a subset of valid ILE RPG declarations as valid host variable declarations.

Most variables defined in ILE RPG can be used in SQL statements. A partial listing of variables that are not supported includes the following:

- Unsigned integers
- Pointer
- Tables
- UDATE
- UDAY
- UMONTH
- UYEAR
- Look-ahead fields
- Named constants which refer to figurative constants or built-in functions
- Multiple dimension arrays
- Definitions requiring the resolution of %SIZE or %ELEM
- Definitions requiring the resolution of constants unless the constant is used in OCCURS, DIM, OVERLAY, or POS and the constant is declared before it is used in the OCCURS, DIM, OVERLAY, or POS.

Fields used as host variables are passed to SQL using the CALL/PARM functions of ILE RPG. If a field cannot be used in the result field of the PARM, it cannot be used as a host variable.

Date and time host variables are always assigned to corresponding date and time subfields in the structures generated by the SQL precompiler. The generated date and time subfields are declared using the format and separator specified by the DATFMT, DATSEP, TIMFMT, and TIMSEP parameters on the CRTSQLRPGI command or with the SET OPTION statement. Conversion from the user declared host variable format to the precompile specified format occurs on assignment to and from the SQL generated structure. If the DATFMT parameter value is a system format (\*MDY, \*YMD, \*DMY, or \*JUL), then all input and output host variables must contain date values within the range 1940-2039. If any date value is outside of this range, then the DATFMT on the precompile must be specified as one of the IBM SQL formats of \*ISO, \*USA, \*EUR, or \*JIS.

The SQL precompiler accepts variables defined as VARYING(2), but does not support VARYING(4). The LEN keyword is recognized, but only lengths up to the SQL limit for the data type are accepted.

Character host variables will use the RPG CCSID value if one is specified. An SQL DECLARE VARIABLE statement cannot be used to change the CCSID of a host variable whose CCSID has been defined in RPG.

Graphic host variables will use the RPG CCSID value if one is specified. An SQL DECLARE VARIABLE statement cannot be used to change the CCSID of a host variable whose CCSID has been defined in RPG, or a host variable that is defined as UCS-2 or UTF-16.

The precompiler supports RPG logical (indicator) variables as the BOOLEAN data type. An RPG indicator variable cannot be used as an SQL indicator variable.

The precompiler supports EXTNAME, but does not support EXTNAME(*filename* : *fmtname* : *fieldtype*), where *fieldtype* is \*NULL, \*ALL, \*INPUT, \*OUTPUT, or \*KEY.

The precompiler supports LIKERE(*intrecname*), but does not support the optional second parameter.

The precompiler supports EXTDESC(literal), but does not support EXTDESC(constant).

For SQLTYPE declarations, the precompiler only supports the CCSID keyword. All other keywords are ignored.

### ***Declaring binary host variables in ILE RPG applications that use SQL***

ILE RPG does not have variables that correspond to the SQL binary data types.

To create host variables that can be used with these data types, use the SQLTYPE keyword. The SQL precompiler replaces this declaration with an ILE RPG language declaration in the output source member. Binary declarations can be either standalone or within a data structure.

#### ***BINARY example***

- The following declaration in free-form:

```
DCL-S MYBINARY    SQLTYPE(BINARY:50);
```

results in the generation of the following code:

```
DCL-S MYBINARY CHAR(50) CCSID(*HEX);
```

- The following declaration in fixed-form:

```
D MYBINARY      S          SQLTYPE(BINARY:50)
```

results in the generation of the following code:

```
D MYBINARY      S          50A CCSID(*HEX)
```

#### ***VARBINARY example***

- The following declaration in free-form:

```
DCL-S MYVARBINARY SQLTYPE(VARBINARY:100);
```

results in the generation of the following code:

```
DCL-S MYVARBINARY VARCHAR(100) CCSID(*HEX)
```

- The following declaration in fixed-form:

```
D MYVARBINARY  S          SQLTYPE(VARBINARY:100)
```

results in the generation of the following code:

```
D MYVARBINARY  S          100A VARYING CCSID(*HEX)
```

#### **Notes:**

1. For BINARY host variables, the length must be in the range 1 to 32766.
2. For VARBINARY host variables, the length must be in the range 1 to 32740.
3. BINARY and VARBINARY host variables are allowed to be declared in host structures.
4. SQLTYPE, BINARY, and VARBINARY can be in mixed case.
5. SQLTYPE must be between positions 44 to 80 for fixed-form declarations.
6. When a BINARY or VARBINARY is declared as a standalone host variable, position 24 must contain the character **S** and position 25 must be blank for fixed-form declarations.
7. The standalone field indicator **S** in position 24 for fixed-form declarations should be omitted when a BINARY or VARBINARY host variable is declared in a host structure.

## Declaring LOB host variables in ILE RPG applications that use SQL

ILE RPG does not have variables that correspond to the SQL data types for LOBs (large objects).

To create host variables that can be used with these data types, use the SQLTYPE keyword. The SQL precompiler replaces this declaration with an ILE RPG language structure in the output source member. LOB declarations can be either standalone or within a data structure.

### LOB host variables in ILE RPG applications that use SQL

Here are some examples of LOB host variables (CLOB, DBCLOB, BLOB) in ILE RPG applications.

#### CLOB example

- The following declaration in free-form:

```
DCL-S MYCLOB      SQLTYPE(CLOB:1000);
```

results in the generation of the following structure:

```
DCL-DS MYCLOB;
  MYCLOB_LEN  UNS(10);
  MYCLOB_DATA CHAR(1000);
END-DS MYCLOB;
```

- The following declaration in fixed-form:

```
D MYCLOB          S          SQLTYPE(CLOB:1000)
```

results in the generation of the following structure:

```
D MYCLOB          DS
D MYCLOB_LEN      10U
D MYCLOB_DATA     1000A
```

#### DBCLOB example

- The following declaration in free-form:

```
DCL-S MYDBCLOB   SQLTYPE(DBCLOB:400);
```

results in the generation of the following structure:

```
DCL-DS MYDBCLOB;
  MYDBCLOB_LEN  UNS(10);
  MYDBCLOB_DATA GRAPH(400);
END-DS MYDBCLOB;
```

- The following declaration in fixed-form:

```
D MYDBCLOB        S          SQLTYPE(DBCLOB:400)
```

results in the generation of the following structure:

```
D MYDBCLOB        DS
D MYDBCLOB_LEN    10U
D MYDBCLOB_DATA   400G
```

#### BLOB example

- The following declaration in free-form:

```
DCL-S MYBLOB     SQLTYPE(BLOB:500);
```

results in the generation of the following structure:

```
DCL-DS MYBLOB;  
  MYBLOB_LEN UNS(10);  
  MYBLOB_DATA CHAR(500) CCSID(*HEX);  
END-DS MYBLOB;
```

- The following declaration in fixed-form:

```
D MYBLOB          S          SQLTYPE(BLOB:500)
```

results in the generation of the following structure:

```
D MYBLOB          DS  
D MYBLOB_LEN      10U  
D MYBLOB_DATA     500A CCSID(*HEX)
```

#### Notes:

1. For BLOB and CLOB host variables, the length must be in the range 1 to 16 773 100.
2. For DBCLOB host variables, the length must be in the range 1 to 8 386 550.
3. LOB host variables are allowed to be declared in host structures.
4. LOB host variables are not allowed in host structure arrays. LOB locators should be used instead.
5. LOB host variables declared in structure arrays cannot be used as standalone host variables.
6. SQLTYPE, BLOB, CLOB, DBCLOB can be in mixed case.
7. SQLTYPE must be between positions 44 to 80 for fixed-form declarations.
8. When a LOB is declared as a stand-alone host variable, position 24 must contain the character 'S' and position 25 must be blank for fixed-form declarations.
9. The stand-alone field indicator S in position 24 for fixed-form declarations should be omitted when a LOB is declared in a host structure.
10. LOB host variables cannot be initialized.

*LOB locators in ILE RPG applications that use SQL*

BLOB, CLOB, and DBCLOB locators have similar syntax. Here is an example of a BLOB locator.

#### Example: BLOB locator

- The following declaration in free-form:

```
DCL-S MYBLOB      SQLTYPE(BLOB_LOCATOR);
```

results in the following generation:

```
DCL-S MYBLOB UNS(10);
```

- The following declaration in fixed-form:

```
D MYBLOB          S          SQLTYPE(BLOB_LOCATOR)
```

results in the following generation:

```
D MYBLOB          S          10U
```

#### Notes:

1. LOB locators are allowed to be declared in host structures.
2. SQLTYPE, BLOB\_LOCATOR, CLOB\_LOCATOR, DBCLOB\_LOCATOR can be in mixed case.
3. SQLTYPE must be between positions 44 to 80 for fixed-form declarations.

4. When a LOB locator is declared as a standalone host variable, position 24 must contain the character 'S' and position 25 must be blank for fixed-form declarations.
5. The standalone field indicator **S** in position 24 for fixed-form declarations should be omitted when a LOB locator is declared in a host structure.
6. LOB locators cannot be initialized.

*LOB file reference variables in ILE RPG applications that use SQL*

Here is an example of a CLOB file reference variable in ILE RPG. BLOB and DBCLOB file reference variables have similar syntax.

### **CLOB file reference example**

- The following declaration in free-form:

```
DCL-S MY_FILE SQLTYPE(CLOB_FILE);
```

results in the generation of the following structure:

```
DCL-DS MY_FILE;
  MY_FILE_NL UNS(10);
  MY_FILE_DL UNS(10);
  MY_FILE_FO UNS(10);
  MY_FILE_NAME CHAR(255);
END-DS MY_FILE;
```

- The following declaration in fixed-form:

```
D MY_FILE      S          SQLTYPE(CLOB_FILE)
```

results in the generation of the following structure:

```
D MY_FILE      DS
D MY_FILE_NL   10U
D MY_FILE_DL   10U
D MY_FILE_FO   10U
D MY_FILE_NAME 255A
```

#### **Notes:**

1. LOB file reference variables are allowed to be declared in host structures.
2. SQLTYPE, BLOB\_FILE, CLOB\_FILE, DBCLOB\_FILE can be in mixed case.
3. SQLTYPE must be between positions 44 to 80 for fixed-form declarations.
4. When a LOB file reference is declared as a standalone host variable, position 24 must contain the character 'S' and position 25 must be blank for fixed-form declarations.
5. The standalone field indicator 'S' in position 24 for fixed-form declarations should be omitted when a LOB file reference variable is declared in a host structure.
6. LOB file reference variables cannot be initialized.

The pre-compiler will generate declarations for the following file option constants. You can use these constants to set the xxx\_FO variable when you use file reference host variables.

- SQFRD (2)
- SQFCRT (8)
- SQFOVR (16)
- SQFAPP (32)

#### **Related reference**

[LOB file reference variables](#)

## Declaring XML host variables in ILE RPG applications that use SQL

ILE RPG does not have variables that correspond to the SQL data type for XML.

To create host variables that can be used with this data type, use the SQLTYPE keyword. The SQL precompiler replaces this declaration with an ILE RPG language structure in the output source member. XML declarations can be either standalone or within a data structure.

## XML host variables in ILE RPG applications that use SQL

Here are some examples of XML host variables in ILE RPG applications.

It is recommended that the CCSID keyword be used on the XML\_CLOB or XML\_DBCLOB declaration to explicitly indicate the CCSID to the RPG compiler.

### XML AS CLOB example

- The following declaration in free-form:

```
DCL-S MYXMLCLOB SQLTYPE(XML_CLOB:3000) CCSID(37);
```

results in the generation of the following structure:

```
DCL-DS MYXMLCLOB;  
  MYXMLCLOB_LEN UNS(10);  
  MYXMLCLOB_DATA CHAR(3000) CCSID(37);  
END-DS MYXMLCLOB;
```

- The following declaration in fixed-form:

```
D MYXMLCLOB      S          SQLTYPE(XML_CLOB:3000)
```

results in the generation of the following structure:

```
D MYXMLCLOB      DS  
D MYXMLCLOB_LEN          10U  
D MYXMLCLOB_DATA        3000A
```

### XML AS DBCLOB example

- The following declaration in free-form:

```
DCL-S MYXMLDBCLOB SQLTYPE(XML_DBCLOB:400);
```

results in the generation of the following structure:

```
DCL-DS MYXMLDBCLOB;  
  MYXMLDBCLOB_LEN UNS(10);  
  MYXMLDBCLOB_DATA UCS2(400) CCSID(13488);  
END-DS MYXMLDBCLOB;
```

- The following declaration in fixed-form:

```
D MYXMLDBCLOB      S          SQLTYPE(XML_DBCLOB:400)
```

results in the generation of the following structure:

```
D MYXMLDBCLOB      DS  
D MYXMLDBCLOB_LEN          10U  
D MYXMLDBCLOB_DATA        400C
```

### XML AS BLOB example

- The following declaration in free-form:

```
DCL-S MYXMLBLOB SQLTYPE(XML_BLOB:780);
```

results in the generation of the following structure:

```
DCL-DS MYXMLBLOB;  
  MYXMLBLOB_LEN UNS(10);  
  MYXMLBLOB_DATA CHAR(780) CCSID(*HEX);  
END-DS MYXMLBLOB;
```

- The following declaration in fixed-form:

```
D MYXMLBLOB      S          SQLTYPE(XML_BLOB:780)
```

results in the generation of the following structure:

```
D MYXMLBLOB      DS  
D MYXMLBLOB_LEN          10U  
D MYXMLBLOB_DATA      780A CCSID(*HEX)
```

### Notes:

1. For XML\_BLOB and XML\_CLOB host variables, the length must be in the range 1 to 16 773 100.
2. For XML\_DBCLOB host variables, the length must be in the range 1 to 8 386 550.
3. XML host variables are allowed to be declared in host structures.
4. XML host variables are not allowed in host structure arrays. XML locators should be used instead.
5. XML host variables declared in structure arrays cannot be used as standalone host variables.
6. SQLTYPE, XML\_BLOB, XML\_CLOB, XML\_DBCLOB can be in mixed case.
7. SQLTYPE must be between positions 44 to 80 for fixed-form declarations.
8. The CCSID value for an XML host variable can be explicitly set by using the CCSID keyword or the DECLARE VARIABLE statement. Otherwise, the value specified by the SQL\_XML\_DATA\_CCSID QAQQINI option will be used. The default for this QAQQINI option is CCSID 1208.
9. When XML is declared as a standalone host variable, position 24 must contain the character 'S' and position 25 must be blank for fixed-form declarations.
10. The stand-alone field indicator S in position 24 for fixed-form declarations should be omitted when XML is declared in a host structure.
11. XML host variables cannot be initialized.

## XML locators in ILE RPG applications that use SQL

Here is an example of an XML locator.

### XML locator example

- The following declaration in free-form:

```
DCL-S MYXMLLOC SQLTYPE(XML_LOCATOR);
```

results in the following generation:

```
DCL-S MYXMLLOC UNS(10);
```

- The following declaration in fixed-form:

```
D MYXMLLOC      S          SQLTYPE(XML_LOCATOR)
```

results in the following generation:

```
D MYXMLLOC      S          10U
```

### Notes:

1. XML locators are allowed to be declared in host structures.
2. SQLTYPE, XML\_LOCATOR can be in mixed case.
3. SQLTYPE must be between positions 44 to 80 for fixed-form declarations.
4. When an XML locator is declared as a standalone host variable, position 24 must contain the character 'S' and position 25 must be blank for fixed-form declarations.
5. The standalone field indicator **S** in position 24 for fixed-form declarations should be omitted when an XML locator is declared in a host structure.
6. XML locators cannot be initialized.

## XML file reference variables in ILE RPG applications that use SQL

Here is an example of a XML file reference variable in ILE RPG.

### XML file reference example

- The following declaration in free-form:

```
DCL-S MY_XMLFILE SQLTYPE(XML_CLOB_FILE);
```

results in the generation of the following structure:

```
DCL-DS MY_XMLFILE;  
  MY_XMLFILE_NL UNS(10);  
  MY_XMLFILE_DL UNS(10);  
  MY_XMLFILE_FO UNS(10);  
  MY_XMLFILE_NAME CHAR(255);  
END-DS MY_XMLFILE;
```

- The following declaration in fixed-form:

```
D MY_XMLFILE          S          SQLTYPE(XML_CLOB_FILE)
```

results in the generation of the following structure:

```
D MY_XMLFILE          DS  
D MY_XMLFILE_NL          10U  
D MY_XMLFILE_DL          10U  
D MY_XMLFILE_FO          10U  
D MY_XMLFILE_NAME      255A
```

XML\_BLOB\_FILE and XML\_DBCLOB\_FILE file reference variables have similar syntax.

### Notes:

1. XML file reference variables are allowed to be declared in host structures.
2. SQLTYPE, XML\_BLOB\_FILE, XML\_CLOB\_FILE, XML\_DBCLOB\_FILE can be in mixed case.
3. SQLTYPE must be between positions 44 to 80 for fixed-form declarations.
4. When an XML file reference is declared as a standalone host variable, position 24 must contain the character 'S' and position 25 must be blank for fixed-form declarations.
5. The standalone field indicator 'S' in position 24 for fixed-form declarations should be omitted when an XML file reference variable is declared in a host structure.
6. XML file reference variables cannot be initialized.

The precompiler will generate declarations for the following file option constants. You can use these constants to set the xxx\_FO variable when you use file reference host variables.

- SQFRD (2)
- SQFCRT (8)

- SQFOVR (16)
- SQFAPP (32)

### **Declaring ROWID variables in ILE RPG applications that use SQL**

ILE RPG does not have a variable that corresponds to the SQL data type ROWID.

To create host variables that can be used with this data type, use the SQLTYPE keyword. The SQL precompiler replaces this declaration with an ILE RPG language declaration in the output source member. ROWID declarations can be either standalone or within a data structure.

#### **ROWID example**

- The following declaration in free-form:

```
DCL-S MY_ROWID SQLTYPE(ROWID);
```

results in the following generation:

```
DCL_S MY_ROWID VARCHAR(40) CCSID(*HEX);
```

- The following declaration in fixed-form:

```
D MY_ROWID      S          SQLTYPE(ROWID)
```

results in the following generation:

```
D MY_ROWID      S          40A  VARYING CCSID(*HEX)
```

#### **Notes:**

1. SQLTYPE, ROWID can be in mixed case.
2. ROWID host variables are allowed to be declared in host structures.
3. SQLTYPE must be between positions 44 and 80 for fixed-form declarations.
4. When a ROWID is declared as a standalone host variable, position 24 must contain the character 'S' and position 25 must be blank for fixed-form declarations.
5. The standalone field indicator 'S' in position 24 for fixed-form declarations should be omitted when a ROWID is declared in a host structure.
6. ROWID host variables cannot be initialized.

### **Declaring result set locator variables in ILE RPG applications that use SQL**

ILE RPG does not have a variable that corresponds to the SQL result set locator data type.

To create host variables that can be used with this data type, use the SQLTYPE keyword. The SQL precompiler replaces this declaration with an ILE RPG language declaration in the output source member. Result set locator declarations can be either standalone or within a data structure.

#### **Result set locator example**

- The following declaration in free-form:

```
DCL-S RS_LOC1 SQLTYPE(RESULT_SET_LOCATOR);
```

results in the following generation:

```
DCL-S RS_LOC1 INT(20);
```

- The following declaration in fixed-form:

```
D RS_LOC1      S          SQLTYPE(RESULT_SET_LOCATOR)
```

results in the following generation:

```
D RS_LOC1      S      20I 0
```

#### Notes:

1. SQLTYPE, RESULT\_SET\_LOCATOR can be in mixed case.
2. Result set locator host variables are allowed to be declared in host structures.
3. SQLTYPE must be between positions 44 and 80 for fixed-form declarations.
4. When a result set locator is declared as a standalone host variable, position 24 must contain the character 'S' and position 25 must be blank for fixed-form declarations.
5. The standalone field indicator 'S' in position 24 for fixed-form declarations should be omitted when a result set locator is declared in a host structure.
6. Result set locator host variables cannot be initialized.

## Using host structures in ILE RPG applications that use SQL

The ILE RPG data structure name can be used as a host structure name. The use of the data structure name in an SQL statement implies the specification of the list of subfield names that make up the data structure.

When a data structure contains one or more unnamed subfields, the data structure name cannot be used as a host structure in an SQL statement. The named subfields can be used as host variables.

The following must be considered when using a data structure as a host structure name:

- All subfields must be valid host variable declarations.
- All subfields must have a name.
- No subfield can be defined with the DIM or OCCUR keywords.

Any subfields within a data structure which are defined out of order or that overlap earlier bytes in the data structure will be skipped by the precompiler. This includes bytes that were skipped for alignment or positioning. For example, in the following structure declaration the FIRSTNAME subfield will be skipped since it is defined to use storage prior to the LASTNAME subfield.

```
DCL-DS PEMPL ;
  LASTNAME CHAR(10) POS(11);
  FIRSTNAME CHAR(10) POS(1);
END-DS;
```

In the following example, BIGCHR is an ILE data structure without subfields. SQL treats any references to BIGCHR as a character string with a length of 642.

```
DCL-DS BIGCHR LEN(642);
END-DS;
```

In the next example, PEMPL is the name of the host structure consisting of the subfields EMPNO, FIRSTN, MIDINT, LASTNA, and DEPTNO. A reference to PEMPL uses the subfields. For example, the first column of CORPDATA.EMPLOYEE is placed in *EMPNO*, the second column is placed in *FIRSTN*, and so on.

```
DCL-DS PEMPL ;
  EMPNO CHAR(6);
  FIRSTN CHAR(12);
  MIDINT CHAR(1);
  LASTNA CHAR(15);
  DEPTNO CHAR(3);
END-DS;

...
EMPNO = '000220';
...
EXEC SQL SELECT * INTO :PEMPL
FROM CORPDATA.EMPLOYEE
```

```
WHERE EMPNO = :EMPNO;
```

When writing an SQL statement, references to subfields that are not in a QUALIFIED data structure can be qualified. Use the name of the data structure, followed by a period and the name of the subfield. For example, PEMPL.MIDINT is the same as specifying only MIDINT. If the data structure has the QUALIFIED keyword, then the subfield must be referenced using the data structure name to qualify the subfield name.

In this example, there are two data structures, one QUALIFIED and one not QUALIFIED, that contain the same subfield names:

```
DCL-DS fststruct;
  sub1 INT(5);
  sub2 INT(10);
  sub3 INT(20);
  sub4 INT(10);
END-DS;

DCL-DS secstruct QUALIFIED;
  sub1 CHAR(4);
  sub2 CHAR(12);
  sub3 INT(20);
  myvar CHAR(5);
  sub5 CHAR(20);
END-DS;

DCL-S myvar INT(10);
```

Referencing *secstruct.sub1* as a host variable will be a character variable with a length of 4.

*sub1* as a host variable will have an SQL data type of small integer. It picks up its attributes from the data structure that is not QUALIFIED.

A host variable reference to *myvar* will use the standalone declaration to pick up the data type of integer. If you use *secstruct.myvar*, the character variable in the QUALIFIED structure will be used.

You cannot refer to *sub5* without qualifying it with *secstruct* because it is in a QUALIFIED data structure.

The precompiler will recognize a host structure defined using the LIKEDS keyword. However, the SQL syntax for a host variable only allows using a single level of qualification in an SQL statement. This means that if a data structure DS has a subfield S1 which is defined like a data structure with a subfield S2, an SQL statement cannot refer to S2 using the fully qualified host variable name of DS.S1.S2. If you use S1.S2 as the host variable reference, the precompiler will recognize it as DS.S1.S2. The following additional restrictions apply:

- The top level structure, DS, cannot be an array.
- S1.S2 must be unique. That is, there must be no other valid names in the program ending with S1.S2, such as a structure S1 with a subfield S1.S2, or a structure DS3 with a subfield DS3.S0.S1.S2.

## Example

```
DCL-DS CustomerInfo QUALIFIED;
  Name CHAR(20);
  Address CHAR(50);
END-DS;

DCL-DS ProductInfo QUALIFIED;
  Number CHAR(5);
  Description CHAR(20);
  Cost PACKED(9:2);
END-DS;

DCL-DS SalesTransaction QUALIFIED;
  Buyer LIKEDS(CustomerInfo);
  Seller LIKEDS(CustomerInfo);
  NumProducts INT(10);
  Product LIKEDS(ProductInfo) DIM(10);
END-DS;
```

```
EXEC SQL
  SELECT * INTO :CustomerInfo.Name, :Buyer.Name FROM MYTABLE;
```

*CustomerInfo.Name* will be recognized as a reference to the QUALIFIED structure's variable. *Buyer.Name* will be defined as *SalesTransaction.Buyer.Name*.

You cannot use *SalesTransaction.Buyer.Name* in an SQL statement because only one level of qualification is allowed in SQL syntax. You cannot use *Product.Cost* in an SQL statement because *cost* is in a dimensioned array.

If there is a *SalesTransaction2* defined like *SalesTransaction*, then the subfields that are structures cannot be used in SQL statements. Because only one level of qualification is supported by SQL, a reference to *Buyer.Name* is ambiguous.

## Using host structure arrays in ILE RPG applications that use SQL

A host structure array is defined as an occurrence data structure or a data structure with the keyword DIM coded. Both types of data structures can be used on the SQL FETCH or INSERT statement when processing multiple rows.

The following list of items must be considered when using a data structure with multiple row blocking support.

- All subfields must be valid host variables.
- All subfields must be contiguous. The first FROM position must be 1 and there cannot be overlaps in the TO and FROM positions.
- No subfields using the POS or OVERLAY keywords can be included in the data structure.
- If the date and time format and separator of date and time subfields within the host structure are not the same as the DATFMT, DATSEP, TIMFMT, and TIMSEP parameters on the CRTSQLRPGI command (or in the SET OPTION statement), then the host structure array is not usable.

