



Apache
Trafodion

SQL Reference Manual

Version 2.1.0

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2.1.0	May 1, 2017
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Chapter 1. About This Document

This manual describes reference information about the syntax of SQL statements, functions, and other SQL language elements supported by the Trafodion project's database software.

Trafodion SQL statements and utilities are entered interactively or from script files using a client-based tool, such as the Trafodion Command Interface (TrafCI). To install and configure a client application that enables you to connect to and use a Trafodion database, see the [Trafodion Client Installation Guide](#).



In this manual, SQL language elements, statements, and clauses within statements are based on the ANSI SQL:1999 standard.

1.1. Intended Audience

This manual is intended for database administrators and application programmers who are using SQL to read, update, and create Trafodion SQL tables, which map to HBase tables, and to access native HBase and Hive tables.

You should be familiar with structured query language (SQL) and with the American National Standard Database Language SQL:1999.

1.2. New and Changed Information

This edition includes updates for these new features:

New Feature	Location in the Manual
Incremental UPDATE STATISTICS	UPDATE STATISTICS Statement

1.3. Document Organization

Chapter or Appendix	Description
Introduction	Introduces Trafodion SQL and covers topics such as data consistency, transaction management, and ANSI compliance.
SQL Statements	Describes the SQL statements supported by Trafodion SQL.
SQL Utilities	Describes the SQL utilities supported by Trafodion SQL.
SQL Language Elements	Describes parts of the language, such as database objects, data types, expressions, identifiers, literals, and predicates, which occur within the syntax of Trafodion SQL statements.
SQL Clauses	Describes clauses used by Trafodion SQL statements.
SQL Functions and Expressions	Describes specific functions and expressions that you can use in Trafodion SQL statements.
SQL Runtime Statistics	Describes how to gather statistics for active queries or for the Runtime Management System (RMS) and describes the RMS counters that are returned.
OLAP Functions	Describes specific on line analytical processing functions.
Appendix A: Reserved Words	Lists the words that are reserved in Trafodion SQL.
Appendix B: Limits	Describes limits in Trafodion SQL.

1.4. Notation Conventions

This list summarizes the notation conventions for syntax presentation in this manual.

- UPPERCASE LETTERS

Uppercase letters indicate keywords and reserved words. Type these items exactly as shown. Items not enclosed in brackets are required.

```
SELECT
```

- lowercase letters

Lowercase letters, regardless of font, indicate variable items that you supply. Items not enclosed in brackets are required.

```
file-name
```

- [] Brackets

Brackets enclose optional syntax items.

```
DATETIME [start-field TO] end-field
```

A group of items enclosed in brackets is a list from which you can choose one item or none.

The items in the list can be arranged either vertically, with aligned brackets on each side of the list, or horizontally, enclosed in a pair of brackets and separated by vertical lines.

For example:

```
DROP SCHEMA schema [CASCADE]  
DROP SCHEMA schema [ CASCADE | RESTRICT ]
```

- { } Braces

Braces enclose required syntax items.

```
FROM { grantee [, grantee] ... }
```

A group of items enclosed in braces is a list from which you are required to choose one item.

The items in the list can be arranged either vertically, with aligned braces on each side of the list, or horizontally, enclosed in a pair of braces and separated by vertical lines.

For example:

```
INTERVAL { start-field TO end-field }
{ single-field }
INTERVAL { start-field TO end-field | single-field }
```

- | Vertical Line

A vertical line separates alternatives in a horizontal list that is enclosed in brackets or braces.

```
{expression | NULL}
```

- ... Ellipsis

An ellipsis immediately following a pair of brackets or braces indicates that you can repeat the enclosed sequence of syntax items any number of times.

```
ATTRIBUTE[S] attribute [, attribute] ...
{ , sql-expression } ...
```

An ellipsis immediately following a single syntax item indicates that you can repeat that syntax item any number of times.