For all statements, other than the blocked FETCH and blocked INSERT, if an occurrence data structure is used, the current occurrence is used. For the blocked FETCH and blocked INSERT, the occurrence is set to 1.

The following example uses a host structure array called DEPARTMENT and a blocked FETCH statement to retrieve 10 rows from the DEPARTMENT table.

```
DCL-DS DEPARTMENT OCCURS(10);
  DEPTNO CHAR(3);
  DEPTNM CHAR(29);
  MGRNO CHAR(6);
  ADMRD CHAR(3);
END-DS;

DCL-DS IND_ARRAY OCCURS(10);
  INDS INT(5) DIM(4);
END-DS;

...
EXEC SQL DECLARE C1 CURSOR FOR
  SELECT * FROM CORPDATA.DEPARTMENT;
...
EXEC SQL FETCH C1 FOR 10 ROWS
  INTO :DEPARTMENT:IND_ARRAY;
```

Blocked FETCH and blocked INSERT are the only SQL statements that allow a data structure with the DIM keyword. Data structures with the DIM keyword cannot have a name that starts with 'TAB'. If the data structure name starts with 'TAB', the data structure is considered a table instead of an array and is not supported by SQL. A host variable reference with a subscript like *MyStructure(index).MySubfield* is not supported by SQL.

## Example

```
DCL-DS fststruct DIM(10) QUALIFIED;
  sub1 INT(5);
  sub2 INT(10);
  sub3 INT(20);
  sub4 INT(10);
END-DS;

EXEC SQL FETCH C1 FOR 10 ROWS INTO :fststruct;
```

## Using external file descriptions in ILE RPG applications that use SQL

Field definitions for externally described files, including renaming of fields, are recognized by the SQL precompiler. The external definition form of the data structure can be used to obtain a copy of the column names to be used as host variables.

How date and time field definition are retrieved and processed by the SQL precompiler depends on whether \*NOCVTDT or \*CVTDT is specified on the OPTION parameter of the CRTSQLRPGI command. If \*NOCVTDT is specified, then date and time field definitions are retrieved including the format and separator. If \*CVTDT is specified, then the format and separator are ignored when date and time field definitions are retrieved, and the precompiler assumes that the variable declarations are date/time host variables in character format. \*CVTDT is a compatibility option for the ILE RPG precompiler.

If the GRAPHIC or VARGRAPHIC column has a UCS-2 CCSID, the generated host variable will have the UCS-2 CCSID assigned to it. If the GRAPHIC or VARGRAPHIC column has a UTF-16 CCSID, the generated host variable will have the UTF-16 CCSID assigned to it.

CLOB, BLOB, and DBCLOB columns in the external file are ignored. No host variable definition will be generated in the host structure for these types.

In the following example, the sample table DEPARTMENT is used as a file in an ILE RPG program. The SQL precompiler retrieves the field (column) definitions for DEPARTMENT for use as host variables.

```
DCL-F DEPARTMENT DISK(*EXT) USAGE(*INPUT) RENAME(ORIGREC:DEPTREC);
```

**Note:** Code an F-spec for a file in your ILE RPG program only if you use ILE RPG statements to do I/O operations to the file. If you use only SQL statements to do I/O operations to the file, you can include the external definition of the file (table) by using an external data structure.

In the following example, the sample table is specified as an external data structure. The SQL precompiler retrieves the field (column) definitions as subfields of the data structure. Subfield names can be used as host variable names, and the data structure name TDEPT can be used as a host structure name. The example shows that the field names can be renamed if required by the program.

```
DCL-DS TDEPT EXT EXTNAME('DEPARTMENT');
  DEPTN EXTFLD('DEPTNAME')
  ADMRD EXTFLD('ADMUDEPT')
END-DS;
```

## External file description considerations for host structure arrays in ILE RPG applications that use SQL

For device files, if INDARA was not specified and the file contains indicators, the declaration is not used as a host structure array. The indicator area is included in the structure that is generated and would cause the storage to be separated.

If OPTION(\*NOCVTDT) is specified and the date and time format and separator of date and time field definitions within the file are not the same as the DATFMT, DATSEP, TIMFMT, and TIMSEP parameters on the CRTSQLRPGI command, then the host structure array is not usable.

In the following example, the DEPARTMENT table is included in the ILE RPG program and used to declare a host structure array. A blocked FETCH statement is then used to retrieve 10 rows into the host structure array.

```
DCL-DS DEPARTMENT EXT OCCURS(10);
END-DS;

EXEC SQL DECLARE C1 CURSOR FOR
  SELECT * FROM CORPDATA.DEPARTMENT;
...
EXEC SQL FETCH C1 FOR 10 ROWS INTO :DEPARTMENT;
```

## Determining equivalent SQL and ILE RPG data types

The precompiler determines the base SQLTYPE and SQLLEN of host variables according to this table. If a host variable appears with an indicator variable, the SQLTYPE is the base SQLTYPE plus one.

<i>Table 9. ILE RPG declarations mapped to typical SQL data types</i>				
RPG data type	RPG coding	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
Data structure (without subfields)	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>DCL-DS <i>name</i> LEN(<i>n</i>) END-DS;</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>Length = <i>n</i> where <i>n</i> ≤ 32766.</li> </ul>	452	<i>n</i>	CHAR( <i>n</i> )
Zoned data	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>ZONED(<i>p</i>:<i>s</i>)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>Defined on Definition specification as subfield with data type <i>S</i> or blank.</li> <li>Defined on Definition specification with data type <i>S</i>.</li> <li>Defined on Input specification with data type <i>S</i> or blank.</li> </ul>	488	<i>p</i> in byte 1, <i>s</i> in byte 2	NUMERIC( <i>p</i> , <i>s</i> ) where <i>p</i> is the number of digits and <i>s</i> is the number of decimal places

Table 9. ILE RPG declarations mapped to typical SQL data types (continued)

RPG data type	RPG coding	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
Packed data	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>PACKED(p:s)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>Defined on Definition specification with decimal positions (pos 69-70) not blank.</li> <li>Defined on Definition specification subfield with data type P.</li> <li>Defined on Definition specification with data type P or blank.</li> <li>Defined on Input specification with data type P.</li> </ul>	484	p in byte 1, s in byte 2	DECIMAL(p, s) where p is the number of digits and s is the number of decimal places
2-byte binary with zero decimal positions	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>BINDEC(<i>digits</i>) where <math>1 \leq \text{digits} \leq 4</math></li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>Defined on Definition specification as subfield with from and to positions and data type B and byte length 2.</li> <li>Defined on Definition specification with data type B and digits from 1 to 4.</li> <li>Defined on Input specification with data type B and byte length 2</li> </ul>	500	2	SMALLINT

Table 9. ILE RPG declarations mapped to typical SQL data types (continued)

RPG data type	RPG coding	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
4-byte binary with zero decimal positions	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• BINDEC(<i>digits</i>) where <math>5 \leq \textit{digits} \leq 9</math></li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Defined on Definition specification as subfield with from and to positions and data type B and byte length 4.</li> <li>• Defined on Definition specification with data type B and digits from 5 to 9.</li> <li>• Defined on Input specification with data type B and byte length 4.</li> </ul>	496	4	INTEGER
2-byte integer	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• INT(5)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Defined on Definition specification as subfield with from and to positions and data type I and byte length 2.</li> <li>• Defined on Definition specification with data type I and digits 5.</li> <li>• Defined on Input specification with data type I and byte length 2.</li> </ul>	500	2	SMALLINT
4-byte integer	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• INT(10)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Defined on Definition specification as subfield with from and to positions and data type I and byte length 4.</li> <li>• Defined on Definition specification with data type I and digits 10.</li> <li>• Defined on Input specification with data type I and byte length 4.</li> </ul>	496	4	INTEGER

Table 9. ILE RPG declarations mapped to typical SQL data types (continued)

RPG data type	RPG coding	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
8-byte integer	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• INT(20)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Defined on Definition specification as subfield with from and to positions and data type I and byte length 8.</li> <li>• Defined on Definition specification with data type I and digits 20.</li> <li>• Defined on Input specification with data type I and byte length 8.</li> </ul>	492	8	BIGINT
short float	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• FLOAT(4)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Data type = F, length = 4.</li> </ul>	480	4	FLOAT (single precision)
long float	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• FLOAT(8)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Data type = F, length = 8.</li> </ul>	480	8	FLOAT (double precision)
Character	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• CHAR(n)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Data type = A or blank, decimal positions blank, length between 1 and 32766.</li> </ul>	452	n	CHAR (n) where n is the length
Character varying length greater than 254	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• VARCHAR(n)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Data type = A or blank, decimal positions blank, VARYING keyword on Definition specification or format *VAR on Input specification.</li> </ul>	448	n	VARCHAR (n) where n is the length

Table 9. ILE RPG declarations mapped to typical SQL data types (continued)

RPG data type	RPG coding	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
Character varying length between 1 and 254	<b>Free-form:</b> <ul style="list-style-type: none"> <li>• VARCHAR(n)</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>• Data type = A or blank, decimal positions blank, VARYING keyword on Definition specification or format *VAR on Input specification.</li> </ul>	456	n	VARCHAR (n) where n is the length
graphic	<b>Free-form:</b> <ul style="list-style-type: none"> <li>• GRAPH(n)</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>• Defined on Definition specification as subfield with from and to positions and data type G and byte-length b.</li> <li>• Defined on Definition specification with data type G and length n.</li> <li>• Defined on Input specification with data type G and byte-length b</li> </ul>	468	m	GRAPHIC(m) where m = n or m = b/2
varying graphic	<b>Free-form:</b> <ul style="list-style-type: none"> <li>• VARGRAPH(n)</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>• Defined on Definition specification as subfield with from and to positions and data type G and byte-length b and VARYING keyword.</li> <li>• Defined on Definition specification with data type G and length n and VARYING keyword.</li> <li>• Defined on Input specification with data type G and byte-length b and format *VAR.</li> </ul>	464	m	VARGRAPHIC(m) where m = n or m = (b-2)/2

Table 9. ILE RPG declarations mapped to typical SQL data types (continued)

RPG data type	RPG coding	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
UCS-2	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• UCS2(n)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Defined on Definition specification as subfield with from and to positions and data type C and byte-length b.</li> <li>• Defined on Definition specification with data type C and length n.</li> <li>• Defined on Input specification with data type C and byte-length b.</li> </ul>	468	m	GRAPHIC(m) with CCSID 13488 or CCSID 1200 where m = n or m = b/2
varying UCS-2	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• VARUCS2(n)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Defined on Definition specification as subfield with from and to positions and data type C and byte-length b and VARYING keyword.</li> <li>• Defined on Definition specification with data type C and length n and VARYING keyword.</li> <li>• Defined on Input specification with data type C and byte-length b and format *VAR.</li> </ul>	464	m	VARGRAPHIC(m) with CCSID 13488 or CCSID 1200 where m = n or m = b/2

Table 9. ILE RPG declarations mapped to typical SQL data types (continued)

RPG data type	RPG coding	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
Date	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• DATE</li> <li>• DATE(fs)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Defined on Definition specification with data type D, format f and separator s from DATFMT keyword.</li> <li>• Defined on Input specification with data type D and format in pos 31-34, separator in pos 35.</li> </ul>	384		DATE DATFMT(f) DATSEP(s) <sup>1</sup>
Time	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• TIME</li> <li>• TIME(fs)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Defined on Definition specification with data type T, format f and separator s from TIMFMT keyword.</li> <li>• Defined on Input specification with data type T and format in pos 31-34, separator in pos 35.</li> </ul>	388		TIME TIMFMT(f) TIMSEP(s) <sup>1</sup>
Timestamp	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• TIMESTAMP(n)</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Data type Z.</li> </ul>	392	19 when n = 0, otherwise 20+n	TIMESTAMP(n)

Table 9. ILE RPG declarations mapped to typical SQL data types (continued)

RPG data type	RPG coding	SQLTYPE of host variable	SQLLEN of host variable	SQL data type
Indicator	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• IND</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Defined on Definition specification as subfield with data type N.</li> <li>• Defined on Definition specification with data type N.</li> <li>• Defined on Input specification with data type N.</li> </ul>	2436	1	BOOLEAN

<sup>1</sup>SQL creates the date/time subfield using the DATE/TIME format specified on the CRTSQLRPGI command. The conversion to the host variable DATE/TIME format occurs when the mapping is done between the host variables and the SQL-generated subfields.

The following table can be used to determine the RPG data type that is equivalent to a given SQL data type.

Table 10. SQL data types mapped to typical RPG declarations

SQL data type	RPG data type	Notes
SMALLINT	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• INT(5)</li> <li>• BINDEC(<i>n</i>) where 1 &lt;= <i>n</i> &lt;= 4</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Definition specification. I in position 40, length must be 5 and 0 in position 42.</li> <li>• Definition specification. B in position 40, length must be ≤ 4 and 0 in position 42.</li> </ul>	
INTEGER	<p><b>Free-form:</b></p> <ul style="list-style-type: none"> <li>• INT(10)</li> <li>• BINDEC(<i>n</i>) where 5 &lt;= <i>n</i> &lt;= 9</li> </ul> <p><b>Fixed-form:</b></p> <ul style="list-style-type: none"> <li>• Definition specification. I in position 40, length must be 10 and 0 in position 42.</li> <li>• Definition specification. B in position 40, length must be ≤ 9 and ≥ 5 and 0 in position 42.</li> </ul>	

Table 10. SQL data types mapped to typical RPG declarations (continued)

SQL data type	RPG data type	Notes
BIGINT	<b>Free-form:</b> <ul style="list-style-type: none"> <li>• INT(20)</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>• Definition specification. I in position 40, length must be 20 and 0 in position 42.</li> </ul>	
DECIMAL	<b>Free-form:</b> <ul style="list-style-type: none"> <li>• PACKED(p:s)</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>• Definition specification. P in position 40 or blank in position 40 for a non-subfield, 0 through 63 in position 41,42.</li> <li>• Defined as numeric on non-definition specification.</li> </ul>	Maximum length of 32 (precision 63) and maximum scale of 63.
NUMERIC	<b>Free-form:</b> <ul style="list-style-type: none"> <li>• ZONED(p:s)</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>• Definition specification. S in position 40 or blank in position 40 for a subfield, 0 through 63 in position 41,42.</li> </ul>	Maximum length of 63 (precision 63) and maximum scale of 63.
DECFLOAT	Not supported	Not supported
FLOAT (single precision)	<b>Free-form:</b> <ul style="list-style-type: none"> <li>• FLOAT(4)</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>• Definition specification. F in position 40, length must be 4.</li> </ul>	
FLOAT (double precision)	<b>Free-form:</b> <ul style="list-style-type: none"> <li>• FLOAT(8)</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>• Definition specification. F in position 40, length must be 8.</li> </ul>	

Table 10. SQL data types mapped to typical RPG declarations (continued)

SQL data type	RPG data type	Notes
CHAR(n)	<b>Free-form:</b> <ul style="list-style-type: none"> <li>CHAR(n)</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>Definition specification. A or blank in positions 40 and blanks in position 41,42.</li> <li>Input field defined without decimal places.</li> <li>Calculation result field defined without decimal places.</li> </ul>	n can be from 1 to 32766.
CHAR(n)	<b>Free-form:</b> <ul style="list-style-type: none"> <li>DCL-DS name LEN(n) END-DS;</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>Data structure name with no subfields in the data structure.</li> </ul>	n can be from 1 to 32766.
VARCHAR(n)	<b>Free-form:</b> <ul style="list-style-type: none"> <li>VARCHAR(n)</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>Definition specification. A or blank in position 40 and VARYING in positions 44-80.</li> </ul>	n can be from 1 to 32740.
CLOB	Not supported	Use SQLTYPE keyword to declare a CLOB.
GRAPHIC(n)	<b>Free-form:</b> <ul style="list-style-type: none"> <li>GRAPH(n)</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>Definition specification. G in position 40.</li> <li>Input field defined with G in position 36.</li> </ul>	n can be 1 to 16383.
VARGRAPHIC(n)	<b>Free-form:</b> <ul style="list-style-type: none"> <li>VARGRAPH(n)</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>Definition specification. G in position 40 and VARYING in positions 44-80.</li> </ul>	n can be from 1 to 16370.
DBCLOB	Not supported	Use SQLTYPE keyword to declare a DBCLOB.
BINARY	Not supported	Use SQLTYPE keyword to declare a BINARY.

Table 10. SQL data types mapped to typical RPG declarations (continued)

SQL data type	RPG data type	Notes
VARBINARY	Not supported	Use SQLTYPE keyword to declare a VARBINARY.
BLOB	Not supported	Use SQLTYPE keyword to declare a BLOB.
DATE	<b>Free-form:</b> <ul style="list-style-type: none"> <li>• DATE</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>• A character field</li> <li>• Definition specification with a D in position 40.</li> <li>• Input field defined with D in position 36.</li> </ul>	If the format is *USA, *JIS, *EUR, or *ISO, the length must be at least 10. If the format is *YMD, *DMY, or *MDY, the length must be at least 8. If the format is *JUL, the length must be at least 6.
TIME	<b>Free-form:</b> <ul style="list-style-type: none"> <li>• TIME</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>• A character field</li> <li>• Definition specification with a T in position 40.</li> <li>• Input field defined with T in position 36.</li> </ul>	Length must be at least 6; to include seconds, length must be at least 8.
TIMESTAMP(n)	<b>Free-form:</b> <ul style="list-style-type: none"> <li>• TIMESTAMP(n)</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>• A character field</li> <li>• Definition specification with a Z in position 40.</li> <li>• Input field defined with Z in position 36.</li> </ul>	For a character field, the length must be at least 19; to include fractional seconds, the length can be 21 to 32. If less than 32, some fractional seconds will be truncated.
BOOLEAN	<b>Free-form:</b> <ul style="list-style-type: none"> <li>• IND</li> </ul> <b>Fixed-form:</b> <ul style="list-style-type: none"> <li>• Definition specification with a N in position 40.</li> <li>• Input field defined with N in position 36.</li> </ul>	
XML	Not supported	Use SQLTYPE keyword to declare an XML.
DATALINK	Not supported	
ROWID	Not supported	Use SQLTYPE keyword to declare a ROWID.

Table 10. SQL data types mapped to typical RPG declarations (continued)

SQL data type	RPG data type	Notes
Result set locator	Not supported	Use SQLTYPE keyword to declare a result set locator.

## Notes on ILE RPG variable declaration and usage

ILE RPG associates precision and scale with all numeric types.

ILE RPG defines numeric operations, assuming the data is in packed format. This means that operations involving binary variables include an implicit conversion to packed format before the operation is performed (and back to binary, if necessary). Data is aligned to the implied decimal point when SQL operations are performed.

## Using indicator variables in ILE RPG applications that use SQL

An indicator variable is a binary field with length less than 5 (2 bytes).

An indicator array can be defined by declaring the variable element length of 4,0 and specifying the DIM on the definition specification.

Indicator variables are declared in the same way as host variables and the declarations of the two can be mixed in any way that seems appropriate to the programmer.

### Related reference

[References to variables](#)

[Indicator variables in applications that use SQL](#)

An *indicator variable* is a halfword integer variable used to communicate additional information about its associated host variable.

## Example: Using indicator variables in ILE RPG applications that use SQL

Here is an example of declaring indicator variables in ILE RPG.

Given the statement:

```
EXEC SQL FETCH CLS_CURSOR INTO :CLSCD,
                                :DAY :DAYIND,
                                :BGN :BGNIND,
                                :END :ENDIND;
```

variables can be declared as follows:

```
DCL-S CLSCD CHAR(7);
DCL-S DAY INT(5);
DCL-S DAYIND INT(5);
DCL-S BGN CHAR(8);
DCL-S BGNIND INT(5);
DCL-S END CHAR(8);
DCL-S ENDIND INT(5)
```

## Example: SQLDA for a multiple row-area fetch in ILE RPG applications that use SQL

Here is an example of the SQL descriptor area (SQLDA) for a multiple row-area fetch in ILE RPG.

```
DCL-C SQL_NUM CONST(4);
EXEC SQL INCLUDE SQLDA;

DCL-DS DEPARTMENT OCCURS(10);
  DEPTNO CHAR(3);
  DEPTNM CHAR(29);
  MGRNO CHAR(6);
  ADMRD CHAR(3);
```

```

END-DS;

DCL-DS IND_ARRAY OCCURS(10);
  INDS INT(5) DIM(4);
END-DS;
...
// setup number of sqlda entries and length of the sqlda
sqld = 4;
sqln = 4;
sqldabc = 336;

// setup the first entry in the sqlda
sqltype = 453;
sqlllen = 3;
sql_var(1) = sqlvar;

// setup the second entry in the sqlda
sqltype = 453;
sqlllen = 29;
sql_var(2) = sqlvar;
...
// setup the fourth entry in the sqlda
sqltype = 453;
sqlllen = 3;
sql_var(4) = sqlvar;
...
EXEC SQL DECLARE C1 CURSOR FOR
  SELECT * FROM CORPDATA.DEPARTMENT;
...
EXEC SQL FETCH C1 FOR 10 ROWS
  USING DESCRIPTOR :SQLDA
  INTO :DEPARTMENT:IND_ARRAY;

```

## Example: Dynamic SQL in an ILE RPG application that uses SQL

Here is an example of using dynamic SQL in ILE RPG.

```

//*****
//* Declare program variables. *
//* STMT initialized to the *
//* listed SQL statement. *
//*****
DCL-S EMPNUM CHAR(6);
DCL-S NAME CHAR(15);
DCL-S STMT CHAR(500)
  INZ('SELECT LASTNAME FROM CORPDATA.EMPLOYEE +
      WHERE EMPNO = ?');
...
//*****
//* Prepare STMT as initialized in declare section *
//*****
EXEC SQL PREPARE S1 FROM :STMT;

//*****
//* Declare Cursor for STMT *
//*****
EXEC SQL DECLARE C1 CURSOR FOR S1;

//*****
//* Assign employee number to use in select statement *
//*****
EMPNUM = '000110';

//*****
//* Open Cursor *
//*****
EXEC SQL OPEN C1 USING :EMPNUM;

//*****
//* Fetch record and put value of *
//* LASTNAME into NAME *
//*****
EXEC SQL FETCH C1 INTO :NAME;

//*****
//* Program processes NAME here *
//*****
...
//*****

```

```
//* Close cursor *  
//*****  
EXEC SQL CLOSE C1;
```

## Coding SQL statements in REXX applications

REXX procedures do not have to be preprocessed. At run time, the REXX interpreter passes statements that it does not understand to the current active command environment for processing.

The command environment can be changed to \*EXECSQL to send all unknown statements to the database manager in two ways:

1. CMDENV parameter on the STREXPRC CL command
2. address positional parameter on the ADDRESS REXX command

For more information about the **STREXPRC** CL command or the **ADDRESS REXX** command, see the [REXX/400® Programmer's Guide](#) topic and the [REXX/400 Reference](#) topic.

**Note:** By using the code examples, you agree to the terms of the [“Code license and disclaimer information”](#) on page 198.

### Related concepts

[Writing applications that use SQL](#)

You can create database applications in host languages that use Db2 for i SQL statements and functions.

### Related reference

[Example programs: Using Db2 for i statements](#)

Here is a sample application that shows how to code SQL statements in each of the languages that Db2 for i supports.

[Example: SQL statements in REXX programs](#)

This example program is written in the REXX programming language.

## Using the SQL communication area in REXX applications

The fields that make up the SQL communication area (SQLCA) are automatically included by the SQL/REXX interface.

An INCLUDE SQLCA statement is not required and is not allowed. The SQLCODE and SQLSTATE fields of the SQLCA contain SQL return codes. These values are set by the database manager after each SQL statement is run. An application can check the SQLCODE or SQLSTATE value to determine whether the last SQL statement was successful.

The SQL/REXX interface uses the SQLCA in a manner consistent with the typical SQL usage. However, the SQL/REXX interface maintains the fields of the SQLCA in separate variables rather than in a contiguous data area. The variables that the SQL/REXX interface maintains for the SQLCA are defined as follows:

### SQLCODE

The primary SQL return code.

### SQLERRMC

Error and warning message tokens.

### SQLERRP

Product code and, if there is an error, the name of the module that returned the error.

### SQLERRD.*n*

Six variables (*n* is a number between 1 and 6) containing diagnostic information.

### SQLWARN.*n*

Eleven variables (*n* is a number between 0 and 10) containing warning flags.

### SQLSTATE

The alternate SQL return code.

## Related reference

[SQL communication area](#)

## Using SQL descriptor areas in REXX applications

There are two types of SQL descriptor areas. One is defined with the ALLOCATE DESCRIPTOR statement. The other is defined using the SQL descriptor area (SQLDA) structure. Only the SQLDA form is discussed here. Allocated descriptors are not supported in REXX.

The following statements can use an SQLDA:

- EXECUTE...USING DESCRIPTOR *descriptor-name*
- FETCH...USING DESCRIPTOR *descriptor-name*
- OPEN...USING DESCRIPTOR *descriptor-name*
- CALL...USING DESCRIPTOR *descriptor-name*
- DESCRIBE *statement-name* INTO *descriptor-name*
- DESCRIBE TABLE *host-variable* INTO *descriptor-name*

Unlike the SQLCA, more than one SQLDA can be in a procedure, and an SQLDA can have any valid name.

Each SQLDA consists of a set of REXX variables with a common stem, where the name of the stem is the *descriptor-name* from the appropriate SQL statements. This must be a simple stem; that is, the stem itself must not contain any periods. The SQL/REXX interface automatically provides the fields of the SQLDA for each unique descriptor name. An INCLUDE SQLDA statement is not required and is not allowed.

The SQL/REXX interface uses the SQLDA in a manner consistent with the typical SQL usage. However, the SQL/REXX interface maintains the fields of the SQLDA in separate variables rather than in a contiguous data area.

The following variables are returned to the application after a DESCRIBE, a DESCRIBE TABLE, or a PREPARE INTO statement:

### **stem.n.SQLNAME**

The name of the nth column in the result table.

The following variables must be provided by the application before an EXECUTE...USING DESCRIPTOR, an OPEN...USING DESCRIPTOR, a CALL...USING DESCRIPTOR, or a FETCH...USING DESCRIPTOR statement. They are returned to the application after a DESCRIBE, a DESCRIBE TABLE, or a PREPARE INTO statement:

### **stem.SQLD**

Number of variable elements that the SQLDA actually contains.

### **stem.n.SQLTYPE**

An integer representing the data type of the nth element (for example, the first element is in stem.1.SQLTYPE).

The following data types are not allowed:

#### **400/401**

NUL-terminated graphic string

#### **404/405**

BLOB host variable

#### **408/409**

CLOB host variable

#### **412/413**

DBCLOB host variable

#### **460/461**

NUL-terminated character string

**476/477**

PASCAL L-string

**496/497**

Large integer (where scale is greater than 0)

**500/501**

Small integer (where scale is greater than 0)

**504/505**

DISPLAY SIGN LEADING SEPARATE

**904/905**

ROWID

**908/909**

VARBINARY host variable

**912/913**

BINARY host variable

**916/917**

BLOB file reference variable

**920/921**

CLOB file reference variable

**924/925**

DBCLOB file reference variable

**960/961**

BLOB locator

**964/965**

CLOB locator

**968/969**

DBCLOB locator

**972**

Result set locator

**988/989**

XML host variable

**996/997**

Decimal floating point host variable

**2452/2453**

XML locator

**stem.n.SQLLEN**

If SQLTYPE does not indicate a DECIMAL or NUMERIC data type, the maximum length of the data contained in stem.n.SQLDATA.

**stem.n.SQLLEN.SQLPRECISION**

If the data type is DECIMAL or NUMERIC, this contains the precision of the number.

**stem.n.SQLLEN.SQLSCALE**

If the type is DECIMAL or NUMERIC, this contains the scale of the number.

**stem.n.SQLCCSID**

The CCSID of the nth column of the data.

The following variables must be provided by the application before an EXECUTE...USING DESCRIPTOR or an OPEN...USING DESCRIPTOR statement, and they are returned to the application after a FETCH...USING DESCRIPTOR statement. They are not used after a DESCRIBE, a DESCRIBE TABLE, or a PREPARE INTO statement:

**stem.n.SQLDATA**

This contains the input value supplied by the application, or the output value fetched by SQL.

This value is converted to the attributes specified in SQLTYPE, SQLLEN, SQLPRECISION, and SQLSCALE.

**stem.n.SQLIND**

If the input or output value is null, this is a negative number.

**Related reference**

[SQL descriptor area](#)

## Embedding SQL statements in REXX applications

An SQL statement can be placed anywhere a REXX command can be placed.

Each SQL statement in a REXX procedure must begin with EXECSQL (in any combination of uppercase and lowercase letters), followed by either:

- The SQL statement enclosed in single or double quotation marks, or
- A REXX variable containing the statement. Note that a colon must not precede a REXX variable when it contains an SQL statement.

For example:

```
EXECSQL "COMMIT"
```

is equivalent to:

```
rexvar = "COMMIT"  
EXECSQL rexvar
```

The command follows normal REXX rules. For example, it can optionally be followed by a semicolon (;) to allow a single line to contain more than one REXX statement. REXX also permits command names to be included within single quotation marks, for example:

```
'EXECSQL COMMIT'
```

The SQL/REXX interface supports the following SQL statements:

ALTER FUNCTION	EXECUTE
ALTER PROCEDURE	EXECUTE IMMEDIATE
ALTER SEQUENCE	FETCH <sup>1</sup>
ALTER TABLE	GRANT
CALL <sup>2</sup>	INSERT <sup>1</sup>
CLOSE	LABEL
COMMENT	LOCK TABLE
COMMIT	OPEN
CREATE ALIAS	PREPARE
CREATE FUNCTION	REFRESH TABLE
CREATE INDEX	RELEASE SAVEPOINT
CREATE PROCEDURE	RENAME
CREATE SCHEMA	REVOKE
CREATE SEQUENCE	ROLLBACK
CREATE TABLE	SAVEPOINT
CREATE TRIGGER	SET CURRENT DECFLOAT ROUNDING MODE
CREATE TYPE	SET CURRENT IMPLICIT XMLPARSE OPTION
CREATE VIEW	SET ENCRYPTION PASSWORD
DECLARE CURSOR <sup>2</sup>	SET OPTION <sup>3</sup>
DECLARE GLOBAL TEMPORARY TABLE	SET PATH
DELETE <sup>2</sup>	SET SCHEMA
DESCRIBE	SET TRANSACTION
DESCRIBE TABLE	SET <i>variable</i> <sup>2</sup>
DROP	UPDATE <sup>2</sup>

The following SQL statements are not supported by the SQL/REXX interface:

ALLOCATE CURSOR	GET DIAGNOSTICS
ALLOCATE DESCRIPTOR	HOLD LOCATOR
ASSOCIATE LOCATORS	INCLUDE
BEGIN DECLARE SECTION	MERGE
CONNECT	RELEASE
DEALLOCATE DESCRIPTOR	SELECT INTO
DECLARE PROCEDURE	SET CONNECTION
DECLARE STATEMENT	SET CURRENT DEGREE
DECLARE VARIABLE	SET DESCRIPTOR
DESCRIBE CURSOR	SET RESULT SETS
DESCRIBE INPUT	SET SESSION AUTHORIZATION
DESCRIBE PROCEDURE	SIGNAL
DISCONNECT	TRANSFER OWNERSHIP
END DECLARE SECTION	TRUNCATE
FREE LOCATOR	VALUES INTO
GET DESCRIPTOR	WHENEVER <sup>4</sup>

1. The blocked form of this statement is not supported.
2. These statements cannot be run directly if they contain host variables; they must be the object of a PREPARE and then an EXECUTE.
3. The SET OPTION statement can be used in a REXX procedure to change some of the processing options used for running SQL statements. These options include the commitment control level and date format. See the [DB2<sup>®</sup> for i SQL reference](#) topic for more information about the [SET OPTION](#) statement.
4. See [“Handling errors and warnings in REXX applications that use SQL”](#) on page 142 for more information.

## Comments in REXX applications that use SQL

Neither SQL comments (--) nor REXX comments are allowed in strings representing SQL statements.

## Continuation of SQL statements in REXX applications that use SQL

The string containing an SQL statement can be split into several strings on several lines, separated by commas or concatenation operators, according to standard REXX usage.

## Including code in REXX applications that use SQL

Unlike the other host languages, support is not provided for including externally defined statements.

## Margins in REXX applications that use SQL

There are no special margin rules for the SQL/REXX interface.

## Names in REXX applications that use SQL

Any valid REXX name not ending in a period (.) can be used for a host variable. The name must be 64 characters or less.

Variable names should not begin with the characters 'SQL', 'RDI', 'DSN', 'RXSQL', or 'QRW'.

## Nulls in REXX applications that use SQL

Although the term *null* is used in both REXX and SQL, the term has different meanings in the two languages.

REXX has a null string (a string of length zero) and a null clause (a clause consisting only of blanks and comments). The SQL null value is a special value that is distinct from all non-null values and denotes the absence of a (non-null) value.

## Statement labels in REXX applications that use SQL

REXX command statements can be labeled as usual.

## Handling errors and warnings in REXX applications that use SQL

The WHENEVER statement is not supported by the SQL/REXX interface. You can use one of several substitutes, however.

Any of the following may be used instead:

- A test of the REXX SQLCODE or SQLSTATE variables after each SQL statement to detect error and warning conditions issued by the database manager, but not for those issued by the SQL/REXX interface.
- A test of the REXX RC variable after each SQL statement to detect error and warning conditions. Each use of the EXEC SQL command sets the RC variable to:

**0**

Statement completed successfully.

**+10**

A SQL warning occurred.

**-10**

An SQL error occurred

**-100**

An SQL/REXX interface error occurred.

This can be used to detect errors and warnings issued by either the database manager or by the SQL/REXX interface.

- The SIGNAL ON ERROR and SIGNAL ON FAILURE facilities can be used to detect errors (negative RC values), but not warnings.

## Using host variables in REXX applications that use SQL

REXX does not provide for variable declarations.

LOB, XML, ROWID, binary, and result set locator host variables are not supported in REXX. New variables are recognized by their appearance in assignment statements. Therefore, there is no declare section, and the BEGIN DECLARE SECTION and END DECLARE SECTION statements are not supported.

All host variables within an SQL statement must be preceded by a colon (:).

The SQL/REXX interface performs substitution in compound variables before passing statements to the database manager. For example:

```
a = 1
b = 2
EXECSQL 'OPEN c1 USING :x.a.b'
```

causes the contents of x.1.2 to be passed to SQL.

## Determining data types of input host variables in REXX applications that use SQL

All data in REXX is in the form of strings.

The data type of input host variables (that is, host variables used in a 'USING host variable' clause in an EXECUTE or OPEN statement) is inferred by the database manager at run time from the contents of the variable according to the table below.

These rules define either numeric, character, or graphic values. A numeric value can be used as input to a numeric column of any type. A character value can be used as input to a character column of any type, or to a date, time, or timestamp column. A graphic value can be used as input to a graphic column of any type.

Table 11. Determining data types of host variables in REXX

Host variable contents	Assumed data type	SQL type code	SQL type description
A number with neither decimal point nor exponent. It can have a leading plus or minus sign.	Signed integers	496/497	INTEGER
A number that includes a decimal point, but no exponent, or a number that does not include a decimal point or an exponent and is greater than 2147483647 or smaller than -2147483647. It can have a leading plus or minus sign. <i>m</i> is the total number of digits in the number. <i>n</i> is the number of digits to the left of the decimal point (if any).	Packed decimal	484/485	DECIMAL( <i>m</i> , <i>n</i> )
A number that is in scientific or engineering notation (that is, followed immediately by an 'E' or 'e', an optional plus or minus sign, and a series of digits). It can have a leading plus or minus sign.	Floating point	480/481	DOUBLE PRECISION

Table 11. Determining data types of host variables in REXX (continued)

Host variable contents	Assumed data type	SQL type code	SQL type description
<p>A string with leading and trailing single quotation marks (') or quotation marks ("), which has length n after removing the two delimiters,</p> <p>or a string with a leading X or x followed by a single quotation mark (') or quotation mark ("), and a trailing single quotation mark (') or quotation mark ("). The string has a length of 2n after removing the X or x and the two delimiters. Each remaining pair of characters is the hexadecimal representation of a single character.</p> <p>or a string of length n, which cannot be recognized as character, numeric, or graphic through other rules in this table</p>	Varying-length character string	448/449	VARCHAR(n)
<p>A string with a leading and trailing single quotation mark (') or quotation marks (") preceded by:<sup>1</sup></p> <ul style="list-style-type: none"> <li>• A string that starts with a G, g, N, or n. This is followed by a single quotation mark or a quotation mark and a shift-out (x'0E') character. This is followed by n graphic characters, each 2 characters long. The string must end with a shift-in (X'0F') character and a single quotation mark or a quotation mark (whichever the string started with).</li> <li>• A string with a leading GX, Gx, gX, or gx, followed by a single quotation mark or a quotation mark and a shift-out (x'0E') character. This is followed by n graphic characters, each 2 characters long. The string must end with a shift-in (X'0F') character and a single quotation mark or a quotation mark (whichever the string started with). The string has a length of 4n after removing the GX and the delimiters. Each remaining group of 4 characters is the hexadecimal representation of a single graphic character.</li> </ul>	Varying-length graphic string	464/465	VARGRAPHIC(n)
Undefined Variable	Variable for which a value has not been assigned	None	Data that is not valid was detected.

<sup>1</sup> The byte immediately following the leading single quotation mark is a X'0E' shift-out character, and the byte immediately preceding the trailing single quotation mark is a X'0F' shift-in character.

## The format of output host variables in REXX applications that use SQL

It is not necessary to determine the data type of an *output host variable* (that is, a host variable used in an 'INTO host variable' clause in a FETCH statement).

Output values are assigned to host variables as follows:

- Character values are assigned without leading and trailing apostrophes.
- Graphic values are assigned without a leading G or apostrophe, without a trailing apostrophe, and without shift-out and shift-in characters.
- Numeric values are translated into strings.
- Integer values do not retain any leading zeros. Negative values have a leading minus sign.
- Decimal values retain leading and trailing zeros according to their precision and scale. Negative values have a leading minus sign. Positive values do not have a leading plus sign.
- Floating-point values are in scientific notation, with one digit to the left of the decimal place. The 'E' is in uppercase.

## Avoiding REXX conversion in REXX applications that use SQL

To guarantee that a string is not converted to a number or assumed to be of graphic type, strings should be enclosed in `''''`. Enclosing the string in single quotation marks does not work.

For example:

```
stringvar = '100'
```

causes REXX to set the variable *stringvar* to the string of characters 100 (without the single quotation marks). This is evaluated by the SQL/REXX interface as the number 100, and it is passed to SQL as such.

On the other hand,

```
stringvar = ''''100''''
```

causes REXX to set the variable *stringvar* to the string of characters '100' (with the single quotation marks). This is evaluated by the SQL/REXX interface as the string 100, and it is passed to SQL as such.

## Using indicator variables in REXX applications that use SQL

An indicator variable is an integer.

Unlike other languages, a valid value must be specified in the host variable even if its associated indicator variable contains a negative value.

### Related reference

[References to variables](#)

[Indicator variables in applications that use SQL](#)

An *indicator variable* is a halfword integer variable used to communicate additional information about its associated host variable.

## Preparing and running a program with SQL statements

---

This topic describes some of the tasks for preparing and running an application program.

### Related concepts

[Writing applications that use SQL](#)

You can create database applications in host languages that use Db2 for i SQL statements and functions.

## Basic processes of the SQL precompiler

You must precompile and compile an application program containing embedded SQL statements before you can run it.

**Note:** SQL statements in a REXX procedure are not precompiled and compiled.

Precompiling of such programs is done by the SQL precompiler. The SQL precompiler scans each statement of the application program source and does the following:

- **Looks for SQL statements and for the definition of host variable names.** The variable names and definitions are used to verify the SQL statements. You can examine the listing after the SQL precompiler completes processing to see if any errors occurred.
- **Verifies that each SQL statement is valid and free of syntax errors.** The validation procedure supplies error messages in the output listing that help you correct any errors that occur.
- **Validates the SQL statements using the description in the database.** During the precompile, SQL statements are checked for valid table, column, and other object references. If a specified object does not exist or you are not authorized to it at the time of the precompile, complete validation will be done at run time. If an object does not exist at run time, an error occurs.

### Notes:

1. Overrides are processed when retrieving external definitions.
  2. You need some authority (at least \*OBJOPR) to any tables or views referred to in the SQL statements in order to validate the SQL statements. The actual authority required to process any SQL statement is checked at run time.
  3. When the RDB parameter is specified on the CRTSQLxxx commands, the precompiler accesses the specified relational database to obtain the table and view descriptions.
- **Prepares each SQL statement for compilation in the host language.** For most SQL statements, the SQL precompiler inserts a comment and a CALL statement to one of the SQL interface modules. For some SQL statements (for example, DECLARE statements), the SQL precompiler produces no host language statement except a comment.
  - **Produces information about each precompiled SQL statement.** The information is stored internally in a temporary source file member, where it is available for use during the bind process.

To get complete diagnostic information when you precompile, specify either of the following:

- OPTION(\*SOURCE \*XREF) for CRTSQLxxx (where xxx=CBL, PLI, or RPG)
- OPTION(\*XREF) OUTPUT(\*PRINT) for CRTSQLxxx (where xxx=CI, CPPI, CBLI, or RPGI)

### Related concepts

[Database programming](#)

[Database file management](#)

[Db2 for i SQL reference](#)

## Input to the SQL precompiler

Application programming statements and embedded SQL statements are the primary input to the SQL precompiler. The statements can be in a source member or, for any ILE precompile, in a source stream file.

In PL/I, C, and C++ source members, the SQL statements must use the margins that are specified in the MARGINS parameter of the **CRTSQLPLI**, **CRTSQLCI**, and **CRTSQLCPPI** commands. The MARGINS parameter is ignored when you precompile from a source stream file.

The SQL precompiler assumes that the host language statements are syntactically correct. If the host language statements are not syntactically correct, the precompiler might not correctly identify SQL statements and host variable declarations. Literals and comments that are not accepted by the

application language compiler can interfere with the precompiler source scanning process and cause errors.

You can use the SQL INCLUDE statement to embed secondary input from the file that is specified by the INCFILE or INCDIR parameter of the CRTSQLxxx command. The SQL INCLUDE statement causes the specified member or source stream file to be read. The included source cannot contain other precompiler INCLUDE statements, but can contain both application program and SQL statements.

When you precompile a source member, the INCFILE parameter is used to find the source that is specified in the SQL INCLUDE statement. When you precompile a source stream file, the INCDIR parameter is used. If a relative path is specified in the INCLUDE statement, the precompiler first searches the current directory. If that file is not found, the name specified on the INCLUDE statement is appended to the INCDIR value. If that is not found, the precompiler searches the directory where the input source is found. If an absolute path is specified for the INCLUDE statement, the precompiler ignores the INCDIR value. No suffixes are appended to the name specified on the INCLUDE statement.

If mixed DBCS constants are specified in the application program source, the source file must be a mixed CCSID.

You can specify many of the precompiler command parameter values directly in the input source by using the SQL SET OPTION statement. These include options such as DATFMT, COMMIT, and NAMING. By specifying them in the input source, you do not need to remember to specify them on the precompiler command.

**Note:** If a value is provided for an option on both the precompile command and on the SET OPTION statement, the value from the SET OPTION statement is used.

The RPG preprocessor options (RPGPPOPT) parameter of the **CRTSQLRPGI** command has two options to call the RPG preprocessor. If \*LVL1 or \*LVL2 is specified, the RPG compiler will be called to preprocess the source before the SQL precompile is run. Preprocessing the SQL source will allow many compiler directives to be handled before the SQL precompile. The preprocessed source will be placed in file QSQLPRE in QTEMP. This source will be used as the input for the SQL precompile. The CCSID used by the SQL precompile is the CCSID of QSQLPRE.

### **Related reference**

[SET OPTION](#)

[Create SQL ILE RPG Object \(CRTSQLRPGI\) command](#)

## **Source file CCSIDs in the SQL precompiler**

The SQL precompiler reads the source records by using the CCSID of the source file or source stream file.

For a UTF-8 source stream file (CCSID 1208), the SQL precompiler uses the CCSID provided by the CVTCCSID parameter on the precompile command. The CVTCCSID parameter must identify a valid single-byte or mixed-byte EBCDIC CCSID. The SQL precompiler converts the UTF-8 source to the CVTCCSID and then considers the CCSID of the primary source to be the CVTCCSID value instead of UTF-8.

When processing SQL INCLUDE statements, the include source is converted to the CCSID of the primary source if necessary. If the include source cannot be converted to the CCSID of the primary source, an error occurs.

The SQL precompiler processes SQL statements using the source CCSID. This affects variant characters the most. For example, the not sign (→) is located at 'BA'X in CCSID 500. This means that if the CCSID of your source file is 500, SQL expects the not sign (→) to be located at 'BA'X.

If the source file CCSID is 65535, SQL processes variant characters as if they had a CCSID of 37. This means that SQL looks for the not sign (→) at '5F'X.

## Output from the SQL precompiler

The SQL precompiler generates two pieces of output: a listing and a source file member.

### ***Listing***

The output listing is sent to the printer file that is specified by the PRTFILE parameter of the CRTSQLxxx command.

The following items are written to the printer file:

- Precompiler options

Options specified in the CRTSQLxxx command.

- Precompiler source

This output supplies precompiler source statements with the record numbers that are assigned by the precompiler, if the listing option is in effect.

- Precompiler cross-reference

If \*XREF was specified in the OPTION parameter, this output supplies a cross-reference listing. The listing shows the precompiler record numbers of SQL statements that contain the referred to host names and column names.

- Precompiler diagnostics

This output supplies diagnostic messages, showing the precompiler record numbers of statements in error.

The output to the printer file will use a CCSID value of 65535. The data will not be converted when it is written to the printer file.

### ***Temporary source file members created by the SQL precompiler***

Source statements processed by the precompiler are written to an output source file. The output source file cannot be a stream file in the Integrated File System (IFS). It must be a database file.

In the precompiler-changed source code, SQL statements have been converted to comments and calls to the SQL run time code. Include files that are processed by SQL are expanded.

The output source file is specified on the CRTSQLxxx command in the TOSRCFILE parameter.

- For languages other than C, C++, and ILE RPG, the default file is QSQLTEMP in the QTEMP library.
- For C and C++ when \*CALC is specified as the output source file, QSQLTEMP will be used if the source file's record length is 92 or less. For a C or C++ source file where the record length is greater than 92, the output source file name will be generated as QSQLTxxxxx, where xxxxx is the record length.
- For RPG when \*CALC is specified as the output source file, QSQLTEMP1 will be used if the source file's record length is 112 or less. For an RPG source file where the record length is greater than 112, the output source file name will be generated as QSQLTxxxxx, where xxxxx is the record length.

The name of the output source file member is the same as the name specified in the PGM or OBJ parameter of the CRTSQLxxx command. This member cannot be changed before being used as input to the compiler. When SQL creates the output source file, it uses the CCSID value of the source file as the CCSID value for the new file. If precompiling from a source stream file and the CCSID of the source stream file is UTF-8 (1208), the output source file is created with the CCSID provided by the CVTCCSID parameter on the precompile command instead of the source file CCSID.

If the precompile generates output in a source file in QTEMP, the file can be moved to a permanent library after the precompile if you want to compile at a later time. You cannot change the records of the source member, or the attempted compile fails.

The source member that is generated by SQL as the result of the precompile should never be edited and reused as an input member to another precompile step. The additional SQL information that is saved with the source member during the first precompile will cause the second precompile to work incorrectly. Once this information is attached to a source member, it stays with the member until the member is deleted.

The SQL precompiler uses the **CRTSRCPF** command to create the output source file. If the defaults for this command have changed, then the results may be unpredictable. If the source file is created by the user, not the SQL precompiler, the file's attributes may be different as well. It is recommended that the user allow SQL to create the output source file. Once it has been created by SQL, it can be reused on later precompiles.

### Sample SQL precompiler output

The precompiler output can provide information about your program source.

To generate the listing:

- For non-ILE precompilers, specify the \*SOURCE (\*SRC) and \*XREF options on the OPTION parameter of the CRTSQLxxx command.
- For ILE precompilers, specify OPTION(\*XREF) and OUTPUT(\*PRINT) on the CRTSQLxxx command.