For example:

```
expression-n ...
```

- Punctuation

Parentheses, commas, semicolons, and other symbols not previously described must be typed as shown.

```
DAY (datetime-expression)
@script-file
```

Quotation marks around a symbol such as a bracket or brace indicate the symbol is a required character that you must type as shown.

For example:

```
"{ " module-name [ , module-name] . . . " }"
```

- Item Spacing

Spaces shown between items are required unless one of the items is a punctuation symbol such as a parenthesis or a comma.

```
DAY (datetime-expression) DAY(datetime-expression)
```

If there is no space between two items, spaces are not permitted. In this example, no spaces are permitted between the period and any other items:

```
myfile.sh
```

- Line Spacing

If the syntax of a command is too long to fit on a single line, each continuation line is indented three spaces and is separated from the preceding line by a blank line.

This spacing distinguishes items in a continuation line from items in a vertical list of selections.

```
match-value [NOT] LIKE _pattern
[ESCAPE esc-char-expression]
```

1.5. Comments Encouraged

We encourage your comments concerning this document. We are committed to providing documentation that meets your needs. Send any errors found, suggestions for improvement, or compliments to user@trafodion.incubator.apache.org.

Include the document title and any comment, error found, or suggestion for improvement you have concerning this document.

Chapter 2. Introduction

The Trafodion SQL database software allows you to use SQL statements, which comply closely to ANSI SQL:1999, to access data in Trafodion SQL tables, which map to HBase tables, and to access native HBase tables and Hive tables.

This introduction describes:

- [SQL Language](#)
- [Using Trafodion SQL to Access HBase Tables](#)
- [Using Trafodion SQL to Access Hive Tables](#)
- [Data Consistency and Access Options](#)
- [Transaction Management](#)
- [ANSI Compliance and Trafodion SQL Extensions](#)
- [Trafodion SQL Error Messages](#)

Other sections of this manual describe the syntax and semantics of individual statements, commands, and language elements.

2.1. SQL Language

The SQL language consists of statements and other language elements that you can use to access SQL databases. For descriptions of individual SQL statements, see [SQL Statements](#).

SQL language elements are part of statements and commands and include data types, expressions, functions, identifiers, literals, and predicates. For more information, see:

- [SQL Language](#)
- [Elements](#)
- [SQL Clauses](#)

For information on specific functions and expressions, see:

- [SQL Functions and Expressions](#)
- [OLAP Functions](#)

2.2. Using Trafodion SQL to Access HBase Tables

You can use Trafodion SQL statements to read, update, and create HBase tables.

- [Initializing the Trafodion Metadata](#)
- [Ways to Access HBase Tables](#)
- [Trafodion SQL Tables Versus Native HBase Tables](#)
- [Supported SQL Statements With HBase Tables](#)

For a list of Control Query Default (CQD) settings for the HBase environment, see the [Trafodion Control Query Default \(CQD\) Reference Guide](#).

2.2.1. Ways to Access HBase Tables

Trafodion SQL supports these ways to access HBase tables:

- [Accessing Trafodion SQL Tables](#)
- [Cell-Per-Row Access to HBase Tables \(Technology Preview\)](#)
- [Rowwise Access to HBase Tables \(Technology Preview\)](#)

Accessing Trafodion SQL Tables

A Trafodion SQL table is a relational SQL table generated by a `CREATE TABLE` statement and mapped to an HBase table. Trafodion SQL tables have regular ANSI names in the catalog `TRAFODION`. A Trafodion SQL table name can be a fully qualified ANSI name of the form `TRAFODION.schema-name.object-name`.

To access a Trafodion SQL table, specify its ANSI table name in a Trafodion SQL statement, similar to how you would specify an ANSI table name when running SQL statements in a relational database.