The format of the precompiler output is:

```

xxxxST1 VxRxMx yymmdd          Create SQL COBOL Program          CBLTEST1          08/06/07 11:14:21  Page  1
Source type.....COBOL
Program name.....CORPDATA/CBLTEST1
Source file.....CORPDATA/SRC
Member.....CBLTEST1
To source file.....QTEMP/QSQLTEMP
(1)Options.....*SRC          *XREF          *SQL
Target release.....VxRxMx
INCLUDE file.....*SRCFILE
Commit.....*CHG
Allow copy of data.....*YES
Close SQL cursor.....*ENDPGM
Allow blocking.....*READ
Delay PREPARE.....*NO
Generation level.....10
Printer file.....*LIBL/QSYSVRT
Date format.....*JOB
Date separator.....*JOB
Time format.....*HMS
Time separator.....*JOB
Replace.....*YES
Relational database.....*LOCAL
User.....*CURRENT
RDB connect method.....*DUW
Default collection.....*NONE
Dynamic default
  collection.....*NO
Package name.....*PGMLIB/*PGM
Path.....*NAMING
SQL rules.....*DB2
User profile.....*NAMING
Dynamic user profile.....*USER
Sort sequence.....*JOB
Language ID.....*JOB
IBM SQL flagging.....*NOFLAG
ANS flagging.....*NONE
Text.....*SRCMBRTXT
Source file CCSID.....65535
Job CCSID.....65535
Decimal result options:
  Maximum precision.....31
  Maximum scale.....31
  Minimum divide scale...0
DECFLOAT rounding mode...*HALFEVEN
Compiler options.....*NONE
(2) Source member changed on 06/06/00 10:16:44

```

**1** A list of the options you specified when the SQL precompiler was called.

**2** The date the source member was last changed.

Figure 2. Sample COBOL precompiler output format

```

1 IDENTIFICATION DIVISION. 100
2 PROGRAM-ID. CBLTEST1. 200
3 ENVIRONMENT DIVISION. 300
4 CONFIGURATION SECTION. 400
5 SOURCE-COMPUTER. IBM-AS400. 500
6 OBJECT-COMPUTER. IBM-AS400. 600
7 INPUT-OUTPUT SECTION. 700
8 FILE-CONTROL. 800
9 SELECT OUTFILE, ASSIGN TO PRINTER-QPRINT, 900
10 FILE STATUS IS FSTAT. 1000
11 DATA DIVISION. 1100
12 FILE SECTION. 1200
13 FD OUTFILE 1300
14 DATA RECORD IS REC-1, 1400
15 LABEL RECORDS ARE OMITTED. 1500
16 01 REC-1. 1600
17 05 CC PIC X. 1700
18 05 DEPT-NO PIC X(3). 1800
19 05 FILLER PIC X(5). 1900
20 05 AVERAGE-EDUCATION-LEVEL PIC ZZZ. 2000
21 05 FILLER PIC X(5). 2100
22 05 AVERAGE-SALARY PIC ZZZZ9.99. 2200
23 01 ERROR-RECORD. 2300
24 05 CC PIC X. 2400
25 05 ERROR-CODE PIC S9(5). 2500
26 05 ERROR-MESSAGE PIC X(70). 2600
27 WORKING-STORAGE SECTION. 2700
28 EXEC SQL 2800
29 INCLUDE SQLCA 2900
30 END-EXEC. 3000
31 77 FSTAT PIC XX. 3100
32 01 AVG-RECORD. 3200
33 05 WORKDEPT PIC X(3). 3300
34 05 AVG-EDUC PIC S9(4) USAGE COMP-4. 3400
35 05 AVG-SALARY PIC S9(6)V99 COMP-3. 3500
36 PROCEDURE DIVISION. 3600
37 ***** 3700
38 * This program will get the average education level and the * 3800
39 * average salary by department. * 3900
40 ***** 4000
41 A000-MAIN-PROCEDURE. 4100
42 OPEN OUTPUT OUTFILE. 4200
43 ***** 4300
44 * Set up WHENEVER statement to handle SQL errors. * 4400
45 ***** 4500
46 EXEC SQL 4600
47 WHENEVER SQLERROR GO TO B000-SQL-ERROR 4700
48 END-EXEC. 4800
    
```

- 1 Record number assigned by the precompiler when it reads the source record. Record numbers are used to identify the source record in error messages and SQL run-time processing.
- 2 Sequence number taken from the source record. The sequence number is the number seen when you use the source entry utility (SEU) to edit the source member.
- 3 Date when the source record was last changed. If Last Change is blank, it indicates that the record has not been changed since it was created.

```

xxxxST1 VxRxMx yymmdd      Create SQL COBOL Program      CBLTEST1      08/06/07 11:14:21      Page 3
Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8      SEQNBR      Last change
49      *****
50      * Declare cursor      *      4900
51      *****      5000
52      EXEC SQL      5100
53      DECLARE CURS CURSOR FOR      5200
54      SELECT WORKDEPT, AVG(EDLEVEL), AVG(SALARY)      5300
55      FROM CORPDATA.EMPLOYEE      5400
56      GROUP BY WORKDEPT      5500
57      END-EXEC.      5600
58      *****      5700
59      * Open cursor      *      5800
60      *****      5900
61      EXEC SQL      6000
62      OPEN CURS      6100
63      END-EXEC.      6200
64      *****      6300
65      * Fetch all result rows      *      6400
66      *****      6500
67      PERFORM A010-FETCH-PROCEDURE THROUGH A010-FETCH-EXIT      6600
68      UNTIL SQLCODE IS = 100.      6700
69      *****      6800
70      * Close cursor      *      6900
71      *****      7000
72      EXEC SQL      7100
73      CLOSE CURS      7200
74      END-EXEC.      7300
75      CLOSE OUTFILE.      7400
76      STOP RUN.      7500
77      *****      7600
78      * Fetch a row and move the information to the output record. *      7700
79      *****      7800
80      A010-FETCH-PROCEDURE.      7900
81      MOVE SPACES TO REC-1.      8000
82      EXEC SQL      8100
83      FETCH CURS INTO :AVG-RECORD      8200
84      END-EXEC.      8300
85      IF SQLCODE IS = 0      8400
86      MOVE WORKDEPT TO DEPT-NO      8500
87      MOVE AVG-SALARY TO AVERAGE-SALARY      8600
88      MOVE AVG-EDUC TO AVERAGE-EDUCATION-LEVEL      8700
89      WRITE REC-1 AFTER ADVANCING 1 LINE.      8800
90      A010-FETCH-EXIT.      8900
91      EXIT.      9000
92      *****      9100
93      * An SQL error occurred. Move the error number to the error *      9200
94      * record and stop running.      *      9300
95      *****      9400
96      B000-SQL-ERROR.      9500
97      MOVE SPACES TO ERROR-RECORD.      9600
98      MOVE SQLCODE TO ERROR-CODE.      9700
99      MOVE "AN SQL ERROR HAS OCCURRED" TO ERROR-MESSAGE.      9800
100     WRITE ERROR-RECORD AFTER ADVANCING 1 LINE.      9900
101     CLOSE OUTFILE.      10000
102     STOP RUN.      10100
* * * * * E N D   O F   S O U R C E   * * * * *      10200

```

```

xxxxST1 VxRxMx yymmdd      Create SQL COBOL Program      CBLTEST1      08/06/07 11:14:21      Page      4
CROSS REFERENCE
1
Data Names
AVERAGE-EDUCATION-LEVEL      20      IN REC-1
AVERAGE-SALARY                22      IN REC-1
AVG-EDUC                       34      SMALL INTEGER PRECISION(4,0) IN AVG-RECORD
AVG-RECORD                     32      STRUCTURE
83
AVG-SALARY                     35      DECIMAL(8,2) IN AVG-RECORD
BIRTHDATE                     55      DATE(10) COLUMN IN CORPDATA.EMPLOYEE
BONUS                          55      DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
B000-SQL-ERROR                ****   LABEL
47
CC                              17      CHARACTER(1) IN REC-1
CC                              24      CHARACTER(1) IN ERROR-RECORD
COMM                           55      DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
CORPDATA                       ****   (4) SCHEMA
(5) 55
CURS                           53      CURSOR
62 73 83
DEPT-NO                        18      CHARACTER(3) IN REC-1
EDLEVEL                        ****   COLUMN
54
(6)
EDLEVEL                        55      SMALL INTEGER PRECISION(4,0) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
EMPLOYEE                       ****   TABLE IN CORPDATA (7)
55
EMPNO                          55      CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
ERROR-CODE                     25      NUMERIC(5,0) IN ERROR-RECORD
ERROR-MESSAGE                  26      CHARACTER(70) IN ERROR-RECORD
ERROR-RECORD                   23      STRUCTURE
FIRSTNAME                      55      VARCHAR(12) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
FSTAT                          31      CHARACTER(2)
HIREDATE                       55      DATE(10) COLUMN IN CORPDATA.EMPLOYEE
JOB                             55      CHARACTER(8) COLUMN IN CORPDATA.EMPLOYEE
LASTNAME                       55      VARCHAR(15) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
MIDINIT                        55      CHARACTER(1) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
PHONENO                        55      CHARACTER(4) COLUMN IN CORPDATA.EMPLOYEE
REC-1                          16
SALARY                         ****   COLUMN
54
SALARY                         55      DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
SEX                             55      CHARACTER(1) COLUMN IN CORPDATA.EMPLOYEE
WORKDEPT                       33      CHARACTER(3) IN AVG-RECORD
WORKDEPT                       ****   COLUMN
54 56
WORKDEPT                       55      CHARACTER(3) COLUMN IN CORPDATA.EMPLOYEE
No errors found in source
102 Source records processed
* * * * * E N D O F L I S T I N G * * * * *

```

### 1

Data names are the symbolic names used in source statements.

### 2

The define column specifies the line number at which the name is defined. The line number is generated by the SQL precompiler. \*\*\*\* means that the object was not defined or the precompiler did not recognize the declarations.

### 3

The reference column contains two types of information:

- The definition of the symbolic name **(4)**
- The line numbers where the symbolic name occurs **(5)**

If the symbolic name refers to a valid host variable, the data-type **(6)** or data-structure **(7)** is also noted.

## Non-ILE SQL precompiler commands

The IBM Db2 Query Manager and SQL Development Kit for i licensed program includes non-ILE precompiler commands for the following host languages: **CRTSQLCBL** (for OPM COBOL), **CRTSQLPLI** (for PL/I PRPQ), and **CRTSQLRPG** (for RPG III, which is part of RPG/400).

Some options only apply to certain languages. For example, the options \*APOST and \*QUOTE are unique to COBOL. They are not included in the commands for the other languages.

## Compiling a non-ILE application program that uses SQL

The SQL precompiler automatically calls the host language compiler after the successful completion of a precompile, unless \*NOGEN is specified.

The **CRTxxxPGM** command is run specifying the program name, source file name, precompiler created source member name, text, and USRPRF.

Within these languages, the following parameters are passed:

- For COBOL, the \*QUOTE or \*APOST is passed on the **CRTCBLPGM** command.
- For RPG and COBOL, SAAFLAG (\*FLAG) is passed on the **CRTxxxPGM** command.
- For RPG and COBOL, the SRTSEQ and LANGID parameter from the CRTSQLxxx command is specified on the **CRTxxxPGM** command.
- For RPG and COBOL, the CVTOPT (\*DATETIME \*VARCHAR) is always specified on the **CRTxxxPGM** command.
- For COBOL and RPG, the TGTRLS parameter value from the CRTSQLxxx command is specified on the **CRTxxxPGM** command. TGTRLS is not specified on the **CRTPLIPGM** command. The program can be saved or restored to the level specified on the TGTRLS parameter of the **CRTSQLPLI** command.
- For PL/I, the MARGINS are set in the temporary source file.
- For all languages, the REPLACE parameter from the **CRTSQLxxx** command is specified on the **CRTxxxPGM** command.

If a package is created as part of the precompile process, the REPLACE parameter value from the **CRTSQLxxx** command is specified on the **CRTSQLPKG** command.

- For all languages, if USRPRF(\*USER) or system naming (\*SYS) with USRPRF(\*NAMING) is specified, then USRPRF(\*USER) is specified on the **CRTxxxPGM** command. If USRPRF(\*OWNER) or SQL naming (\*SQL) with USRPRF(\*NAMING) is specified, then USRPRF(\*OWNER) is specified on the **CRTxxxPGM** command.

Defaults are used for all other parameters with **CRTxxxPGM** commands.

You can interrupt the call to the host language compiler by specifying \*NOGEN on the OPTION parameter of the precompiler command. \*NOGEN specifies that the host language compiler will not be called. Using the object name in the CRTSQLxxx command as the member name, the precompiler created the source member in the output source file (specified as the TOSRCFILE parameter on the CRTSQLxxx command). You now can explicitly call the host language compilers, specify the source member in the output source file, and change the defaults. If the precompile and compile were done as separate steps, the **CRTSQLPKG** command can be used to create the SQL package for a distributed program.

**Note:** You must not change the source member in QTEMP/QSQLTEMP prior to issuing the CRTxxxPGM command or the compile will fail.

## ILE SQL precompiler commands

In the IBM Db2 Query Manager and SQL Development Kit for i licensed program, these ILE precompiler commands exist: **CRTSQLCI**, **CRTSQLCPPI**, **CRTSQLCBLI**, and **CRTSQLRPGI**.

A precompiler command exists for each of the host languages: ILE C, ILE C++, ILE COBOL, and ILE RPG. For each command, you can specify the required parameters and use the defaults for the remaining parameters. Some options are applicable only to one language. The defaults are applicable only to the language you are using. For example, the options \*APOST and \*QUOTE are unique to COBOL. They are not included in the commands for the other languages.

## Compiling an ILE application program that uses SQL

The SQL precompiler automatically calls the host language compiler after the successful completion of a precompile for the **CRTSQLxxx** commands, unless \*NOGEN is specified.

If the \*MODULE option is specified, the SQL precompiler issues the **CRTxxxMOD** command to create the module. If the \*PGM option is specified, the SQL precompiler issues the **CRTBNDxxx** command to create

the program. If the \*SRVPGM option is specified, the SQL precompiler issues the **CRTxxxMOD** command to create the module, followed by the **Create Service Program (CRTSRVPGM)** command to create the service program. The **CRTSQLCPPI** command only creates \*MODULE objects.

Within these languages, the following parameters are passed:

- If DBGVIEW(\*SOURCE) is specified on the **CRTSQLxxx** command, then DBGVIEW(\*ALL) is specified on both the **CRTxxxMOD** and **CRTBNDxxx** commands.
- If DBGVIEW(\*STMT) or DBGVIEW(\*LIST) is specified on the **CRTSQLxxx** command, it is passed on both the **CRTxxxMOD** and **CRTBNDxxx** commands.
- If OUTPUT(\*PRINT) is specified on the **CRTSQLxxx** command, it is passed on both the **CRTxxxMOD** and **CRTBNDxxx** commands.

If OUTPUT(\*NONE) is specified on the **CRTSQLxxx** command, it is not specified on either the **CRTxxxMOD** command or the **CRTBNDxxx** command.

- The TGTRLS parameter value from the **CRTSQLxxx** command is specified on the **CRTxxxMOD**, **CRTBNDxxx**, and **Create Service Program (CRTSRVPGM)** commands.
- The REPLACE parameter value from the **CRTSQLxxx** command is specified on the **CRTxxxMOD**, **CRTBNDxxx**, and **CRTSRVPGM** commands.

If a package is created as part of the precompile process, the REPLACE parameter value from the **CRTSQLxxx** command is specified on the **CRTSQLPKG** command.

- If OBJTYPE is either \*PGM or \*SRVPGM, and USRPRF(\*USER) or system naming (\*SYS) with USRPRF(\*NAMING) is specified, USRPRF(\*USER) is specified on the **CRTBNDxxx** or the **CRTSRVPGM** commands.

If OBJTYPE is either \*PGM or \*SRVPGM, and USRPRF(\*OWNER) or SQL naming (\*SQL) with USRPRF(\*NAMING) is specified, USRPRF(\*OWNER) is specified on the **CRTBNDxxx** or the **CRTSRVPGM** commands.

- The DBGENCKEY value from the **CRTSQLxxx** command is specified on the **CRTxxxMOD** or **CRTBNDxxx** commands.
- For C and C++, the MARGINS are set in the temporary source file.

If the precompiler calculates that the total length of the LOB host variables is close to 15M, the TERASPACE(\*YES \*TSIFC) option is specified on the **CRTCMOD**, **CRTBNDC**, or **CRTCPPMOD** commands.

- For C and C++, the DECFLTRND value is passed on the **CRTCMOD**, **CRTBNDC**, or **CRTCPPMOD** commands.
- For COBOL, the \*QUOTE or \*APOST is passed on the **CRTBNDCBL** or the **CRTCBLMOD** commands.
- For RPG and COBOL, the SRTSEQ and LANGID parameter from the **CRTSQLxxx** command is specified on the **CRTxxxMOD** and **CRTBNDxxx** commands.
- For COBOL, CVTOPT(\*VARCHAR \*DATETIME \*PICGRAPHIC \*FLOAT) is always specified on the **CRTCBLMOD** and **CRTBNDCBL** commands. If OPTION(\*NOCVTDT) is specified (the shipped command default), the additional options \*DATE \*TIME \*TIMESTAMP are also specified for the CVTOPT.
- For RPG, if OPTION(\*CVTDT) is specified, then CVTOPT(\*DATETIME) is specified on the **CRTRPGMOD** and **CRTBNDRPG** commands.

You can interrupt the call to the host language compiler by specifying \*NOGEN on the OPTION parameter of the precompiler command. \*NOGEN specifies that the host language compiler is not called. Using the specified program name in the **CRTSQLxxx** command as the member name, the precompiler creates the source member in the output source file (TOSRCFILE parameter). You can now explicitly call the host language compiler, specify the source member in the output source file, and change the defaults. If the precompile and compile were done as separate steps, the **CRTSQLPKG** command can be used to create the SQL package for a distributed program.

If the program or service program is created later, the USRPRF parameter may not be set correctly on the **CRTBNDxxx**, **Create Program (CRTPGM)**, or **Create Service Program (CRTSRVPGM)** command. The SQL program runs predictably only after the USRPRF parameter is corrected. If system naming is used, then the USRPRF parameter must be set to \*USER. If SQL naming is used, then the USRPRF parameter must be set to \*OWNER.

## Setting compiler options using the precompiler commands

The COMPILEOPT string is available on the precompiler command and on the SET OPTION statement to allow additional parameters to be used on the compiler command.

The COMPILEOPT string is added to the compiler command built by the precompiler. This allows specifying compiler parameters without requiring a two step process of precompiling and then compiling. Do not specify parameters in the COMPILEOPT string that the SQL precompiler passes. Doing so will cause the compiler command to fail with a duplicate parameter error. It is possible that the SQL precompiler will pass additional parameters to the compiler in the future. This could lead to a duplicate parameter error, requiring your COMPILEOPT string to be changed at that time.

If "\*EVENTF" is anywhere in the COMPILEOPT string specified on the precompiler command, the precompiler will behave as if "OPTION(\*EVENTF)" was specified on the precompiler command. This does not apply to the COMPILEOPT string specified on the SET OPTION statement.

If "INCDIR(" is anywhere in the COMPILEOPT string, the precompiler will call the compiler using the SRCSTMF parameter.

```
EXEC SQL SET OPTION COMPILEOPT = 'OPTION(*SHOWINC *EXPMAC)
INCDIR(''/QSYS.LIB/MYLIB.LIB/MYFILE.MBR ''');
```

## Interpreting compile errors in applications that use SQL

Sometimes you will encounter compile errors. Use the following information to interpret these errors.

If you separate the precompile and compile steps, and the source program refers to externally described files, the referred-to files must not be changed between precompile and compile steps. Otherwise, results that are not predictable might occur because the changes to the field definitions are not changed in the temporary source member.

Examples of externally described files are:

- COPY DDS in COBOL
- %INCLUDE in PL/I
- #pragma mapinc and #include in C or C++
- Externally-described files and externally-described data structures in RPG

When the SQL precompiler does not recognize host variables or host structures, messages SQL0312 and SQL5011 are written to the listing. These messages return a detailed reason why the variable was not able to be used. If the information in the message does not resolve the problem, you can try compiling the source. The compiler will not recognize the EXEC SQL statements, ignore these errors. Verify that the compiler interprets the host variable declaration as defined by the SQL precompiler for that language.

## Binding an application that uses SQL

Before you can run your application program, a relationship between the program and any specified tables and views must be established. This process is called *binding*. The result of binding is an *access plan*.

The access plan is a control structure that describes the actions necessary to satisfy each SQL request. An access plan contains information about the program and about the data the program intends to use.

For a nondistributed SQL program, the access plan is stored in the program. For a distributed SQL program (where the RDB parameter is specified on the **CRTSQLxxx** command), the access plan is stored in the SQL package at the specified relational database.

SQL automatically attempts to bind and create access plans when the program object is created. For non-ILE compilations, this occurs as the result of running a successful **CRTxxxPGM** command. For ILE compilations, this occurs as the result of running a successful **CRTBNDxxx**, **CRTPGM**, or **CRTSRVPGM** command. If Db2 for i detects at run time that an access plan is not valid (for example, the referenced tables are in a different library) or detects that changes have occurred to the database that might improve

performance (for example, the addition of indexes), a new access plan is automatically created. Binding does the following things:

1. **It revalidates the SQL statements using the description in the database.** During the bind process, the SQL statements are checked for valid table, column, and other object names. If a specified table or object does not exist at the time of the precompile or compile, the validation is done at run time. If the table or object does not exist at run time, a negative SQLCODE is returned.
2. **It selects the index needed to access the data your program wants to process.** In selecting an index, table sizes, and other factors are considered. It considers all indexes available to access the data and decides which ones (if any) to use when selecting a path to the data.
3. **It attempts to build access plans.** For each SQL statement that is valid, the bind process builds and stores an access plan in the program.

If the characteristics of a table or view your program accesses have changed, the access plan may no longer be valid. When you attempt to run a program that contains an access plan that is not valid, the system automatically attempts to rebuild the access plan. If the access plan cannot be rebuilt, a negative SQLCODE is returned. In this case, you might have to change the program's SQL statements and reissue the CRTSQLxxx command to correct the situation.

Assume that a program contains an SQL statement that refers to COLUMNA in TABLEA and the user deletes and re-creates TABLEA so that COLUMNA no longer exists. When you call the program, the automatic rebind will be unsuccessful because COLUMNA no longer exists. In this case you must change the program source and reissue the CRTSQLxxx command.

## Program references in applications that use SQL

All schemas, tables, views, SQL packages, and indexes referenced in SQL statements in an SQL program are placed in the object information repository (OIR) of the library when the program is created.

You can use the CL command **Display Program References (DSPPGMREF)** to display all object references in the program. If the SQL naming convention is used, the library name is stored in the OIR in one of three ways:

1. If the SQL name is fully qualified, the schema name is stored as the name qualifier.
2. If the SQL name is not fully qualified and the DFTRDBCOL parameter is not specified, the authorization ID of the statement is stored as the name qualifier.
3. If the SQL name is not fully qualified and the DFTRDBCOL parameter is specified, the schema name specified on the DFTRDBCOL parameter is stored as the name qualifier.

If the system naming convention is used, the library name is stored in the OIR in one of three ways:

1. If the object name is fully qualified, the library name is stored as the name qualifier.
2. If the object is not fully qualified and the DFTRDBCOL parameter is not specified, \*LIBL is stored.
3. If the SQL name is not fully qualified and the DFTRDBCOL parameter is specified, the schema name specified on the DFTRDBCOL parameter is stored as the name qualifier.

## Displaying SQL precompiler options

When the SQL application program is successfully compiled, the **Display Module (DSPMOD)**, the **Display Program (DSPPGM)**, or the **Display Service Program (DSPSRVPGM)** command can be used to determine some of the options that were specified on the SQL precompile.

This information may be needed when the source of the program has to be changed. These same SQL precompiler options can then be specified on the CRTSQLxxx command when the program is compiled again.

The **Print SQL Information (PRTSQLINF)** command can also be used to determine some of the options that were specified on the SQL precompile.

## Running a program with embedded SQL

Running a host language program with embedded SQL statements, after the precompile and compile have been successfully done, is the same as running any host program.

Enter the following CALL statement:

```
CALL pgm-name
```

on the system command line.

**Note:** After installing a new release, users may encounter message CPF2218 in QHST using any Structured Query Language (SQL) program if the user does not have \*CHANGE authority to the program. Once a user with \*CHANGE authority calls the program, the access plan is updated and the message will be issued.

### Related concepts

[Control language](#)

## Running a program with embedded SQL: DDM considerations

SQL does not support remote file access through distributed data management (DDM) files, except for the case when a RDB is specified in the DDM file. SQL does support remote access through Distributed Relational Database Architecture™ (DRDA).

## Running a program with embedded SQL: Override considerations

You can use overrides (specified by the **OVRDBF** command) to direct a reference to a different table or view or to change certain operational characteristics of the program or SQL Package.

The following parameters are processed if an override is specified:

- TOFILE
- MBR
- SEQONLY
- INHWRT
- WAITRCD

All other override parameters are ignored. Overrides of statements in SQL packages are accomplished by doing both of the following:

1. Specifying the OVRSCOPE(\*JOB) parameter on the **OVRDBF** command
2. Sending the command to the application server by using the **Submit Remote Command (SBMRMTCMD)** command

To override tables and views that are created with long names, you can create an override using the system name that is associated with the table or view. When the long name is specified in an SQL statement, the override is found using the corresponding system name.

An alias is actually created as a DDM file. You can create an override that refers to an alias name (DDM file). In this case, an SQL statement that refers to the file that has the override actually uses the file to which the alias refers.

### Related concepts

[Database programming](#)

[Database file management](#)

## Running a program with embedded SQL: SQL return codes

An SQL return code is sent by the database manager after the completion of each SQL statement. Your program can check the SQLCODE or SQLSTATE after every SQL statement.

## Related concepts

[SQL messages and codes](#)

# Example programs: Using Db2 for i statements

---

Here is a sample application that shows how to code SQL statements in each of the languages that Db2 for i supports.

The sample application gives raises based on commission.

Each sample program produces the same report, which is shown at the end of this topic. The first part of the report shows, by project, all employees working on the project who received a raise. The second part of the report shows the new salary expense for each project.

## Notes about the sample programs

The following notes apply to all the sample programs:

SQL statements can be entered in uppercase or lowercase.

**1**

This host language statement retrieves the external definitions for the SQL table PROJECT. These definitions can be used as host variables or as a host structure.

### Notes:

1. In RPG/400, field names in an externally described structure that are longer than 6 characters must be renamed.
2. REXX does not support the retrieval of external definitions.

**2**

The SQL INCLUDE SQLCA statement is used to include the SQLCA for PL/I, C, and COBOL programs. For RPG programs, the SQL precompiler automatically places the SQLCA data structure into the source at the end of the Input specification section. For REXX, the SQLCA fields are maintained in separate variables rather than in a contiguous data area mapped by the SQLCA.

**3**

This SQL WHENEVER statement defines the host language label to which control is passed if an SQLERROR (SQLCODE < 0) occurs in an SQL statement. This WHENEVER SQLERROR statement applies to all the following SQL statements until the next WHENEVER SQLERROR statement is encountered. REXX does not support the WHENEVER statement. Instead, REXX uses the SIGNAL ON ERROR facility.

**4**

This SQL UPDATE statement updates the SALARY column, which contains the employee salary by the percentage in the host variable PERCENTAGE (PERCNT for RPG). The updated rows are those that have employee commissions greater than 2000. For REXX, this is PREPARE and EXECUTE since UPDATE cannot be run directly if there is a host variable.

**5**

This SQL COMMIT statement commits the changes made by the SQL UPDATE statement. Record locks on all changed rows are released.

**Note:** The program was precompiled using COMMIT(\*CHG). (For REXX, \*CHG is the default.)

**6**

This SQL DECLARE CURSOR statement defines cursor C1, which joins two tables, EMPLOYEE and EMPPROJECT, and returns rows for employees who received a raise (commission > 2000). Rows are returned in ascending order by project number and employee number (PROJNO and EMPNO columns). For REXX, this is a PREPARE and DECLARE CURSOR since the DECLARE CURSOR statement cannot be specified directly with a statement string if it has host variables.

**7**

This SQL OPEN statement opens cursor C1 so that the rows can be fetched.

**8**

This SQL WHENEVER statement defines the host language label to which control is passed when all rows are fetched (SQLCODE = 100). For REXX, the SQLCODE must be explicitly checked.

**9**

This SQL FETCH statement returns all columns for cursor C1 and places the returned values into the corresponding elements of the host structure.

**10**

After all rows are fetched, control is passed to this label. The SQL CLOSE statement closes cursor C1.

**11**

This SQL DECLARE CURSOR statement defines cursor C2, which joins the three tables, EMPPROJACT, PROJECT, and EMPLOYEE. The results are grouped by columns PROJNO and PROJNAME. The COUNT function returns the number of rows in each group. The SUM function calculates the new salary cost for each project. The ORDER BY 1 clause specifies that rows are retrieved based on the contents of the final results column (EMPPROJACT.PROJNO). For REXX, this is a PREPARE and DECLARE CURSOR since the DECLARE CURSOR statement cannot be specified directly with a statement string if it has host variables.

**12**

This SQL FETCH statement returns the results columns for cursor C2 and places the returned values into the corresponding elements of the host structure described by the program.

**13**

This SQL WHENEVER statement with the CONTINUE option causes processing to continue to the next statement regardless if an error occurs on the SQL ROLLBACK statement. Errors are not expected on the SQL ROLLBACK statement; however, this prevents the program from going into a loop if an error does occur. REXX does not support the WHENEVER statement. Instead, REXX uses the SIGNAL OFF ERROR facility.

**14**

This SQL ROLLBACK statement restores the table to its original condition if an error occurred during the update.

### **Related concepts**

#### Coding SQL statements in C and C++ applications

To embed SQL statements in an ILE C or C++ program, you need to be aware of some unique application and coding requirements. This topic also defines the requirements for host structures and host variables.

#### Coding SQL statements in COBOL applications

There are unique application and coding requirements for embedding SQL statements in a COBOL program. In this topic, requirements for host structures and host variables are defined.

#### Coding SQL statements in PL/I applications

There are some unique application and coding requirements for embedding SQL statements in a PL/I program. In this topic, requirements for host structures and host variables are defined.

#### Coding SQL statements in ILE RPG applications

You need to be aware of the unique application and coding requirements for embedding SQL statements in an ILE RPG program. In this topic, the coding requirements for host variables are defined.

#### Coding SQL statements in RPG/400 applications

The RPG/400 licensed program supports both RPG II and RPG III programs.

#### Coding SQL statements in REXX applications

REXX procedures do not have to be preprocessed. At run time, the REXX interpreter passes statements that it does not understand to the current active command environment for processing.

## **Example: SQL statements in ILE C and C++ programs**

This example program is written in the C programming language.

The same program would work in C++ if the following conditions are true:

- An SQL BEGIN DECLARE SECTION statement was added before line 18

- An SQL END DECLARE SECTION statement was added after line 42

**Note:** By using the code examples, you agree to the terms of the [“Code license and disclaimer information”](#) on page 198.

```

xxxxST1 VxRxMx yymmdd          Create SQL ILE C Object          CEX          08/06/07 15:52:26
Page 1
Source type.....C
Object name.....CORPDATA/CEX
Source file.....CORPDATA/SRC
Member.....CEX
To source file.....QTEMP/QSQLTEMP
Options.....*XREF
Listing option.....*PRINT
Target release.....VxRxMx
INCLUDE file.....*SRCFILE
Commit.....*CHG
Allow copy of data.....*YES
Close SQL cursor.....*ENDACTGRP
Allow blocking.....*READ
Delay PREPARE.....*NO
Generation level.....10
Margins.....*SRCFILE
Printer file.....*LIBL/QSYSPRT
Date format.....*JOB
Date separator.....*JOB
Time format.....*HMS
Time separator.....*JOB
Replace.....*YES
Relational database.....*LOCAL
User.....*CURRENT
RDB connect method.....*DUW
Default collection.....*NONE
Dynamic default
  collection.....*NO
Package name.....*OBJLIB/*OBJ
Path.....*NAMING
SQL rules.....*DB2
Created object type.....*PGM
Debugging view.....*NONE
User profile.....*NAMING
Dynamic user profile.....*USER
Sort sequence.....*JOB
Language ID.....*JOB
IBM SQL flagging.....*NOFLAG
ANS flagging.....*NONE
Text.....*SRCMBRTXT
Source file CCSID.....65535
Job CCSID.....65535
Decimal result options:
  Maximum precision.....31
  Maximum scale.....31
  Minimum divide scale...0
DECFLOAT rounding mode...*HALFEVEN
Compiler options.....*NONE
Source member changed on 06/06/00 17:15:17

```

Figure 3. Sample C program using SQL statements

```

xxxxST1 VxRxMx yymmdd      Create SQL ILE C Object          CEX          08/06/07 15:52:26
Page      2
Record   *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8 SEQNBR Last
change
1 #include "string.h"                                     100
2 #include "stdlib.h"                                    200
3 #include "stdio.h"                                    300
4                                                         400
5 main()                                                 500
6 {                                                       600
7 /* A sample program which updates the salaries for those employees */ 700
8 /* whose current commission total is greater than or equal to the */ 800
9 /* value of 'commission'. The salaries of those who qualify are */ 900
10 /* increased by the value of 'percentage', retroactive to 'raise_date' */ 1000
11 /* A report is generated showing the projects that these employees */ 1100
12 /* have contributed to, ordered by project number and employee ID. */ 1200
13 /* A second report shows each project having an end date occurring */ 1300
14 /* after 'raise_date' (is potentially affected by the retroactive */ 1400
15 /* raises) with its total salary expenses and a count of employees */ 1500
16 /* who contributed to the project. */ 1600
17                                                         1700
18     short work_days = 253; /* work days during in one year */ 1800
19     float commission = 2000.00; /* cutoff to qualify for raise */ 1900
20     float percentage = 1.04; /* raised salary as percentage */ 2000
21     char raise_date??(12??) = "1982-06-01"; /* effective raise date */ 2100
22                                                         2200
23     /* File declaration for qprint */ 2300
24     FILE *qprint; 2400
25                                                         2500
26     /* Structure for report 1 */ 2600
27     1 #pragma mapinc ("project", "CORPDATA/PROJECT(PROJECT)", "both", "p z") 2700
28     #include "project" 2800
29     struct { 2900
30         CORPDATA_PROJECT_PROJECT_both_t Proj_struct; 3000
31         char empno??(7??); 3100
32         char name??(30??); 3200
33         float salary; 3300
34         } rpt1; 3400
35                                                         3500
36     /* Structure for report 2 */ 3600
37     struct { 3700
38         char projno??(7??); 3800
39         char project_name??(37??); 3900
40         short employee_count; 4000
41         double total_proj_cost; 4100
42         } rpt2; 4200
43                                                         4300
44     2 exec sql include SQLCA; 4400
45                                                         4500
46     qprint=fopen("QPRINT", "w"); 4600
47                                                         4700
48     /* Update the selected projects by the new percentage. If an error */ 4800
49     /* occurs during the update, ROLLBACK the changes. */ 4900
50     3 EXEC SQL WHENEVER SQLERROR GO TO update_error; 5000
51     4 EXEC SQL 5100
52         UPDATE CORPDATA/EMPLOYEE 5200
53             SET SALARY = SALARY * :percentage 5300
54             WHERE COMM >= :commission ; 5400
55                                                         5500
56     /* Commit changes */ 5600
57     5 EXEC SQL 5700
58         COMMIT; 5800
59     EXEC SQL WHENEVER SQLERROR GO TO report_error; 5900
60                                                         6000

```

```

xxxxST1 VxRmMx yymmdd      Create SQL ILE C Object          CEX          08/06/07 15:52:26
Page      3
Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8 SEQNBR Last
change
61      /* Report the updated statistics for each employee assigned to the */          6100
62      /* selected projects. */                                                    6200
63                                                                                   6300
64      /* Write out the header for Report 1 */                                       6400
65      fprintf(qprint,"                REPORT OF PROJECTS AFFECTED \          6500
66 BY RAISES");
67      fprintf(qprint,"\n\nPROJECT  EMPID      EMPLOYEE NAME      ");          6600
68      fprintf(qprint, "                SALARY\n");
69                                                                                   6900
70      6 exec sql                                                                    7000
71          declare c1 cursor for                                                    7100
72              select distinct projno, empproject.empno,                            7200
73                  lastname||', '||firstnme, salary                                7300
74              from corpdata/empproject, corpdata/employee                          7400
75              where empproject.empno = employee.empno and comm >= :commission      7500
76              order by projno, empno;
77      7 EXEC SQL                                                                    7700
78          OPEN C1;
79                                                                                   7900
80      /* Fetch and write the rows to QPRINT */                                       8000
81      8 EXEC SQL WHENEVER NOT FOUND GO TO done1;                                    8100
82                                                                                   8200
83      do {
84      10 EXEC SQL                                                                    8400
85          FETCH C1 INTO :Proj_struct.PROJNO, :rpt1.empno,                            8500
86              :rpt1.name, :rpt1.salary;
87          fprintf(qprint,"\n%6s %6s %-30s %8.2f",                                  8700
88              rpt1.Proj_struct.PROJNO,rpt1.empno,                                  8800
89              rpt1.name,rpt1.salary);
90          }
91      while (SQLCODE==0);
92                                                                                   9200
93      done1:
94      EXEC SQL
95          CLOSE C1;
96                                                                                   9600
97      /* For all projects ending at a date later than the 'raise_date' * /          9700
98      /* (that is, those projects potentially affected by the salary raises), */      9800
99      /* generate a report containing the project number, project name */           9900
100     /* the count of employees participating in the project, and the */           10000
101     /* total salary cost of the project. */                                       10100
102                                                                                   10200
103     /* Write out the header for Report 2 */                                       10300
104     fprintf(qprint,"\n\n\n                ACCUMULATED STATISTICS\          10400
105 BY PROJECT");
106     fprintf(qprint, "\n\nPROJECT                \          10600
107     NUMBER OF          TOTAL");
108     fprintf(qprint, "\n\nNUMBER          PROJECT NAME          \          10800
109     EMPLOYEES          COST\n");
110                                                                                   11000
111     11 EXEC SQL                                                                    11100
112         DECLARE C2 CURSOR FOR                                                    11200
113             SELECT EMPPROJECT.PROJNO, PROJNAME, COUNT(*),                            11300
114                 SUM ( ( DAYS(EMENDATE) - DAYS(EMSTDATE) ) * EMPETIME *            11400
115                     (DECIMAL( SALARY / :work_days ,8,2)))                          11500
116             FROM CORPDATA/EMPPROJECT, CORPDATA/PROJECT, CORPDATA/EMPLOYEE          11600
117             WHERE EMPPROJECT.PROJNO=PROJECT.PROJNO AND                            11700
118                 EMPPROJECT.EMPNO =EMPLOYEE.EMPNO AND                            11800
119                 PRENDATE > :raise_date
120             GROUP BY EMPPROJECT.PROJNO, PROJNAME
121             ORDER BY 1;
122     EXEC SQL
123         OPEN C2;

```

```

xxxxST1 VxRxMx yymmdd          Create SQL ILE C Object          CEX          08/06/07 15:52:26
Page 4
Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8 SEQNBR Last
change
124                                     12400
125      /* Fetch and write the rows to QPRINT */          12500
126      EXEC SQL WHENEVER NOT FOUND GO TO done2;          12600
127                                     12700
128      do {          12800
129      12 EXEC SQL          12900
130          FETCH C2 INTO :rpt2;          13000
131          fprintf(qprint, "\n%6s %-36s %6d %9.2f",          13100
132              rpt2.projno, rpt2.project_name, rpt2.employee_count,
133              rpt2.total_proj_cost);          13200
134          }          13300
135      while (SQLCODE==0);          13400
136                                     13500
137      done2:          13600
138      EXEC SQL          13700
139          CLOSE C2;          13800
140      goto finished;          13900
141                                     14000
142      /* Error occurred while updating table. Inform user and rollback */          14100
143      /* changes. */          14200
144      update_error:          14300
145      13 EXEC SQL WHENEVER SQLERROR CONTINUE;          14400
146      fprintf(qprint, "*** ERROR Occurred while updating table. SQLCODE="          14500
147          "%5d\n", SQLCODE);          14600
148      14 EXEC SQL          14700
149          ROLLBACK;          14800
150      goto finished;          14900
151                                     15000
152      /* Error occurred while generating reports. Inform user and exit. */          15100
153      report_error:          15200
154      fprintf(qprint, "*** ERROR Occurred while generating reports. "          15300
155          "SQLCODE=%5d\n", SQLCODE);          15400
156      goto finished;          15500
157                                     15600
158      /* All done */          15700
159      finished:          15800
160          fclose(qprint);          15900
161          exit(0);          16000
162                                     16100
163      }          16200
* * * * * E N D O F S O U R C E * * * * *          16300

```

CROSS REFERENCE

Data Names	Define	Reference
commission	19	FLOAT(24) 54 75
done1	****	LABEL 81
done2	****	LABEL 126
employee_count	40	SMALL INTEGER PRECISION(4,0) IN rpt2
empno	31	VARCHAR(7) IN rpt1 85
name	32	VARCHAR(30) IN rpt1 86
percentage	20	FLOAT(24) 53
project_name	39	VARCHAR(37) IN rpt2
projno	38	VARCHAR(7) IN rpt2
raise_date	21	VARCHAR(12) 119
report_error	****	LABEL 59
rpt1	34	
rpt2	42	STRUCTURE 130
salary	33	FLOAT(24) IN rpt1 86
total_proj_cost	41	FLOAT(53) IN rpt2
update_error	****	LABEL 50
work_days	18	SMALL INTEGER PRECISION(4,0) 115
ACTNO	74	SMALL INTEGER PRECISION(4,0) COLUMN (NOT NULL) IN
CORPDATA.EMPPROJECT		
BIRTHDATE	74	DATE(10) COLUMN IN CORPDATA.EMPLOYEE
BONUS	74	DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
COMM	****	COLUMN 54 75
COMM	74	DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
CORPDATA	****	SCHEMA 52 74 74 116 116 116
C1	71	CURSOR 78 85 95
C2	112	CURSOR 123 130 139
DEPTNO	27	VARCHAR(3) IN Proj_struct
DEPTNO	116	CHARACTER(3) COLUMN (NOT NULL) IN CORPDATA.PROJECT
EDLEVEL	74	SMALL INTEGER PRECISION(4,0) COLUMN (NOT NULL) IN
CORPDATA.EMPLOYEE		
EMENDATE	74	DATE(10) COLUMN IN CORPDATA.EMPPROJECT
EMENDATE	****	COLUMN 114
EMPLOYEE	****	TABLE IN CORPDATA 52 74 116
EMPLOYEE	****	TABLE 75 118
EMPNO	****	COLUMN IN EMPPROJECT 72 75 76 118
EMPNO	****	COLUMN IN EMPLOYEE 75 118
EMPNO	74	CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.EMPPROJECT
EMPNO	74	CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
EMPPROJECT	****	TABLE 72 75 113 117 118 120
EMPPROJECT	****	TABLE IN CORPDATA 74 116

```

xxxxST1 VxRxMx yymmdd          Create SQL ILE C Object          CEX          08/06/07 15:52:26
Page 6
CROSS REFERENCE

EMPTIME          74          DECIMAL(5,2) COLUMN IN CORPDATA.EMPPROJECT
EMPTIME          ****          COLUMN
                               114
EMSTDATE        74          DATE(10) COLUMN IN CORPDATA.EMPPROJECT
EMSTDATE        ****          COLUMN
                               114
FIRSTNME        ****          COLUMN
                               73
FIRSTNME        74          VARCHAR(12) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
HIREDATE        74          DATE(10) COLUMN IN CORPDATA.EMPLOYEE
JOB             74          CHARACTER(8) COLUMN IN CORPDATA.EMPLOYEE
LASTNAME        ****          COLUMN
                               73
LASTNAME        74          VARCHAR(15) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
MAJPROJ        27          VARCHAR(6) IN Proj_struct
MAJPROJ        116         CHARACTER(6) COLUMN IN CORPDATA.PROJECT
MIDINIT        74          CHARACTER(1) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
Proj_struct    30          STRUCTURE IN rpt1
PHONENO        74          CHARACTER(4) COLUMN IN CORPDATA.EMPLOYEE
PRENDATE        27          DATE(10) IN Proj_struct
PRENDATE        ****          COLUMN
                               119
PRENDATE        116         DATE(10) COLUMN IN CORPDATA.PROJECT
PROJECT        ****          TABLE IN CORPDATA
                               116
PROJECT        ****          TABLE
                               117
PROJNAME        27          VARCHAR(24) IN Proj_struct
PROJNAME        ****          COLUMN
                               113 120
PROJNAME        116         VARCHAR(24) COLUMN (NOT NULL) IN CORPDATA.PROJECT
PROJNO         27          VARCHAR(6) IN Proj_struct
                               85
PROJNO         ****          COLUMN
                               72 76
PROJNO         74          CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.EMPPROJECT
PROJNO         ****          COLUMN IN EMPPROJECT
                               113 117 120
PROJNO         ****          COLUMN IN PROJECT
                               117
PROJNO         116         CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.PROJECT
PRSTAFF        27          DECIMAL(5,2) IN Proj_struct
PRSTAFF        116         DECIMAL(5,2) COLUMN IN CORPDATA.PROJECT
PRSTDATE        27          DATE(10) IN Proj_struct
PRSTDATE        116         DATE(10) COLUMN IN CORPDATA.PROJECT
RESPEMP        27          VARCHAR(6) IN Proj_struct
RESPEMP        116         CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.PROJECT
SALARY         ****          COLUMN
                               53 53 73 115
SALARY         74          DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
SEX            74          CHARACTER(1) COLUMN IN CORPDATA.EMPLOYEE
WORKDEPT       74          CHARACTER(3) COLUMN IN CORPDATA.EMPLOYEE
No errors found in source
163 Source records processed
***** END OF LISTING *****

```

## Related concepts

### Coding SQL statements in C and C++ applications

To embed SQL statements in an ILE C or C++ program, you need to be aware of some unique application and coding requirements. This topic also defines the requirements for host structures and host variables.

## Example: SQL statements in COBOL and ILE COBOL programs

This example program is written in the COBOL programming language.

**Note:** By using the code examples, you agree to the terms of the [“Code license and disclaimer information”](#) on page 198.

```

xxxxST1 VxRxMx yymmdd      Create SQL COBOL Program      CBLEX      08/06/07 11:09:13
Page 1
Source type.....COBOL
Program name.....CORPDATA/CBLEX
Source file.....CORPDATA/SRC
Member.....CBLEX
To source file.....QTEMP/QSQLTEMP
Options.....*SRC      *XREF
Target release.....VxRxMx
INCLUDE file.....*SRCFILE
Commit.....*CHG
Allow copy of data.....*YES
Close SQL cursor.....*ENDPGM
Allow blocking.....*READ
Delay PREPARE.....*NO
Generation level.....10
Printer file.....*LIBL/QSYSPRT
Date format.....*JOB
Date separator.....*JOB
Time format.....*HMS
Time separator.....*JOB
Replace.....*YES
Relational database.....*LOCAL
User.....*CURRENT
RDB connect method.....*DUW
Default collection.....*NONE
Dynamic default
collection.....*NO
Package name.....*PGMLIB/*PGM
Path.....*NAMING
SQL rules.....*DB2
Created object type.....*PGM
User profile.....*NAMING
Dynamic user profile.....*USER
Sort sequence.....*JOB
Language ID.....*JOB
IBM SQL flagging.....*NOFLAG
ANS flagging.....*NONE
Text.....*SRCMBRTXT
Source file CCSID.....65535
Job CCSID.....65535
Decimal result options:
  Maximum precision.....31
  Maximum scale.....31
  Minimum divide scale...0
DECFLOAT rounding mode...*HALFEVEN
Compiler options.....*NONE
Source member changed on 07/01/96 09:44:58

```

Figure 4. Sample COBOL program using SQL statements

```

xxxxST1 VxRxMx yymmdd      Create SQL COBOL Program          CBLEX          08/06/07 11:09:13
Page      2
Record   *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8   SEQNBR Last
change
1
2
3      *****
4      * A sample program that updates the salaries for those *
5      * employees whose current commission total is greater than or *
6      * equal to the value of COMMISSION. The salaries of those who *
7      * qualify are increased by the value of PERCENTAGE retroactive *
8      * to RAISE-DATE. A report is generated showing the projects *
9      * that these employees have contributed to ordered by the *
10     * project number and employee ID. A second report shows each *
11     * project having an end date occurring after RAISE-DATE *
12     * (that is, potentially affected by the retroactive raises ) *
13     * with its total salary expenses and a count of employees *
14     * who contributed to the project. *
15     *****
16
17     IDENTIFICATION DIVISION.
18
19     PROGRAM-ID. CBLEX.
20     ENVIRONMENT DIVISION.
21     CONFIGURATION SECTION.
22     SOURCE-COMPUTER. IBM-AS400.
23     OBJECT-COMPUTER. IBM-AS400.
24     INPUT-OUTPUT SECTION.
25
26     FILE-CONTROL.
27         SELECT PRINTFILE ASSIGN TO PRINTER-QPRINT
28         ORGANIZATION IS SEQUENTIAL.
29
30     DATA DIVISION.
31
32     FILE SECTION.
33
34     FD PRINTFILE
35         BLOCK CONTAINS 1 RECORDS
36         LABEL RECORDS ARE OMITTED.
37     01 PRINT-RECORD PIC X(132).
38
39     WORKING-STORAGE SECTION.
40     77 WORK-DAYS PIC S9(4) BINARY VALUE 253.
41     77 RAISE-DATE PIC X(11) VALUE "1982-06-01".
42     77 PERCENTAGE PIC S999V99 PACKED-DECIMAL.
43     77 COMMISSION PIC S99999V99 PACKED-DECIMAL VALUE 2000.00.
44
45     *****
46     * Structure for report 1. *
47     *****
48
49     1 01 RPT1.
50         COPY DDS-PROJECT OF CORPDATA-PROJECT.
51         05 EMPNO PIC X(6).
52         05 NAME PIC X(30).
53         05 SALARY PIC S9(6)V99 PACKED-DECIMAL.
54
55

```

```

xxxxST1 VxRxMx yymmdd      Create SQL COBOL Program          CBLEX          08/06/07 11:09:13
Page      3
Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8 SEQNBR Last
change
56 *****
57 * Structure for report 2. *
58 *****
59
60 01 RPT2.
61 15 PROJNO PIC X(6).
62 15 PROJECT-NAME PIC X(36).
63 15 EMPLOYEE-COUNT PIC S9(4) BINARY.
64 15 TOTAL-PROJ-COST PIC S9(10)V99 PACKED-DECIMAL.
65
66 2 EXEC SQL
67 INCLUDE SQLCA
68 END-EXEC.
69 77 CODE-EDIT PIC ---99.
70
71 *****
72 * Headers for reports. *
73 *****
74
75 01 RPT1-HEADERS.
76 05 RPT1-HEADER1.
77 10 FILLER PIC X(21) VALUE SPACES.
78 10 FILLER PIC X(111)
79 VALUE "REPORT OF PROJECTS AFFECTED BY RAISES".
80 05 RPT1-HEADER2.
81 10 FILLER PIC X(9) VALUE "PROJECT".
82 10 FILLER PIC X(10) VALUE "EMPID".
83 10 FILLER PIC X(35) VALUE "EMPLOYEE NAME".
84 10 FILLER PIC X(40) VALUE "SALARY".
85 01 RPT2-HEADERS.
86 05 RPT2-HEADER1.
87 10 FILLER PIC X(21) VALUE SPACES.
88 10 FILLER PIC X(111)
89 VALUE "ACCUMULATED STATISTICS BY PROJECT".
90 05 RPT2-HEADER2.
91 10 FILLER PIC X(9) VALUE "PROJECT".
92 10 FILLER PIC X(38) VALUE SPACES.
93 10 FILLER PIC X(16) VALUE "NUMBER OF".
94 10 FILLER PIC X(10) VALUE "TOTAL".
95 05 RPT2-HEADER3.
96 10 FILLER PIC X(9) VALUE "NUMBER".
97 10 FILLER PIC X(38) VALUE "PROJECT NAME".
98 10 FILLER PIC X(16) VALUE "EMPLOYEES".
99 10 FILLER PIC X(65) VALUE "COST".
100 01 RPT1-DATA.
101 05 PROJNO PIC X(6).
102 05 FILLER PIC XXX VALUE SPACES.
103 05 EMPNO PIC X(6).
104 05 FILLER PIC X(4) VALUE SPACES.
105 05 NAME PIC X(30).
106 05 FILLER PIC X(3) VALUE SPACES.
107 05 SALARY PIC ZZZZ9.99.
108 05 FILLER PIC X(96) VALUE SPACES.
109 01 RPT2-DATA.
110 05 PROJNO PIC X(6).
111 05 FILLER PIC XXX VALUE SPACES.
112 05 PROJECT-NAME PIC X(36).
113 05 FILLER PIC X(4) VALUE SPACES.
114 05 EMPLOYEE-COUNT PIC ZZZ9.
115 05 FILLER PIC X(5) VALUE SPACES.
116 05 TOTAL-PROJ-COST PIC ZZZZZZZ9.99.
117 05 FILLER PIC X(56) VALUE SPACES.
118

```

```

xxxxST1 VxRxMx yymmdd      Create SQL COBOL Program      CBLEX      08/06/07 11:09:13      Page 4
Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8      SEQNBR Last
change
119          PROCEDURE DIVISION.
120
121          A000-MAIN.
122              MOVE 1.04 TO PERCENTAGE.
123              OPEN OUTPUT PRINTFILE.
124
125          *****
126          * Update the selected employees by the new percentage. If an *
127          * error occurs during the update, roll back the changes, *
128          *****
129
130          3 EXEC SQL
131              WHENEVER SQLERROR GO TO E010-UPDATE-ERROR
132          END-EXEC.
133          4 EXEC SQL
134              UPDATE CORPDATA/EMPLOYEE
135              SET SALARY = SALARY * :PERCENTAGE
136              WHERE COMM >= :COMMISSION
137          END-EXEC.
138
139          *****
140          * Commit changes. *
141          *****
142
143          5 EXEC SQL
144              COMMIT
145          END-EXEC.
146
147          EXEC SQL
148              WHENEVER SQLERROR GO TO E020-REPORT-ERROR
149          END-EXEC.
150
151          *****
152          * Report the updated statistics for each employee receiving *
153          * a raise and the projects that the employee participates in *
154          *****
155
156          *****
157          * Write out the header for Report 1. *
158          *****
159
160              write print-record from rpt1-header1
161              before advancing 2 lines.
162              write print-record from rpt1-header2
163              before advancing 1 line.
164          6 exec sql
165              declare c1 cursor for
166              SELECT DISTINCT projno, empproject.empno,
167              lastname||", "||firstnme ,salary
168              from corpdata/empproject, corpdata/employee
169              where empproject.empno =employee.empno and
170              comm >= :commission
171              order by projno, empno
172          end-exec.
173          7 EXEC SQL
174              OPEN C1
175          END-EXEC.
176
177          PERFORM B000-GENERATE-REPORT1 THRU B010-GENERATE-REPORT1-EXIT
178          UNTIL SQLCODE NOT EQUAL TO ZERO.
179