Example

```
CREATE TABLE trafodion.sales.odetail
( ordernum NUMERIC (6) UNSIGNED NO DEFAULT NOT NULL
, partnum NUMERIC (4) UNSIGNED NO DEFAULT NOT NULL
, unit_price NUMERIC (8,2) NO DEFAULT NOT NULL
, qty_ordered NUMERIC (5) UNSIGNED NO DEFAULT NOT NULL
, PRIMARY KEY (ordernum, partnum)
);

INSERT INTO trafodion.sales.odetail VALUES ( 900000, 7301, 425.00, 100 );

SET SCHEMA trafodion.sales;

SELECT * FROM odetail;
```

For more information about Trafodion SQL tables, see [Trafodion SQL Tables Versus Native HBase Tables](#).

Cell-Per-Row Access to HBase Tables (Technology Preview)



This is a *Technology Preview (Complete But Not Tested)* feature, meaning that it is functionally complete but has not been tested or debugged.

To access HBase data using cell-per-row mode, specify the schema `HBASE . "CELL"` and the full ANSI name of the table as a delimited table name. You can specify the name of any HBase table, regardless of whether it was created through Trafodion SQL.

Example

```
select * from hbase._CELL_.TRAFDION.MYSCH.MYTAB;
select * from hbase._CELL_.table_created_in_HBase;
```

All tables accessed through this schema have the same column layout:

```
>>invoke hbase._CELL_.table_created_in_HBase;
(
ROW_ID      VARCHAR(100)    ...
, COL_FAMILY VARCHAR(100)    ...
, COL_NAME   VARCHAR(100)    ...
, COL_TIMESTAMP LARGEINT    ...
, COL_VALUE   VARCHAR(1000)   ...
)
PRIMARY KEY (ROW_ID)

>>select * from hbase._CELL_.mytab;
```

Rowwise Access to HBase Tables (Technology Preview)



This is a *Technology Preview (Complete But Not Tested)* feature, meaning that it is functionally complete but has not been tested or debugged.

To access HBase data using rowwise mode, specify the schema `HBASE . "ROW"` and the full ANSI name of the table as a delimited table name. You can specify the name of any HBase table, regardless of whether it was created through Trafodion SQL.

Example

```
select * from hbase._ROW_.TRAFODION.MYSCH.MYTAB;
select * from hbase._ROW_.table_created_in_HBase;
```

All column values of the row are returned as a single, big varchar:

```
>>invoke hbase._ROW_.mytab;
(
  ROW_ID VARCHAR(100) ...
, COLUMN_DETAILS VARCHAR(10000) ...
)
PRIMARY KEY (ROW_ID)

>>select * from hbase._ROW_.mytab;
```

2.2.2. Trafodion SQL Tables Versus Native HBase Tables

Trafodion SQL tables have many advantages over regular HBase tables:

- They can be made to look like regular, structured SQL tables with fixed columns.
- They support the usual SQL data types supported in relational databases.
- They support compound keys, unlike HBase tables that have a single row key (a string).
- They support indexes.
- They support *salting*, which is a technique of adding a hash value of the row key as a key prefix to avoid hot spots for sequential keys. For the syntax, see the [CREATE TABLE Statement](#).

The problem with Trafodion SQL tables is that they use a fixed format to represent column values, making it harder for native HBase applications to access them. Also, they have a fixed structure, so users lose the flexibility of dynamic columns that comes with HBase.

2.2.3. Supported SQL Statements With HBase Tables

You can use these SQL statements with HBase tables:

SELECT Statement	INSERT Statement
UPDATE Statement	DELETE Statement
MERGE Statement	GET Statement
INVOKE Statement	ALTER TABLE Statement
CREATE INDEX Statement	CREATE TABLE Statement
CREATE VIEW Statement	DROP INDEX Statement
DROP TABLE Statement	DROP VIEW Statement
GRANT Statement	REVOKE Statement

2.3. Using Trafodion SQL to Access Hive Tables

You can use Trafodion SQL statements to access Hive tables.

- [ANSI Names for Hive Tables](#)
- [Type Mapping From Hive to Trafodion SQL](#)
- [Supported SQL Statements With Hive Tables](#)

For a list of Control Query Default (CQD) settings for the Hive environment, see the [Trafodion Control Query Default \(CQD\) Reference Guide](#).