```

```

xxxxST1 VxRxMx yymmdd      Create SQL COBOL Program      CBLEX      08/06/07 11:09:13  Page
5
Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8  SEQNBR Last
change
180      10 A100-DONE1.
181          EXEC SQL
182              CLOSE C1
183          END-EXEC.
184
185          *****
186          * For all projects ending at a date later than the RAISE- *
187          * DATE (that is, those projects potentially affected by the *
188          * salary raises), generate a report containing the project *
189          * number, project name, the count of employees *
190          * participating in the project, and the total salary cost *
191          * for the project. *
192          *****
193
194          *****
195          * Write out the header for Report 2. *
196          *****
197
198          MOVE SPACES TO PRINT-RECORD.
199          WRITE PRINT-RECORD BEFORE ADVANCING 2 LINES.
200          WRITE PRINT-RECORD FROM RPT2-HEADER1
201              BEFORE ADVANCING 2 LINES.
202          WRITE PRINT-RECORD FROM RPT2-HEADER2
203              BEFORE ADVANCING 1 LINE.
204          WRITE PRINT-RECORD FROM RPT2-HEADER3
205              BEFORE ADVANCING 2 LINES.
206
207          EXEC SQL
208              11 DECLARE C2 CURSOR FOR
209                  SELECT EMPPROJECT.PROJNO, PROJNAME, COUNT(*),
210                      SUM ( (DAYS(EMENDATE)-DAYS(EMSTDATE)) *
211                          EMPTIME * DECIMAL((SALARY / :WORK-DAYS),8,2))
212                  FROM CORPDATA/EMPPROJECT, CORPDATA/PROJECT,
213                      CORPDATA/EMPLOYEE
214                  WHERE EMPPROJECT.PROJNO=PROJECT.PROJNO AND
215                      EMPPROJECT.EMPNO =EMPLOYEE.EMPNO AND
216                      PRENDATE > :RAISE-DATE
217                  GROUP BY EMPPROJECT.PROJNO, PROJNAME
218                  ORDER BY 1
219          END-EXEC.
220          EXEC SQL
221              OPEN C2
222          END-EXEC.
223
224          PERFORM C000-GENERATE-REPORT2 THRU C010-GENERATE-REPORT2-EXIT
225              UNTIL SQLCODE NOT EQUAL TO ZERO.
226
227          A200-DONE2.
228          EXEC SQL
229              CLOSE C2
230          END-EXEC
231
232          *****
233          * All done. *
234          *****
235
236          A900-MAIN-EXIT.
237          CLOSE PRINTFILE.
238          STOP RUN.
239
240

```

```

xxxxST1 VxRxMx yymmdd          Create SQL COBOL Program          CBLEX          08/06/07 11:09:13
Page 6
Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8 SEQNBR Last
change
241 *****
242 * Fetch and write the rows to PRINTFILE. *
243 *****
244
245 B000-GENERATE-REPORT1.
246 8 EXEC SQL
247     WHENEVER NOT FOUND GO TO A100-DONE1
248     END-EXEC.
249 9 EXEC SQL
250     FETCH C1 INTO :PROJECT.PROJNO, :RPT1.EMPNO,
251     :RPT1.NAME, :RPT1.SALARY
252     END-EXEC.
253     MOVE CORRESPONDING RPT1 TO RPT1-DATA.
254     MOVE PROJNO OF RPT1 TO PROJNO OF RPT1-DATA.
255     WRITE PRINT-RECORD FROM RPT1-DATA
256     BEFORE ADVANCING 1 LINE.
257
258 B010-GENERATE-REPORT1-EXIT.
259     EXIT.
260
261 *****
262 * Fetch and write the rows to PRINTFILE. *
263 *****
264
265 C000-GENERATE-REPORT2.
266 EXEC SQL
267     WHENEVER NOT FOUND GO TO A200-DONE2
268     END-EXEC.
269 12 EXEC SQL
270     FETCH C2 INTO :RPT2
271     END-EXEC.
272     MOVE CORRESPONDING RPT2 TO RPT2-DATA.
273     WRITE PRINT-RECORD FROM RPT2-DATA
274     BEFORE ADVANCING 1 LINE.
275
276 C010-GENERATE-REPORT2-EXIT.
277     EXIT.
278
279 *****
280 * Error occurred while updating table. Inform user and *
281 * roll back changes. *
282 *****
283
284 E010-UPDATE-ERROR.
285 13 EXEC SQL
286     WHENEVER SQLERROR CONTINUE
287     END-EXEC.
288     MOVE SQLCODE TO CODE-EDIT.
289     STRING "*** ERROR Occurred while updating table. SQLCODE="
290     CODE-EDIT DELIMITED BY SIZE INTO PRINT-RECORD.
291     WRITE PRINT-RECORD.
292 14 EXEC SQL
293     ROLLBACK
294     END-EXEC.
295     STOP RUN.
296
297 *****
298 * Error occurred while generating reports. Inform user and *
299 * exit. *
300 *****
301
302 E020-REPORT-ERROR.
303     MOVE SQLCODE TO CODE-EDIT.
304     STRING "*** ERROR Occurred while generating reports. SQLCODE
305     "-" CODE-EDIT DELIMITED BY SIZE INTO PRINT-RECORD.
306     WRITE PRINT-RECORD.
307     STOP RUN.
308
309 * * * * * E N D O F S O U R C E * * * * *

```

```

xxxxST1 VxRxMx yymmdd      Create SQL COBOL Program      CBLEX      08/06/07 11:09:13
Page 7
CROSS REFERENCE
Data Names      Define      Reference
ACTNO           168      SMALL INTEGER PRECISION(4,0) COLUMN (NOT NULL) IN
CORPDATA.EMPPROJACT
A100-DONE1      ****      LABEL
                                         247
A200-DONE2      ****      LABEL
                                         267
BIRTHDATE      134      DATE(10) COLUMN IN CORPDATA.EMPLOYEEE
BONUS          134      DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEEE
CODE-EDIT      69
COMM           ****      COLUMN
                                         136 170
COMM           134      DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEEE
COMMISSION     43      DECIMAL(7,2)
                                         136 170
CORPDATA       ****      SCHEMA
                                         134 168 168 213 213 214
C1             165      CURSOR
                                         174 182 250
C2             209      CURSOR
                                         222 230 270
DEPTNO         50      CHARACTER(3) IN PROJECT
DEPTNO         213      CHARACTER(3) COLUMN (NOT NULL) IN CORPDATA.PROJECT
EDLEVEL        134      SMALL INTEGER PRECISION(4,0) COLUMN (NOT NULL) IN
CORPDATA.EMPLOYEEE
EMENDATE       168      DATE(10) COLUMN IN CORPDATA.EMPPROJACT
EMENDATE       ****      COLUMN
                                         211
EMPLOYEE       ****      TABLE IN CORPDATA
                                         134 168 214
EMPLOYEE       ****      TABLE
                                         169 216
EMPLOYEE-COUNT 63      SMALL INTEGER PRECISION(4,0) IN RPT2
EMPLOYEE-COUNT 114      IN RPT2-DATA
EMPNO          51      CHARACTER(6) IN RPT1
                                         250
EMPNO          103      CHARACTER(6) IN RPT1-DATA
EMPNO          134      CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEEE
EMPNO          ****      COLUMN IN EMPPROJACT
                                         166 169 171 216
EMPNO          ****      COLUMN IN EMPLOYEEE
                                         169 216
EMPNO          168      CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.EMPPROJACT
EMPPROJACT     ****      TABLE
                                         166 169 210 215 216 218
EMPPROJACT     ****      TABLE IN CORPDATA
                                         168 213
EMPTIME        168      DECIMAL(5,2) COLUMN IN CORPDATA.EMPPROJACT
EMPTIME        ****      COLUMN
                                         212
EMSTDATE       168      DATE(10) COLUMN IN CORPDATA.EMPPROJACT
EMSTDATE       ****      COLUMN
                                         211
E010-UPDATE-ERROR ****      LABEL
                                         131
E020-REPORT-ERROR ****      LABEL
                                         148
FIRSTNAME      134      VARCHAR(12) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEEE
FIRSTNAME      ****      COLUMN
                                         167
HIREDATE       134      DATE(10) COLUMN IN CORPDATA.EMPLOYEEE
JOB            134      CHARACTER(8) COLUMN IN CORPDATA.EMPLOYEEE
LASTNAME       134      VARCHAR(15) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEEE
LASTNAME       ****      COLUMN
                                         167
MAJPROJ        50      CHARACTER(6) IN PROJECT
MAJPROJ        213      CHARACTER(6) COLUMN IN CORPDATA.PROJECT
MIDINIT        134      CHARACTER(1) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEEE
NAME           52      CHARACTER(30) IN RPT1
                                         251
NAME           105      CHARACTER(30) IN RPT1-DATA

```

```

xxxxST1 VxRxMx yymmdd      Create SQL COBOL Program      CBLEX      08/06/07 11:09:13
Page 8
CROSS REFERENCE
PERCENTAGE                42      DECIMAL(5,2)
                               135
PHONENO                    134      CHARACTER(4) COLUMN IN CORPDATA.EMPLOYEE
PRENDATE                    50      DATE(10) IN PROJECT
PRENDATE                    ****      COLUMN
                               217
PRENDATE                    213      DATE(10) COLUMN IN CORPDATA.PROJECT
PRINT-RECORD                37      CHARACTER(132)
PROJECT                     50      STRUCTURE IN RPT1
PROJECT                     ****      TABLE IN CORPDATA
                               213
PROJECT                     ****      TABLE
                               215
PROJECT-NAME                 62      CHARACTER(36) IN RPT2
PROJECT-NAME                 112     CHARACTER(36) IN RPT2-DATA
PROJNAME                     50      VARCHAR(24) IN PROJECT
PROJNAME                     ****      COLUMN
                               210 218
PROJNAME                     213     VARCHAR(24) COLUMN (NOT NULL) IN CORPDATA.PROJECT
PROJNO                        50      CHARACTER(6) IN PROJECT
                               250
PROJNO                       61      CHARACTER(6) IN RPT2
PROJNO                       101     CHARACTER(6) IN RPT1-DATA
PROJNO                       110     CHARACTER(6) IN RPT2-DATA
PROJNO                       ****      COLUMN
                               166 171
PROJNO                       168     CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.EMPPROJACT
PROJNO                       ****      COLUMN IN EMPPROJACT
                               210 215 218
PROJNO                       ****      COLUMN IN PROJECT
                               215
PROJNO                       213     CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.PROJECT
PRSTAFF                      50      DECIMAL(5,2) IN PROJECT
PRSTAFF                      213     DECIMAL(5,2) COLUMN IN CORPDATA.PROJECT
PRSTDATE                     50      DATE(10) IN PROJECT
PRSTDATE                     213     DATE(10) COLUMN IN CORPDATA.PROJECT
RAISE-DATE                   41      CHARACTER(11)
                               217
RESPEMP                      50      CHARACTER(6) IN PROJECT
RESPEMP                      213     CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.PROJECT
RPT1                         49
RPT1-DATA                    100
RPT1-HEADERS                 75
RPT1-HEADER1                 76      IN RPT1-HEADERS
RPT1-HEADER2                 80      IN RPT1-HEADERS
RPT2                         60      STRUCTURE
                               270
RPT2-DATA                    109
SS REFERENCE
RPT2-HEADERS                 85
RPT2-HEADER1                 86      IN RPT2-HEADERS
RPT2-HEADER2                 90      IN RPT2-HEADERS
RPT2-HEADER3                 95      IN RPT2-HEADERS
SALARY                       53      DECIMAL(8,2) IN RPT1
                               251
SALARY                       107     IN RPT1-DATA
SALARY                       ****      COLUMN
                               135 135 167 212
SALARY                       134     DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
SEX                           134     CHARACTER(1) COLUMN IN CORPDATA.EMPLOYEE
TOTAL-PROJ-COST              64      DECIMAL(12,2) IN RPT2
TOTAL-PROJ-COST              116     IN RPT2-DATA
WORK-DAYS                    40      SMALL INTEGER PRECISION(4,0)
                               212
WORKDEPT                    134     CHARACTER(3) COLUMN IN CORPDATA.EMPLOYEE
No errors found in source
  307 Source records processed
* * * * * E N D O F L I S T I N G * * * * *

```

## Related concepts

### Coding SQL statements in COBOL applications

There are unique application and coding requirements for embedding SQL statements in a COBOL program. In this topic, requirements for host structures and host variables are defined.

## Example: SQL statements in PL/I programs

This example program is written in the PL/I programming language.

**Note:** By using the code examples, you agree to the terms of the [“Code license and disclaimer information”](#) on page 198.

```

xxxxST1 VxRxMx yymmdd   Create SQL PL/I Program           PLIEX           08/06/07 12:53:36
Page 1
Source type.....PLI
Program name.....CORPDATA/PLIEX
Source file.....CORPDATA/SRC
Member.....PLIEX
To source file.....QTEMP/QSQLTEMP
Options.....*SRC      *XREF
Target release.....VxRxMx
INCLUDE file.....*SRCFILE
Commit.....*CHG
Allow copy of data.....*YES
Close SQL cursor.....*ENDPGM
Allow blocking.....*READ
Delay PREPARE.....*NO
Generation level.....10
Margins.....*SRCFILE
Printer file.....*LIBL/QSYSPRT
Date format.....*JOB
Date separator.....*JOB
Time format.....*HMS
Time separator.....*JOB
Replace.....*YES
Relational database.....*LOCAL
User.....*CURRENT
RDB connect method.....*DUW
Default collection.....*NONE
Dynamic default
  collection.....*NO
Package name.....*PGMLIB/*PGM
Path.....*NAMING
SQL rules.....*DB2
User profile.....*NAMING
Dynamic user profile.....*USER
Sort sequence.....*JOB
Language ID.....*JOB
IBM SQL flagging.....*NOFLAG
ANS flagging.....*NONE
Text.....*SRCMBRTXT
Source file CCSID.....65535
Job CCSID.....65535
Decimal result options:
  Maximum precision.....31
  Maximum scale.....31
  Minimum divide scale...0
DECFLOAT rounding mode...*HALFEVEN
Compiler options.....*NONE
Source member changed on 07/01/96 12:53:08

```

Figure 5. Sample PL/I program using SQL statements

```

xxxxST1 VxRxMx yymmdd      Create SQL PL/I Program      PLIEX      08/06/07 12:53:36  Page
2
Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8 SEQNBR Last
change

1  /* A sample program that updates the salaries for those employees */      100
2  /* whose current commission total is greater than or equal to the */      200
3  /* value of COMMISSION. The salaries of those who qualify are */      300
4  /* increased by the value of PERCENTAGE, retroactive to RAISE_DATE. */      400
5  /* A report is generated showing the projects that these employees */      500
6  /* have contributed to, ordered by project number and employee ID. */      600
7  /* A second report shows each project having an end date occurring */      700
8  /* after RAISE_DATE (that is, those projects potentially affected */      800
9  /* by the retroactive raises) with its total salary expenses and a */      900
10 /* count of employees who contributed to the project. */      1000
11 /****** */      1100
12      1200
13      1300
14  PLIEX: PROC;      1400
15      1500
16      DCL RAISE_DATE CHAR(10);      1600
17      DCL WORK_DAYS FIXED BIN(15);      1700
18      DCL COMMISSION FIXED DECIMAL(8,2);      1800
19      DCL PERCENTAGE FIXED DECIMAL(5,2);      1900
20      2000
21      /* File declaration for sysprint */      2100
22      DCL SYSPRINT FILE EXTERNAL OUTPUT STREAM PRINT;      2200
23      2300
24      /* Structure for report 1 */      2400
25      DCL 1 RPT1,      2500
26  1%INCLUDE PROJECT (PROJECT, RECORD,,COMMA);      2600
27          15 EMPNO CHAR(6),      2700
28          15 NAME CHAR(30),      2800
29          15 SALARY FIXED DECIMAL(8,2);      2900
30      3000
31      /* Structure for report 2 */      3100
32      DCL 1 RPT2,      3200
33          15 PROJNO CHAR(6),      3300
34          15 PROJECT_NAME CHAR(36),      3400
35          15 EMPLOYEE_COUNT FIXED BIN(15),      3500
36          15 TOTL_PROJ_COST FIXED DECIMAL(10,2);      3600
37      3700
38  2 EXEC SQL INCLUDE SQLCA;      3800
39      3900
40      COMMISSION = 2000.00;      4000
41      PERCENTAGE = 1.04;      4100
42      RAISE_DATE = '1982-06-01';      4200
43      WORK_DAYS = 253;      4300
44      OPEN FILE(SYSPRINT);      4400
45      4500
46      /* Update the selected employees' salaries by the new percentage. */      4600
47      /* If an error occurs during the update, roll back the changes. */      4700
48  3 EXEC SQL WHENEVER SQLERROR GO TO UPDATE_ERROR;      4800
49  4 EXEC SQL      4900
50      UPDATE CORPDATA/EMPLOYEE      5000
51          SET SALARY = SALARY * :PERCENTAGE      5100
52          WHERE COMM >= :COMMISSION ;      5200
53      5300
54      /* Commit changes */      5400
55  5 EXEC SQL      5500
56      COMMIT;      5600
57      EXEC SQL WHENEVER SQLERROR GO TO REPORT_ERROR;      5700
58      5800

```

xxxxST1	VxRxMx	yymmdd	Create SQL PL/I Program	PLIEX	08/06/07 12:53:36	Page 3				
Record	*...+... 1	...+... 2	...+... 3	...+... 4	...+... 5	...+... 6	...+... 7	...+... 8	SEQNBR	Last
change										
59			/* Report the updated statistics for each project supported by one */						5900	
60			/* of the selected employees. */						6000	
61									6100	
62			/* Write out the header for Report 1 */						6200	
63			put file(sysprint)						6300	
64			edit('REPORT OF PROJECTS AFFECTED BY EMPLOYEE RAISES')						6400	
65			(col(22),a);						6500	
66			put file(sysprint)						6600	
67			edit('PROJECT','EMPID','EMPLOYEE NAME','SALARY')						6700	
68			(skip(2),col(1),a,col(10),a,col(20),a,col(55),a);						6800	
69									6900	
70	6	exec	sql						7000	
71			declare c1 cursor for						7100	
72			select DISTINCT projno, EMPPROJECT.empno,						7200	
73			lastname  ', '  firstnme, salary						7300	
74			from CORPDATA/EMPPROJECT, CORPDATA/EMPLOYEE						7400	
75			where EMPPROJECT.empno = EMPLOYEE.empno and						7500	
76			comm >= :COMMISSION						7600	
77			order by projno, empno;						7700	
78	7	EXEC	SQL						7800	
79			OPEN C1;						7900	
80									8000	
81			/* Fetch and write the rows to SYSPRINT */						8100	
82	8	EXEC	SQL WHENEVER NOT FOUND GO TO DONE1;						8200	
83									8300	
84			DO UNTIL (SQLCODE ^= 0);						8400	
85	9	EXEC	SQL						8500	
86			FETCH C1 INTO :RPT1.PROJNO, :rpt1.EMPNO, :RPT1.NAME,						8600	
87			:RPT1.SALARY;						8700	
88			PUT FILE(SYSPRINT)						8800	
89			EDIT(RPT1.PROJNO,RPT1.EMPNO,RPT1.NAME,RPT1.SALARY)						8900	
90			(SKIP,COL(1),A,COL(10),A,COL(20),A,COL(54),F(8,2));						9000	
91			END;						9100	
92									9200	
93			DONE1:						9300	
94	10	EXEC	SQL						9400	
95			CLOSE C1;						9500	
96									9600	
97			/* For all projects ending at a date later than 'raise_date' */						9700	
98			/* (that is, those projects potentially affected by the salary */						9800	
99			/* raises), generate a report containing the project number, */						9900	
100			/* project name, the count of employees participating in the */						10000	
101			/* project, and the total salary cost of the project. */						10100	
102									10200	
103			/* Write out the header for Report 2 */						10300	
104			PUT FILE(SYSPRINT) EDIT('ACCUMULATED STATISTICS BY PROJECT')						10400	
105			(SKIP(3),COL(22),A);						10500	
106			PUT FILE(SYSPRINT)						10600	
107			EDIT('PROJECT','NUMBER OF','TOTAL')						10700	
108			(SKIP(2),COL(1),A,COL(48),A,COL(63),A);						10800	
109			PUT FILE(SYSPRINT)						10900	
110			EDIT('NUMBER','PROJECT NAME','EMPLOYEES','COST')						11000	
111			(SKIP,COL(1),A,COL(10),A,COL(48),A,COL(63),A,SKIP);						11100	
112									11200	

```

xxxxST1 VxRxMx yymmdd          Create SQL PL/I Program          PLIEX          08/06/07 12:53:36
Page      4
Record   *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8 SEQNBR Last
change
113 11 EXEC SQL                                                    11300
114     DECLARE C2 CURSOR FOR                                       11400
115         SELECT EMPPROJECT.PROJNO, PROJNAME, COUNT(*),           11500
116             SUM( (DAYS(EMENDATE) - DAYS(EMSTDATE)) * EMPTIME *   11600
117                 DECIMAL(( SALARY / :WORK_DAYS ),8,2) )           11700
118         FROM CORPDATA/EMPPROJECT, CORPDATA/PROJECT, CORPDATA/EMPLOYEE 11800
119         WHERE EMPPROJECT.PROJNO=PROJECT.PROJNO AND               11900
120             EMPPROJECT.EMPNO =EMPLOYEE.EMPNO AND                12000
121             PRENDATE > :RAISE_DATE                               12100
122         GROUP BY EMPPROJECT.PROJNO, PROJNAME                     12200
123         ORDER BY 1;                                              12300
124     EXEC SQL                                                    12400
125         OPEN C2;                                                 12500
126                                                                12600
127         /* Fetch and write the rows to SYSPRINT */              12700
128         EXEC SQL WHENEVER NOT FOUND GO TO DONE2;                 12800
129                                                                12900
130         DO UNTIL (SQLCODE ^= 0);                                  13000
131     12 EXEC SQL                                                  13100
132         FETCH C2 INTO :RPT2;                                       13200
133         PUT FILE(SYSPRINT)                                         13300
134             EDIT(RPT2.PROJNO,RPT2.PROJECT_NAME,EMPLOYEE_COUNT,    13400
135                 TOTL_PROJ_COST)                                    13500
136                 (SKIP,COL(1),A,COL(10),A,COL(50),F(4),COL(62),F(8,2)); 13600
137         END;                                                       13700
138                                                                13800
139     DONE2:                                                         13900
140     EXEC SQL                                                    14000
141         CLOSE C2;                                                 14100
142         GO TO FINISHED;                                           14200
143                                                                14300
144         /* Error occurred while updating table. Inform user and roll back */ 14400
145         /* changes.                                              */ 14500
146     UPDATE_ERROR:                                                14600
147     13 EXEC SQL WHENEVER SQLERROR CONTINUE;                       14700
148         PUT FILE(SYSPRINT) EDIT('*** ERROR Occurred while updating table.'|| 14800
149             ' SQLCODE=',SQLCODE)(A,F(5));                          14900
150     14 EXEC SQL                                                  15000
151         ROLLBACK;                                                 15100
152         GO TO FINISHED;                                           15200
153                                                                15300
154         /* Error occurred while generating reports. Inform user and exit. */ 15400
155     REPORT_ERROR:                                                15500
156         PUT FILE(SYSPRINT) EDIT('*** ERROR Occurred while generating '|| 15600
157             'reports. SQLCODE=',SQLCODE)(A,F(5));                  15700
158         GO TO FINISHED;                                           15800
159                                                                15900
160         /* All done */                                           16000
161     FINISHED:                                                     16100
162         CLOSE FILE(SYSPRINT);                                     16200
163         RETURN;                                                  16300
164                                                                16400
165     END PLIEX;                                                    16500
                                     * * * * * E N D O F S O U R C E * * * * *

```

## CROSS REFERENCE

## Data Names

	Define	Reference
ACTNO	74	SMALL INTEGER PRECISION(4,0) COLUMN (NOT NULL) IN
CORPDATA.EMPPROJECT		
BIRTHDATE	74	DATE(10) COLUMN IN CORPDATA.EMPLOYEE
BONUS	74	DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
COMM	****	COLUMN
		52 76
COMM	74	DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
COMMISSION	18	DECIMAL(8,2)
		52 76
CORPDATA	****	SCHEMA
		50 74 74 118 118 118
C1	71	CURSOR
		79 86 95
C2	114	CURSOR
		125 132 141
DEPTNO	26	CHARACTER(3) IN RPT1
DEPTNO	118	CHARACTER(3) COLUMN (NOT NULL) IN CORPDATA.PROJECT
DONE1	****	LABEL
		82
DONE2	****	LABEL
		128
EDLEVEL	74	SMALL INTEGER PRECISION(4,0) COLUMN (NOT NULL) IN
CORPDATA.EMPLOYEE		
EMENDATE	74	DATE(10) COLUMN IN CORPDATA.EMPPROJECT
EMENDATE	****	COLUMN
		116
EMPLOYEE	****	TABLE IN CORPDATA
		50 74 118
EMPLOYEE	****	TABLE
		75 120
EMPLOYEE_COUNT	35	SMALL INTEGER PRECISION(4,0) IN RPT2
EMPNO	27	CHARACTER(6) IN RPT1
		86
EMPNO	****	COLUMN IN EMPPROJECT
		72 75 77 120
EMPNO	****	COLUMN IN EMPLOYEE
		75 120
EMPNO	74	CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.EMPPROJECT
EMPNO	74	CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
EMPPROJECT	****	TABLE
		72 75 115 119 120 122
EMPPROJECT	****	TABLE IN CORPDATA
		74 118
EMPTIME	74	DECIMAL(5,2) COLUMN IN CORPDATA.EMPPROJECT
EMPTIME	****	COLUMN
		116
EMSTDATE	74	DATE(10) COLUMN IN CORPDATA.EMPPROJECT
EMSTDATE	****	COLUMN
		116
FIRSTNME	****	COLUMN
		73
FIRSTNME	74	VARCHAR(12) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
HIREDATE	74	DATE(10) COLUMN IN CORPDATA.EMPLOYEE
JOB	74	CHARACTER(8) COLUMN IN CORPDATA.EMPLOYEE
LASTNAME	****	COLUMN
		73
LASTNAME	74	VARCHAR(15) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
MAJPROJ	26	CHARACTER(6) IN RPT1
MAJPROJ	118	CHARACTER(6) COLUMN IN CORPDATA.PROJECT
MIDINIT	74	CHARACTER(1) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
NAME	28	CHARACTER(30) IN RPT1
		86
PERCENTAGE	19	DECIMAL(5,2)
		51
PHONENO	74	CHARACTER(4) COLUMN IN CORPDATA.EMPLOYEE

```

xxxxST1 VxRxMx yymmdd          Create SQL PL/I Program          PLIEX          08/06/07 12:53:36
Page 6
CROSS REFERENCE
PRENDATE          26          DATE(10) IN RPT1
PRENDATE          ****          COLUMN
                                121
PRENDATE          118          DATE(10) COLUMN IN CORPDATA.PROJECT
PROJECT           ****          TABLE IN CORPDATA
                                118
PROJECT           ****          TABLE
                                119
PROJECT_NAME      34          CHARACTER(36) IN RPT2
PROJNAME          26          VARCHAR(24) IN RPT1
PROJNAME          ****          COLUMN
                                115 122
PROJNAME          118          VARCHAR(24) COLUMN (NOT NULL) IN CORPDATA.PROJECT
PROJNO           26          CHARACTER(6) IN RPT1
                                86
PROJNO           33          CHARACTER(6) IN RPT2
PROJNO           ****          COLUMN
                                72 77
PROJNO           74          CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.EMPPROJECT
PROJNO           ****          COLUMN IN EMPPROJECT
                                115 119 122
PROJNO           ****          COLUMN IN PROJECT
                                119
PROJNO           118          CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.PROJECT
PRSTAFF          26          DECIMAL(5,2) IN RPT1
PRSTAFF          118          DECIMAL(5,2) COLUMN IN CORPDATA.PROJECT
PRSTDATE         26          DATE(10) IN RPT1
PRSTDATE         118          DATE(10) COLUMN IN CORPDATA.PROJECT
RAISE_DATE       16          CHARACTER(10)
                                121
REPORT_ERROR     ****          LABEL
                                57
RESPEMP          26          CHARACTER(6) IN RPT1
RESPEMP          118          CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.PROJECT
RPT1             25          STRUCTURE
RPT2             32          STRUCTURE
                                132
SALARY           29          DECIMAL(8,2) IN RPT1
                                87
SALARY           ****          COLUMN
                                51 51 73 117
SALARY           74          DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
SEX              74          CHARACTER(1) COLUMN IN CORPDATA.EMPLOYEE
SYSPRINT         22
TOTL_PROJ_COST   36          DECIMAL(10,2) IN RPT2
UPDATE_ERROR     ****          LABEL
                                48
WORK_DAYS        17          SMALL INTEGER PRECISION(4,0)
                                117
WORKDEPT         74          CHARACTER(3) COLUMN IN CORPDATA.EMPLOYEE
No errors found in source
165 Source records processed
* * * * * E N D O F L I S T I N G * * * * *

```

## Related concepts

### Coding SQL statements in PL/I applications

There are some unique application and coding requirements for embedding SQL statements in a PL/I program. In this topic, requirements for host structures and host variables are defined.

## Example: SQL statements in RPG/400 programs

This example program is written in the RPG programming language.

**Note:** By using the code examples, you agree to the terms of the [“Code license and disclaimer information”](#) on page 198.

```

xxxxST1 VxRxMx yymmdd      Create SQL RPG Program      RPGEX      08/06/07 12:55:22
Page 1
Source type.....RPG
Program name.....CORPDATA/RPGEX
Source file.....CORPDATA/SRC
Member.....RPGEX
To source file.....QTEMP/QSQLTEMP
Options.....*SRC      *XREF
Target release.....VxRxMx
INCLUDE file.....*SRCFILE
Commit.....*CHG
Allow copy of data.....*YES
Close SQL cursor.....*ENDPGM
Allow blocking.....*READ
Delay PREPARE.....*NO
Generation level.....10
Printer file.....*LIBL/QSYSVRT
Date format.....*JOB
Date separator.....*JOB
Time format.....*HMS
Time separator.....*JOB
Replace.....*YES
Relational database.....*LOCAL
User.....*CURRENT
RDB connect method.....*DUW
Default collection.....*NONE
Dynamic default
collection.....*NO
Package name.....*PGMLIB/*PGM
Path.....*NAMING
SQL rules.....*DB2
User profile.....*NAMING
Dynamic user profile.....*USER
Sort sequence.....*JOB
Language ID.....*JOB
IBM SQL flagging.....*NOFLAG
ANS flagging.....*NONE
Text.....*SRCMBRTXT
Source file CCSID.....65535
Job CCSID.....65535
Decimal result options:
  Maximum precision.....31
  Maximum scale.....31
  Minimum divide scale...0
DECFLOAT rounding mode...*HALFEVEN
Compiler options.....*NONE
Source member changed on 07/01/96 17:06:17

```

Figure 6. Sample RPG/400 program using SQL statements

```

xxxxST1 VxRxMx yymmdd      Create SQL RPG Program      RPGEX      08/06/07 12:55:22
Page      2
Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8 SEQNBR Last
change
1      H      100
2      F* File declaration for QPRINT      200
3      F*      300
4      FQPRINT 0 F 132      PRINTER      400
5      I*      500
6      I* Structure for report 1.      600
7      I*      700
8      1 IRPT1 E DSPROJECT      800
9      I      PROJNAME      PROJNM      900
10     I      RESPEMP      RESEM      1000
11     I      PRSTAFF      STAFF      1100
12     I      PRSTDATE      PRSTD      1200
13     I      PRENDATE      PREND      1300
14     I      MAJPROJ      MAJPRJ      1400
15     I*      1500
16     I      DS      1600
17     I      1 6 EMPNO      1700
18     I      7 36 NAME      1800
19     I      P 37 412SALARY      1900
20     I*      2000
21     I* Structure for report 2.      2100
22     I*      2200
23     IRPT2 DS      2300
24     I      1 6 PRJNUM      2400
25     I      7 42 PNAME      2500
26     I      B 43 440EMPCNT      2600
27     I      P 45 492PRCOST      2700
28     I*      2800
29     I      DS      2900
30     I      B 1 20WRKDAY      3000
31     I      P 3 62COMMI      3100
32     I      7 16 RDATE      3200
33     I      P 17 202PERCNT      3300
34     2 C*      3400
35     C      Z-ADD253      WRKDAY      3500
36     C      Z-ADD2000.00      COMMI      3600
37     C      Z-ADD1.04      PERCNT      3700
38     C      MOVE1 '1982-06-' RDATE      3800
39     C      MOVE '01'      RDATE      3900
40     C      SETON      LR      3901
41     C*      4000
42     C* Update the selected projects by the new percentage. If an      4100
43     C* error occurs during the update, roll back the changes.      4200
44     C*      4300
45     3 C/EXEC SQL WHENEVER SQLERROR GOTO UPDERR      4400
46     C/END-EXEC      4500
47     C*      4600
48     4 C/EXEC SQL      4700
49     C+ UPDATE CORPDATA/EMPLOYEE      4800
50     C+ SET SALARY = SALARY * :PERCNT      4900
51     C+ WHERE COMM >= :COMMI      5000
52     C/END-EXEC      5100
53     C*      5200
54     C* Commit changes.      5300
55     C*      5400
56     5 C/EXEC SQL COMMIT      5500
57     C/END-EXEC      5600
58     C*      5700
59     C/EXEC SQL WHENEVER SQLERROR GO TO RPTErr      5800
60     C/END-EXEC      5900

```

```

xxxxST1 VxRxMx yymmdd          Create SQL RPG Program          RPGEX          08/06/07 12:55:22  Page
3
Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8 SEQNBR Last
change
61      C*                               6000
62      C* Report the updated statistics for each employee assigned to 6100
63      C* selected projects. 6200
64      C*                               6300
65      C* Write out the header for report 1. 6400
66      C*                               6500
67      C          EXCPTRECA 6600
68      6 C/EXEC SQL DECLARE C1 CURSOR FOR 6700
69      C+   SELECT DISTINCT PROJNO, EMPPROJACT.EMPNO, 6800
70      C+   LASTNAME||', '||FIRSTNAME, SALARY 6900
71      C+   FROM CORPDATA/EMPPROJACT, CORPDATA/EMPLOYEE 7000
72      C+   WHERE EMPPROJACT.EMPNO = EMPLOYEE.EMPNO AND 7100
73      C+   COMM >= :COMMI 7200
74      C+   ORDER BY PROJNO, EMPNO 7300
75      C/END-EXEC 7400
76      C*                               7500
77      7 C/EXEC SQL 7600
78      C+   OPEN C1 7700
79      C/END-EXEC 7800
80      C*                               7900
81      C* Fetch and write the rows to QPRINT. 8000
82      C*                               8100
83      8 C/EXEC SQL WHENEVER NOT FOUND GO TO DONE1 8200
84      C/END-EXEC 8300
85      C          SQLCOD      DOUNE0 8400
86      C/EXEC SQL 8500
87      9 C+   FETCH C1 INTO :PROJNO, :EMPNO, :NAME, :SALARY 8600
88      C/END-EXEC 8700
89      C          EXCPTRECB 8800
90      C          END 8900
91      C          DONE1      TAG 9000
92      C/EXEC SQL 9100
93      10 C+   CLOSE C1 9200
94      C/END-EXEC 9300
95      C*                               9400
96      C* For all project ending at a date later than the raise date 9500
97      C* (that is, those projects potentially affected by the salary raises), 9600
98      C* generate a report containing the project number, project name, 9700
99      C* the count of employees participating in the project, and the 9800
100     C* total salary cost of the project. 9900
101     C*                               10000
102     C* Write out the header for report 2. 10100
103     C*                               10200
104     C          EXCPTRECC 10300
105     11 C/EXEC SQL 10400
106     C+   DECLARE C2 CURSOR FOR 10500
107     C+   SELECT EMPPROJACT.PROJNO, PROJNAME, COUNT(*), 10600
108     C+   SUM((DAYS(EMENDATE) - DAYS(EMSTDATE)) * EMPTIME * 10700
109     C+   DECIMAL((SALARY/:WRKDAY),8,2)) 10800
110     C+   FROM CORPDATA/EMPPROJACT, CORPDATA/PROJECT, CORPDATA/EMPLOYEE 10900
111     C+   WHERE EMPPROJACT.PROJNO = PROJECT.PROJNO AND 11000
112     C+   EMPPROJACT.EMPNO = EMPLOYEE.EMPNO AND 11100
113     C+   PRENDATE > :RDATE 11200
114     C+   GROUP BY EMPPROJACT.PROJNO, PROJNAME 11300
115     C+   ORDER BY 1 11400
116     C/END-EXEC 11500
117     C*                               11600
118     C/EXEC SQL OPEN C2 11700
119     C/END-EXEC 11800
120     C*                               11900
121     C* Fetch and write the rows to QPRINT. 12000
122     C*                               12100
123     C/EXEC SQL WHENEVER NOT FOUND GO TO DONE2 12200
124     C/END-EXEC 12300

```

```

xxxxST1 VxRxMx yymmdd Create SQL RPG Program          RPGEX          08/06/07 12:55:22 Page 4
125      C          SQLCOD      DOUNE0                      12400
126      C/EXEC SQL                                12500
127      12 C+   FETCH C2 INTO :RPT2                      12600
128      C/END-EXEC                                12700
129      C          EXCPTRECD                      12800
130      C          END                                12900
131      C          DONE2      TAG                      13000
132      C/EXEC SQL CLOSE C2                          13100
133      C/END-EXEC                                13200
134      C          RETRN                              13300
135      C*                                           13400
136      C* Error occurred while updating table. Inform user and roll back 13500
137      C* changes.                                  13600
138      C*                                           13700
139      C          UPDERR      TAG                      13800
140      C          EXCPTRECE                      13900
141      13 C/EXEC SQL WHENEVER SQLERROR CONTINUE      14000
142      C/END-EXEC                                14100
143      C*                                           14200
144      14 C/EXEC SQL                                14300
145      C+   ROLLBACK                                14400
146      C/END-EXEC                                14500
147      C          RETRN                              14600
148      C*                                           14700
149      C* Error occurred while generating reports. Inform user and exit. 14800
150      C*                                           14900
151      C          RPTERR      TAG                      15000
152      C          EXCPTRECF                      15100
153      C*                                           15200
154      C* All done.                                  15300
155      C*                                           15400
156      C          FINISH      TAG                      15500
157      OQPRINT E 0201          RECA                  15700
158      0          45 'REPORT OF PROJECTS AFFEC'          15800
159      0          64 'TED BY EMPLOYEE RAISES'          15900
160      0          E 01          RECA                  16000
161      0          7 'PROJECT'                          16100
162      0          17 'EMPLOYEE'                        16200
163      0          32 'EMPLOYEE NAME'                   16300
164      0          60 'SALARY'                          16400
165      0          E 01          RECB                  16500
166      0          PROJNO      6                      16600
167      0          EMPNO       15                     16700
168      0          NAME        50                     16800
169      0          SALARYL     61                     16900
170      0          E 22          RECC                  17000
171      0          42 'ACCUMULATED STATISTIC'           17100
172      0          54 'S BY PROJECT'                   17200
173      0          E 01          RECC                  17300
174      0          7 'PROJECT'                          17400
175      0          56 'NUMBER OF'                      17500
176      0          67 'TOTAL'                          17600
177      0          E 02          RECC                  17700
178      0          6 'NUMBER'                          17800
179      0          21 'PROJECT NAME'                   17900
180      0          56 'EMPLOYEES'                     18000
181      0          66 'COST'                           18100
182      0          E 01          RECD                  18200
183      0          PRJNUM      6                      18300
184      0          PNAME       45                     18400
185      0          EMPCNTL     54                     18500
186      0          PRCOSTL     70                     18600
187      0          E 01          RECE                  18700
188      0          28 '*** ERROR Occurred while'       18800
189      0          52 ' updating table. SQLCODE'       18900
190      0          53 '='                               19000
191      0          SQLCODL     62                     19100
192      0          E 01          RECF                  19200
193      0          28 '*** ERROR Occurred while'       19300
194      0          52 ' generating reports. SQL'       19400
195      0          57 'CODE='                          19500
196      0          SQLCODL     67                     19600
          * * * * * E N D   O F   S O U R C E   * * * * *

```

```

xxxxST1 VxRxMx yymmdd      Create SQL RPG Program          RPGEX          08/06/07 12:55:22  Page
5
CROSS REFERENCE
Data Names                Define  Reference
ACTNO                     68      SMALL INTEGER PRECISION(4,0) COLUMN (NOT NULL) IN
CORPDATA.EMPPROJECT
BIRTHDATE                 48      DATE(10) COLUMN IN CORPDATA.EMPLOYEE
BONUS                     48      DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
COMM                      ****
                        48 68
COMM                      48      DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
COMMI                     31      DECIMAL(7,2)
                        48 68
CORPDATA                  ****
                        SCHEMA
                        48 68 68 105 105 105
C1                         68      CURSOR
                        77 86 92
C2                         105     CURSOR
                        118 126 132
DEPTNO                    8       CHARACTER(3) IN RPT1
DEPTNO                    105     CHARACTER(3) COLUMN (NOT NULL) IN CORPDATA.PROJECT
DONE1                     91      LABEL
                        83
DONE2                     131     LABEL
                        123
EDLEVEL                   48      SMALL INTEGER PRECISION(4,0) COLUMN (NOT NULL) IN
CORPDATA.EMPLOYEE
EMENDATE                  68      DATE(10) COLUMN IN CORPDATA.EMPPROJECT
EMENDATE                  ****
                        COLUMN
                        105
EMPCNT                    26      SMALL INTEGER PRECISION(4,0) IN RPT2
EMPLOYEE                  ****
                        TABLE IN CORPDATA
                        48 68 105
EMPLOYEE                  ****
                        TABLE
                        68 105
EMPNO                     17      CHARACTER(6)
                        86
EMPNO                     48      CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
EMPNO                     ****
                        COLUMN IN EMPPROJECT
                        68 68 68 105
EMPNO                     ****
                        COLUMN IN EMPLOYEE
                        68 105
EMPNO                     68      CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.EMPPROJECT
EMPPROJECT               ****
                        TABLE
                        68 68 105 105 105 105
EMPPROJECT               ****
                        TABLE IN CORPDATA
                        68 105
EMPTIME                   68      DECIMAL(5,2) COLUMN IN CORPDATA.EMPPROJECT
EMPTIME                   ****
                        COLUMN
                        105
EMSTDATE                  68      DATE(10) COLUMN IN CORPDATA.EMPPROJECT
EMSTDATE                  ****
                        COLUMN
                        105
FINISH                    156     LABEL
FIRSTNME                  48      VARCHAR(12) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
FIRSTNME                  ****
                        COLUMN
                        68
HIREDATE                  48      DATE(10) COLUMN IN CORPDATA.EMPLOYEE
JOB                        48      CHARACTER(8) COLUMN IN CORPDATA.EMPLOYEE
LASTNAME                  48      VARCHAR(15) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
LASTNAME                  ****
                        COLUMN
                        68
MAJPRJ                    8       CHARACTER(6) IN RPT1
MAJPROJ                   105     CHARACTER(6) COLUMN IN CORPDATA.PROJECT
MIDINIT                   48      CHARACTER(1) COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
NAME                      18      CHARACTER(30)
                        86
PERCNT                    33      DECIMAL(7,2)
                        48
PHONENO                   48      CHARACTER(4) COLUMN IN CORPDATA.EMPLOYEE
PNAME                     25      CHARACTER(36) IN RPT2
PRCOST                    27      DECIMAL(9,2) IN RPT2
PREND                     8       DATE(10) IN RPT1
PRENDATE                  ****
                        COLUMN
                        105

```

```

xxxxST1 VxRxMx yymmdd          Create SQL RPG Program          RPGEX          08/06/07 12:55:22
Page 6
PRENDATE          105          DATE(10) COLUMN IN CORPDATA.PROJECT
PRJNUM           24          CHARACTER(6) IN RPT2
CROSS REFERENCE
PROJECT          ****          TABLE IN CORPDATA
                                105
PROJECT          ****          TABLE
                                105
PROJNAME         ****          COLUMN
                                105 105
PROJNAME         105          VARCHAR(24) COLUMN (NOT NULL) IN CORPDATA.PROJECT
PROJNM           8          VARCHAR(24) IN RPT1
PROJNO           8          CHARACTER(6) IN RPT1
                                86
PROJNO           ****          COLUMN
                                68 68
PROJNO           68          CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.EMPPROJECT
PROJNO           ****          COLUMN IN EMPPROJECT
                                105 105 105
PROJNO           ****          COLUMN IN PROJECT
                                105
PROJNO           105          CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.PROJECT
PRSTAFF          105          DECIMAL(5,2) COLUMN IN CORPDATA.PROJECT
PRSTD            8          DATE(10) IN RPT1
PRSTDATE         105          DATE(10) COLUMN IN CORPDATA.PROJECT
RDATE            32          CHARACTER(10)
                                105
RESEM            8          CHARACTER(6) IN RPT1
RESPEMP          105          CHARACTER(6) COLUMN (NOT NULL) IN CORPDATA.PROJECT
RPTERR           151          LABEL
                                59
RPT1             8          STRUCTURE
RPT2             23          STRUCTURE
                                126
SALARY           19          DECIMAL(9,2)
                                86
SALARY           ****          COLUMN
                                48 48 68 105
SALARY           48          DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
SEX              48          CHARACTER(1) COLUMN IN CORPDATA.EMPLOYEE
STAFF            8          DECIMAL(5,2) IN RPT1
UPDERR           139          LABEL
                                45
WORKDEPT         48          CHARACTER(3) COLUMN IN CORPDATA.EMPLOYEE
WRKDAY           30          SMALL INTEGER PRECISION(4,0)
                                105
No errors found in source
  196 Source records processed
          * * * * * E N D O F L I S T I N G * * * * *

```

## Related concepts

[Coding SQL statements in RPG/400 applications](#)

The RPG/400 licensed program supports both RPG II and RPG III programs.

## Example: SQL statements in ILE RPG programs

This example program is written in the ILE RPG programming language.

**Note:** By using the code examples, you agree to the terms of the [“Code license and disclaimer information”](#) on page 198.

```

xxxxST1 VxRxMx yymmdd          Create SQL ILE RPG Object          RPGLEEX          11/11/13
11:23:30          Page          1
Source type.....RPG
Object name.....CORPDATA/RPGLEEX
Source file.....CORPDATA/SRC
Member.....*OBJ
To source file.....QTEMP/QSQLTEMP1
Options.....*XREF
RPG preprocessor options..*NONE
Listing option.....*PRINT
Target release.....VxRxMx
INCLUDE file.....*SRCFILE
Commit.....*CHG
Allow copy of data.....*OPTIMIZE
Close SQL cursor.....*ENDMOD
Allow blocking.....*ALLREAD
Delay PREPARE.....*NO
Concurrent access
  resolution.....*DFT
Generation level.....10
Printer file.....*LIBL/QSYSPRT
Date format.....*JOB
Date separator.....*JOB
Time format.....*HMS
Time separator.....*JOB
Replace.....*YES
Relational database.....*LOCAL
User.....*CURRENT
RDB connect method.....*DUW
Default collection.....*NONE
Dynamic default
  collection.....*NO
Package name.....*OBJLIB/*OBJ
Path.....*NAMING
SQL rules.....*DB2
Created object type.....*PGM
Debugging view.....*NONE
Debugging encryption key..*NONE
User profile.....*NAMING
Dynamic user profile.....*USER
Sort sequence.....*JOB
Language ID.....*JOB
IBM SQL flagging.....*NOFLAG
ANS flagging.....*NONE
Text.....*SRCMBRTXT
Source file CCSID.....37
Job CCSID.....37
Decimal result options:
  Maximum precision.....31
  Maximum scale.....31
  Minimum divide scale...0
DECFLOAT rounding mode...*HALFEVEN
Compiler options.....*NONE

```

Figure 7. Sample ILE RPG program using SQL statements

```

Source member changed on 11/11/13 11:20:02
xxxxST1 VxRmMx yymmdd Create SQL ILE RPG Object RPLLEEX 11/11/13
11:23:30 Page 2
Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8 SEQNBR Last
change Comments
1 CTL-OPT; 000100
2 // File declaration for QPRINT 000200
3 // 000300
4 DCL-F QPRINT PRINTER(132) USAGE(*OUTPUT); 000400
5 // 000500
6 // Structure for report 1. 000600
7 // 000700
8 1 DCL-DS RPT1 EXT EXTNAME('CORPDATA/PROJECT'); 000800
9 END-DS; 000900
10 // 001000
11 DCL-DS *N; 001100
12 EMPNO CHAR(6); 001200
13 NAME CHAR(30); 001300
14 SALARY PACKED(9:2); 001400
15 END-DS; 001500
16 // 001600
17 // Structure for report 2. 001700
18 // 001800
19 DCL-DS RPT2; 001900
20 PRJNUM CHAR(6); 002000
21 PNAME CHAR(36); 002100
22 EMPCNT BINDEC(4:0); 002200
23 PRCOST PACKED(9:2); 002300
24 END-DS; 002400
25 // 002500
26 DCL-DS *N; 002600
27 WRKDAY BINDEC(4:0); 002700
28 COMMI PACKED(7:2); 002800
29 RDATE CHAR(10); 002900
30 PERCNT PACKED(7:2); 003000
31 END-DS; 003100
32 // 003200
33 2 WRKDAY = 253; 003300
34 COMMI = 2000.00; 003400
35 PERCNT = 1.04; 003500
36 RDATE = '1982-06-01'; 003600
37 // 003700
38 // Update the selected projects by the new percentage. If an 003800
39 // error occurs during the update, roll back the changes. 003900
40 // 004000
41 3 EXEC SQL WHENEVER SQLERROR GOTO UPDERR; 004100
42 // 004200
43 EXEC SQL 004300
44 4 UPDATE CORPDATA/EMPLOYEE 004400
45 SET SALARY = SALARY * :PERCNT 004500
46 WHERE COMM >= :COMMI; 004600
47 // 004700
48 // Commit changes. 004800
49 // 004900
50 5 EXEC SQL COMMIT; 005000
51 // 005100
52 EXEC SQL WHENEVER SQLERROR GO TO RPTERR; 005200
53 // 005300
54 // Report the updated statistics for each employee assigned to 005400
55 // selected projects. 005500
56 // 005600
57 // Write out the header for report 1. 005700
58 // 005800
59 EXCEPT RECA; 005900
60 6 EXEC SQL DECLARE C1 CURSOR FOR 006000
61 SELECT DISTINCT PROJNO, EMPPROJACT.EMPNO, 006100
62 LASTNAME||', '||FIRSTNAME, SALARY 006200
63 FROM CORPDATA/EMPPROJACT, CORPDATA/EMPLOYEE 006300
64 WHERE EMPPROJACT.EMPNO = EMPLOYEE.EMPNO AND 006400
65 COMM >= :COMMI 006500
66 ORDER BY PROJNO, EMPNO; 006600
67 // 006700
68 7 EXEC SQL OPEN C1; 006800

```

```

xxxxST1 VxRxMx yymmdd          Create SQL ILE RPG Object      RPGLEEX          11/11/13
11:23:30      Page      3
69          //                                          006900
70          // Fetch and write the rows to QPRINT.          007000
71          //                                          007100
72      8    EXEC SQL WHENEVER NOT FOUND GO TO DONE1;          007200
73          DOU SQLCOD <> 0;                                  007300
74      9    EXEC SQL FETCH C1 INTO :PROJNO, :EMPNO, :NAME, :SALARY; 007400
75          EXCEPT RECB;                                    007500
76          ENDDO;                                          007600
77      C    DONE1          TAG                                007700
78      10   EXEC SQL CLOSE C1;                                007800
79          //                                          007900
80          // For all project ending at a date later than the raise date
81          // (that is, those projects potentially affected by the salary raises),
82          // generate a report containing the project number, project name,
83          // the count of employees participating in the project, and the
84          // total salary cost of the project.              008400
85          //                                          008500
86          // Write out the header for report 2.            008600
87          //                                          008700
88          EXCEPT RECC;                                    008800
89          EXEC SQL                                          008900
90      11   DECLARE C2 CURSOR FOR                              009000
91          SELECT EMPPROJECT.PROJNO, PROJNAME, COUNT(*),
92          SUM((DAYS(EMENDATE) - DAYS(EMSTDATE)) * EMPTIME *
93          DECIMAL((SALARY/:WRKDAY),8,2))
94          FROM CORPDATA/EMPPROJECT, CORPDATA/PROJECT, CORPDATA/EMPLOYEE
95          WHERE EMPPROJECT.PROJNO = PROJECT.PROJNO AND
96          EMPPROJECT.EMPNO = EMPLOYEE.EMPNO AND
97          PRENDATE > :RDATE
98          GROUP BY EMPPROJECT.PROJNO, PROJNAME              009800
99          ORDER BY 1;                                       009900
100         //                                          010000
101         EXEC SQL OPEN C2;                                  010100
102         //                                          010200
103         // Fetch and write the rows to QPRINT.            010300
104         //                                          010400
105         EXEC SQL WHENEVER NOT FOUND GO TO DONE2;          010500
106         DOU SQLCOD <> 0;                                  010600
107      12   EXEC SQL FETCH C2 INTO :RPT2;                    010700
108         EXCEPT RECD;                                    010800
109         ENDDO;                                          010900
110      C    DONE2          TAG                                011000
111      EXEC SQL CLOSE C2;                                    011100
112      C    GOTO          FINISH                             011200
113         //                                          011300
114         // Error occured while updating table. Inform user and rollback
115         // changes.                                        011400
116         //                                          011500
117      C    UPDERR          TAG                                011700
118         EXCEPT RECE;                                    011800
119      13   EXEC SQL WHENEVER SQLERROR CONTINUE;            011900
120         //                                          012000
121      14   EXEC SQL ROLLBACK;                                012100
122      C    GOTO          FINISH                             012200
123         //                                          012300
124         // Error occured while generating reports. Inform user and exit.
125         //                                          012400
126      C    RPTERR          TAG                                012600
127         EXCEPT RECF;                                    012700
128         //                                          012800
129         // All done.                                      012900
130         //                                          013000
131      C    FINISH          TAG                                013100
132         *INLR = *ON;                                       013200
133      QQPRINT      E          RECA          0 2 01          013300
134      0                                          013400
135      0                                          013500
136      0          E          RECA          0 1          013600
137      0                                          013700
138      0          7 'PROJECT'                                013800
139      0          14 'EMPID'                                013900
140      0          32 'EMPLOYEE NAME'                        014000
141      0          59 'SALARY'                                014000

```

```

xxxxST1 VxRxMx yymmdd          Create SQL ILE RPG Object          RPGLEEX          11/11/13
11:23:30      Page 4
141      0      E      RECB      0 1      014100
142      0      PROJNO      6      014200
143      0      EMPNO      15      014300
144      0      NAME      49      014400
145      0      SALARY      L 61      014500
146      0      E      RECC      2 2      014600
147      0      42 'ACCUMULATED STATISTIC'      014700
148      0      54 'S BY PROJECT'      014800
149      0      E      RECC      0 1      014900
150      0      7 'PROJECT'      015000
151      0      56 'NUMBER OF'      015100
152      0      67 'TOTAL'      015200
153      0      E      RECC      0 2      015300
154      0      6 'NUMBER'      015400
155      0      21 'PROJECT NAME'      015500
156      0      56 'EMPLOYEES'      015600
157      0      66 'COST'      015700
158      0      E      RECD      0 1      015800
159      0      PRJNUM      6      015900
160      0      PNAME      45      016000
161      0      EMPCNT      L 54      016100
162      0      PRCOST      L 70      016200
163      0      E      RECE      0 1      016300
164      0      28 '*** ERROR Occurred while'      016400
165      0      52 ' updating table. SQLCODE'      016500
166      0      53 '='      016600
167      0      SQLCOD      L 62      016700
168      0      E      RECF      0 1      016800
169      0      28 '*** ERROR Occurred while'      016900
170      0      52 ' generating reports. SQL'      017000
171      0      57 'CODE='      017100
172      0      SQLCOD      L 67      017200
          * * * * * E N D O F S O U R C E * * * * *

```

Data Names	Define	Reference
		CROSS REFERENCE
ACTNO	63	SMALL INTEGER PRECISION(4,0) COLUMN (NOT NULL) IN
CORPDATA.EMPPROJECT		
BIRTHDATE	63	DATE(10) COLUMN IN CORPDATA.EMPLOYEE
BONUS	63	DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
COMM	****	COLUMN
		46 65
COMM	63	DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
COMMI	28	DECIMAL(7,2)
		46 65
CORPDATA	****	SCHEMA
		44 63 63 94 94 94
C1	60	CURSOR
		68 74 78
C2	90	CURSOR
		101 107 111
DEPTNO	8	CHARACTER(3) IN RPT1
DEPTNO	94	CHARACTER(3) CCSID 37 COLUMN (NOT NULL) IN CORPDATA.PROJECT
DONE1	77	LABEL
		72
DONE2	110	LABEL
		105
EDLEVEL	63	SMALL INTEGER PRECISION(4,0) COLUMN (NOT NULL) IN
CORPDATA.EMPLOYEE		
EMENDATE	63	DATE(10) COLUMN IN CORPDATA.EMPPROJECT
EMENDATE	****	COLUMN
		92
EMPCNT	22	SMALL INTEGER PRECISION(4,0) IN RPT2
EMPLOYEE	****	TABLE IN CORPDATA
		44 63 94
EMPLOYEE	****	TABLE
		64 96
EMPNO	12	CHARACTER(6)
		74
EMPNO	****	COLUMN IN EMPPROJECT
		64 66 96
EMPNO	****	COLUMN IN EMPLOYEE
		64 96
EMPNO	63	CHARACTER(6) CCSID 37 COLUMN (NOT NULL) IN CORPDATA.EMPPROJECT
EMPNO	63	CHARACTER(6) CCSID 37 COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
EMPPROJECT	****	TABLE IN CORPDATA
		63 94
EMPPROJECT	****	TABLE
		64 95 96 98
EMPTIME	63	DECIMAL(5,2) COLUMN IN CORPDATA.EMPPROJECT
		CROSS REFERENCE
EMPTIME	****	COLUMN
		92
EMSTDATE	63	DATE(10) COLUMN IN CORPDATA.EMPPROJECT
EMSTDATE	****	COLUMN
		92
FINISH	131	LABEL
FIRSTNME	****	COLUMN
		62
FIRSTNME	63	VARCHAR(12) CCSID 37 COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
HIREDATE	63	DATE(10) COLUMN IN CORPDATA.EMPLOYEE
JOB	63	CHARACTER(8) CCSID 37 COLUMN IN CORPDATA.EMPLOYEE
LASTNAME	****	COLUMN
		62
LASTNAME	63	VARCHAR(15) CCSID 37 COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
MAJPROJ	8	CHARACTER(6) IN RPT1
MAJPROJ	94	CHARACTER(6) CCSID 37 COLUMN IN CORPDATA.PROJECT
MIDINIT	63	CHARACTER(1) CCSID 37 COLUMN (NOT NULL) IN CORPDATA.EMPLOYEE
NAME	13	CHARACTER(30)
		74
PERCNT	30	DECIMAL(7,2)
		45
PHONENO	63	CHARACTER(4) CCSID 37 COLUMN IN CORPDATA.EMPLOYEE
PNAME	21	CHARACTER(36) IN RPT2
PRCOST	23	DECIMAL(9,2) IN RPT2
PRENDATE	8	DATE(8) IN RPT1
PRENDATE	****	COLUMN
		97
PRENDATE	94	DATE(10) COLUMN IN CORPDATA.PROJECT
PRJNUM	20	CHARACTER(6) IN RPT2

```

xxxxST1 VxRxMx yymmdd      Create SQL ILE RPG Object      RPGLEEX      11/11/13
11:23:30          Page    6
                                CROSS REFERENCE
PROJECT          ****      TABLE IN CORPDATA
                                94
PROJECT          ****      TABLE
                                95
PROJNAME         8          VARCHAR(24) IN RPT1
PROJNAME         ****      COLUMN
                                91 98
PROJNAME         94         VARCHAR(24) CCSID 37 COLUMN (NOT NULL) IN CORPDATA.PROJECT
PROJNO           8          CHARACTER(6) IN RPT1
                                74
PROJNO           ****      COLUMN
                                61 66
PROJNO           63         CHARACTER(6) CCSID 37 COLUMN (NOT NULL) IN CORPDATA.EMPPROJECT
PROJNO           ****      COLUMN IN EMPPROJECT
                                95 98
PROJNO           ****      COLUMN IN PROJECT
                                95
PROJNO           94         CHARACTER(6) CCSID 37 COLUMN (NOT NULL) IN CORPDATA.PROJECT
PRSTAFF          8          DECIMAL(5,2) IN RPT1
PRSTAFF          94         DECIMAL(5,2) COLUMN IN CORPDATA.PROJECT
PRSTDATE         8          DATE(8) IN RPT1
PRSTDATE         94         DATE(10) COLUMN IN CORPDATA.PROJECT
RDATE            29         CHARACTER(10)
                                97
RESPEMP          8          CHARACTER(6) IN RPT1
RESPEMP          94         CHARACTER(6) CCSID 37 COLUMN (NOT NULL) IN CORPDATA.PROJECT
RPTERR           126        LABEL
                                52
RPT1             8          STRUCTURE
RPT2             19         STRUCTURE
                                107
SALARY           14         DECIMAL(9,2)
                                74
SALARY           ****      COLUMN
                                45 45 62 93
SALARY           63         DECIMAL(9,2) COLUMN IN CORPDATA.EMPLOYEE
SEX              63         CHARACTER(1) CCSID 37 COLUMN IN CORPDATA.EMPLOYEE
UPDERR           117        LABEL
                                41
WORKDEPT         63         CHARACTER(3) CCSID 37 COLUMN IN CORPDATA.EMPLOYEE
WRKDAY           27         SMALL INTEGER PRECISION(4,0)
                                93
No errors found in source
  172 Source records processed
***** END OF LISTING *****

```

## Related concepts

### Coding SQL statements in ILE RPG applications

You need to be aware of the unique application and coding requirements for embedding SQL statements in an ILE RPG program. In this topic, the coding requirements for host variables are defined.

## Example: SQL statements in REXX programs

This example program is written in the REXX programming language.

**Note:** By using the code examples, you agree to the terms of the [“Code license and disclaimer information”](#) on page 198.

```

Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8
1  /*****
2  /* A sample program which updates the salaries for those employees */
3  /* whose current commission total is greater than or equal to the */
4  /* value of COMMISSION. The salaries of those who qualify are */
5  /* increased by the value of PERCENTAGE, retroactive to RAISE_DATE. */
6  /* A report is generated and dumped to the display which shows the */
7  /* projects which these employees have contributed to, ordered by */
8  /* project number and employee ID. A second report shows each */
9  /* project having an end date occurring after RAISE DATE (i.e. is */
10 /* potentially affected by the retroactive raises) with its total */
11 /* salary expenses and a count of employees who contributed to the */
12 /* project. */
13 /******
14
15
16 /* Initialize RC variable */
17 RC = 0
18
19 /* Initialize HV for program usage */
20 COMMISSION = 2000.00;
21 PERCENTAGE = 1.04;
22 RAISE_DATE = '1982-06-01';
23 WORK_DAYS = 253;
24
25 /* Create the output file to dump the 2 reports. Perform an OVRDBF */
26 /* to allow us to use the SAY REXX command to write to the output */
27 /* file. */
28 ADDRESS '*COMMAND',
29         'DLTF FILE(CORPDATA/REPORTFILE)'
30 ADDRESS '*COMMAND',
31         'CRTPF FILE(CORPDATA/REPORTFILE) RCDLEN(80)'
32 ADDRESS '*COMMAND',
33         'OVRDBF FILE(STDOUT) TOFILE(CORPDATA/REPORTFILE) MBR(REPORTFILE)'
34
35 /* Update the selected employee's salaries by the new percentage. */
36 /* If an error occurs during the update, ROLLBACK the changes. */
37 3SIGNAL ON ERROR
38 ERRLOC = 'UPDATE_ERROR'
39 UPDATE_STMT = 'UPDATE CORPDATA/EMPLOYEE ',
40              'SET SALARY = SALARY * ? ',
41              'WHERE COMM >= ? ',
42 EXECSQL,
43         'PREPARE S1 FROM :UPDATE_STMT'
44 4EXECSQL,
45         'EXECUTE S1 USING :PERCENTAGE,',
46         ':COMMISSION '
47 /* Commit changes */
48 5EXECSQL,
49         'COMMIT'
50 ERRLOC = 'REPORT_ERROR'
51

```

Figure 8. Sample REXX Procedure Using SQL Statements

```

Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8
52 /* Report the updated statistics for each project supported by one */
53 /* of the selected employees. */
54
55 /* Write out the header for Report 1 */
56 SAY ' '
57 SAY ' '
58 SAY ' '
59 SAY '          REPORT OF PROJECTS AFFECTED BY EMPLOYEE RAISES'
60 SAY ' '
61 SAY 'PROJECT  EMPID      EMPLOYEE NAME          SALARY'
62 SAY '-----  ----      -'
63 SAY ' '
64
65 SELECT_STMT = 'SELECT DISTINCT PROJNO, EMPPROJACT.EMPNO, '
66              '          LASTNAME||' '||FIRSTNAME, SALARY '
67              'FROM CORPDATA/EMPPROJACT, CORPDATA/EMPLOYEE '
68              'WHERE EMPPROJACT.EMPNO = EMPLOYEE.EMPNO AND '
69              '          COMM >= ? '
70              'ORDER BY PROJNO, EMPNO '
71
72 EXECSQL, 'PREPARE S2 FROM :SELECT_STMT'
73
74 6EXECSQL, 'DECLARE C1 CURSOR FOR S2'
75
76 7EXECSQL, 'OPEN C1 USING :COMMISSION'
77
78 /* Handle the FETCH errors and warnings inline */
79 SIGNAL OFF ERROR
80
81 /* Fetch all of the rows */
82 DO UNTIL (SQLCODE <> 0)
83   9EXECSQL,
84     'FETCH C1 INTO :RPT1.PROJNO, :RPT1.EMPNO, '
85     '          :RPT1.NAME, :RPT1.SALARY '
86
87   /* Process any errors that may have occurred. Continue so that */
88   /* we close the cursor for any warnings. */
89   IF SQLCODE < 0 THEN
90     SIGNAL ERROR
91
92   /* Stop the loop when we hit the EOF. Don't try to print out the */
93   /* fetched values. */
94   8IF SQLCODE = 100 THEN
95     LEAVE
96
97   /* Print out the fetched row */
98   SAY RPT1.PROJNO ' ' RPT1.EMPNO ' ' RPT1.NAME ' ' RPT1.SALARY
99 END;
100
101 10EXECSQL,
102   'CLOSE C1'
103
104 /* For all projects ending at a date later than 'raise_date' */
105 /* (that is, those projects potentially affected by the salary raises) */
106 /* generate a report containing the project number, project name, */
107 /* the count of employees participating in the project, and the */
108 /* total salary cost of the project. */
109

```

```

Record *...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+... 7 ...+... 8
110 /* Write out the header for Report 2 */
111 SAY ' '
112 SAY ' '
113 SAY ' '
114 SAY ' ACCUMULATED STATISTICS BY PROJECT'
115 SAY ' '
116 SAY 'PROJECT PROJECT NAME NUMBER OF TOTAL'
117 SAY 'NUMBER EMPLOYEES COST'
118 SAY '-----'
119 SAY ' '
120
121
122 /* Go to the common error handler */
123 SIGNAL ON ERROR
124
125 SELECT_STMT = 'SELECT EMPPROJACT.PROJNO, PROJNAME, COUNT(*),
126 ' SUM( (DAYS(EMENDATE) - DAYS(EMSTDATE)) * EMPTIME *
127 ' DECIMAL(( SALARY / ? ),8,2) )
128 ' FROM CORPDATA/EMPPROJACT, CORPDATA/PROJECT, CORPDATA/EMPLOYEE',
129 ' WHERE EMPPROJACT.PROJNO = PROJECT.PROJNO AND
130 ' EMPPROJACT.EMPNO = EMPLOYEE.EMPNO AND
131 ' PRENDATE > ?
132 ' GROUP BY EMPPROJACT.PROJNO, PROJNAME
133 ' ORDER BY 1
134
135 EXECSQL,
136 'PREPARE S3 FROM :SELECT_STMT'
137
138 EXECSQL,
139 'DECLARE C2 CURSOR FOR S3'
140
141 /* Handle the FETCH errors and warnings inline */
142 SIGNAL OFF ERROR
143
144 /* Fetch all of the rows */
145 DO UNTIL (SQLCODE <> 0)
146 12EXECSQL,
147 'FETCH C2 INTO :RPT2.PROJNO, :RPT2.PROJNAME, ',
148 ' :RPT2.EMPCOUNT, :RPT2.TOTAL_COST '
149
150 /* Process any errors that may have occurred. Continue so that */
151 /* we close the cursor for any warnings. */
152 IF SQLCODE < 0 THEN
153 SIGNAL ERROR
154
155 /* Stop the loop when we hit the EOF. Don't try to print out the */
156 /* fetched values. */
157 IF SQLCODE = 100 THEN
158 LEAVE
159
160 /* Print out the fetched row */
161 SAY RPT2.PROJNO ' ' RPT2.PROJNAME ' ',
162 RPT2.EMPCOUNT ' ' RPT2.TOTAL_COST
163
164 END;
165 EXECSQL,
166 'CLOSE C2'
167

```

```

168 /* Delete the OVRDBF so that we will continue writing to the output */
169 /* display. */
170 ADDRESS '*COMMAND',
171 'DLTOVR FILE(STDOUT)'
172
173 /* Leave procedure with a successful or warning RC */
174 EXIT RC
175
176
177 /* Error occurred while updating the table or generating the */
178 /* reports. If the error occurred on the UPDATE, rollback all of */
179 /* the changes. If it occurred on the report generation, display the */
180 /* REXX RC variable and the SQLCODE and exit the procedure. */
181 ERROR:
182
183 13SIGNAL OFF ERROR
184
185 /* Determine the error location */
186 SELECT
187 /* When the error occurred on the UPDATE statement */
188 WHEN ERRLOC = 'UPDATE_ERROR' THEN
189 DO
190 SAY '*** ERROR Occurred while updating table.',
191 'SQLCODE = ' SQLCODE
192 14EXECSQL,
193 'ROLLBACK'
194 END
195 /* When the error occurred during the report generation */
196 WHEN ERRLOC = 'REPORT_ERROR' THEN
197 SAY '*** ERROR Occurred while generating reports. ',
198 'SQLCODE = ' SQLCODE
199 OTHERWISE
200 SAY '*** Application procedure logic error occurred '
201 END
202
203
204 /* Delete the OVRDBF so that we will continue writing to the */
205 /* output display. */
206 ADDRESS '*COMMAND',
207 'DLTOVR FILE(STDOUT)'
208
209 /* Return the error RC received from SQL. */
210 EXIT RC
211
                * * * * * E N D O F S O U R C E * * * * *

```

## Related concepts

### [Coding SQL statements in REXX applications](#)

REXX procedures do not have to be preprocessed. At run time, the REXX interpreter passes statements that it does not understand to the current active command environment for processing.

## Report produced by example programs that use SQL

This report is produced by each of the example programs.

```

                REPORT OF PROJECTS AFFECTED BY RAISES

PROJECT  EMPID      EMPLOYEE NAME                SALARY
AD3100   000010    HAAS, CHRISTINE              54860.00
AD3110   000070    PULASKI, EVA                 37616.80
AD3111   000240    MARINO, SALVATORE           29910.40
AD3113   000270    PEREZ, MARIA                28475.20
IF1000   000030    KWAN, SALLY                 39780.00
IF1000   000140    NICHOLLS, HEATHER          29556.80
IF2000   000030    KWAN, SALLY                 39780.00
IF2000   000140    NICHOLLS, HEATHER          29556.80
MA2100   000010    HAAS, CHRISTINE              54860.00
MA2100   000110    LUCCHESI, VICENZO           48360.00
MA2110   000010    HAAS, CHRISTINE              54860.00
MA2111   000200    BROWN, DAVID                28849.60
MA2111   000220    LUTZ, JENNIFER              31033.60
MA2112   000150    ADAMSON, BRUCE              26291.20
OP1000   000050    GEYER, JOHN                 41782.00
OP1010   000090    HENDERSON, EILEEN           30940.00
OP1010   000280    SCHNEIDER, ETHEL            27300.00
OP2010   000050    GEYER, JOHN                 41782.00
OP2010   000100    SPENSER, THEODORE           27196.00
OP2012   000330    LEE, WING                   26384.80
PL2100   000020    THOMPSON, MICHAEL           42900.00

```

ACCUMULATED STATISTICS BY PROJECT

PROJECT NUMBER	PROJECT NAME	NUMBER OF EMPLOYEES	TOTAL COST
AD3100	ADMIN SERVICES	1	19623.11
AD3110	GENERAL ADMIN SYSTEMS	1	58877.28
AD3111	PAYROLL PROGRAMMING	7	66407.56
AD3112	PERSONNEL PROGRAMMING	9	28845.70
AD3113	ACCOUNT PROGRAMMING	14	72114.52
IF1000	QUERY SERVICES	4	35178.99
IF2000	USER EDUCATION	5	55212.61
MA2100	WELD LINE AUTOMATION	2	114001.52
MA2110	W L PROGRAMMING	1	85864.68
MA2111	W L PROGRAM DESIGN	3	93729.24
MA2112	W L ROBOT DESIGN	6	166945.84
MA2113	W L PROD CONT PROGS	5	71509.11
OP1000	OPERATION SUPPORT	1	16348.86
OP1010	OPERATION	5	167828.76
OP2010	SYSTEMS SUPPORT	2	91612.62
OP2011	SCP SYSTEMS SUPPORT	2	31224.60
OP2012	APPLICATIONS SUPPORT	2	41294.88
OP2013	DB/DC SUPPORT	2	37311.12
PL2100	WELD LINE PLANNING	1	43576.92

## CL command descriptions for host language precompilers

The IBM Db2 Query Manager and SQL Development Kit for i licensed program provides commands for precompiling programs coded in these programming languages.

### Create SQL COBOL Program command

The **Create SQL COBOL Program (CRTSQLCBL)** command calls the SQL precompiler.

It precompiles COBOL source containing SQL statements, produces a temporary source member, and then optionally calls the COBOL compiler to compile the program.

## Create SQL ILE COBOL Object command

The **Create SQL ILE COBOL Object (CRTSQLCBLI)** command calls the SQL precompiler, which precompiles COBOL source containing SQL statements, produces a temporary source member, and then optionally calls the ILE COBOL compiler to create a module, a program, or a service program.

## Create SQL ILE C Object command

The **Create SQL ILE C Object (CRTSQLCI)** command calls the SQL precompiler, which precompiles C source containing SQL statements, produces a temporary source member, and then optionally calls the ILE C compiler to create a module, create a program, or create a service program.

## Create SQL ILE C++ Object command

The **Create SQL ILE C++ Object (CRTSQLCPPI)** command calls the SQL precompiler, which precompiles C++ source containing SQL statements, produces a temporary source member, and then optionally calls the C++ compiler to create a module.

## Create SQL PL/I Program command

The **Create SQL PL/I Program (CRTSQLPLI)** command calls a SQL precompiler, which precompiles PL/I source containing SQL statements, produces a temporary source member, and optionally calls the PL/I compiler to compile the program.

## Create SQL RPG Program command

The **Create SQL RPG Program (CRTSQLRPG)** command calls the SQL precompiler, which precompiles the RPG source containing the SQL statements, produces a temporary source member, and then optionally calls the RPG compiler to compile the program.

## Create SQL ILE RPG Object command

The **Create SQL ILE RPG Object (CRTSQLRPGI)** command calls the SQL precompiler, which precompiles RPG source containing SQL statements, produces a temporary source member, and then optionally calls the ILE RPG compiler to create a module, create a program, or create a service program.

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