2.3.1. ANSI Names for Hive Tables

Hive tables appear in the Trafodion Hive ANSI name space in a special catalog and schema named `HIVE.HIVE`.

To select from a Hive table named `T`, specify an implicit or explicit name, such as `HIVE.HIVE.T`, in a Trafodion SQL statement.

Example This example should work if a Hive table named `T` has already been defined:

```
set schema hive.hive;
CQD HIVE_MAX_STRING_LENGTH '20'; -- creates a more readable display
select * from t; -- implicit table name

set schema trafodion.seabase;

select * from hive.hive.t; -- explicit table name
```

2.3.2. Type Mapping From Hive to Trafodion SQL

Trafodion performs the following data-type mappings:

Hive Type	Trafodion SQL Type
tinyint	smallint
smallint	smallint
int	int
bigint	largeint
string	varchar(<i>n</i> bytes) character set utf8 ¹
float	real
double	float(54)
timestamp	timestamp(6) ²

1. The value *n* is determined by CQD HIVE_MAX_STRING_LENGTH. See the [Trafodion Control Query Default \(CQD\) Reference Guide](#).
2. Hive supports timestamps with nanosecond resolution (precision of 9). Trafodion SQL supports only microsecond resolution (precision 6).

2.3.3. Supported SQL Statements With Hive Tables

You can use these SQL statements with Hive tables:

- [SELECT Statement](#)
- [LOAD Statement](#)
- [GET TABLES](#) (See the [GET Statement](#).)
- [INVOKE Statement](#)

2.4. Data Consistency and Access Options

Access options for DML statements affect the consistency of the data that your query accesses.

For any DML statement, you specify access options by using the `FOR option ACCESS` clause and, for a `SELECT` statement, by using this same clause, you can also specify access options for individual tables and views referenced in the `FROM` clause.

The possible settings for *option* in a DML statement are:

- **READ COMMITTED**

Specifies that the data accessed by the DML statement must be from committed rows.

The SQL default access option for DML statements is `READ COMMITTED`.

For related information about transactions, see [Transaction Isolation Levels](#).

2.4.1. READ COMMITTED

This option allows you to access only committed data.

The implementation requires that a lock can be acquired on the data requested by the DML statement—but does not actually lock the data, thereby reducing lock request conflicts. If a lock cannot be granted (implying that the row contains uncommitted data), the DML statement request waits until the lock in place is released.

`READ COMMITTED` provides the next higher level of data consistency (compared to `READ UNCOMMITTED`). A statement executing with this access option does not allow dirty reads, but both non-repeatable reads and phantoms are possible.

`READ COMMITTED` provides sufficient consistency for any process that does not require a repeatable read capability.

`READ COMMITTED` is the default isolation level.

2.5. Transaction Management

A transaction (a set of database changes that must be completed as a group) is the basic recoverable unit in case of a failure or transaction interruption. Transactions are controlled through client tools that interact with the database using ODBC or JDBC.

The typical order of events is:

1. Transaction is started.
2. Database changes are made.
3. Transaction is committed.

If, however, the changes cannot be made or if you do not want to complete the transaction, then you can abort the transaction so that the database is rolled back to its original state.

This subsection discusses these considerations for transaction management:

- [User-Defined and System-Defined Transactions](#)
- [Rules for DML Statements](#)
- [Effect of AUTOCOMMIT Option](#)
- [Concurrency](#)
- [Transaction Isolation Levels](#)

2.5.1. User-Defined and System-Defined Transactions

Transactions you define are called *user-defined transactions*. To be sure that a sequence of statements executes successfully or not at all, you can define one transaction consisting of these statements by using the BEGIN WORK statement and COMMIT WORK statement. You can abort a transaction by using the ROLLBACK WORK statement.

If AUTOCOMMIT is on, then you do not have to end the transaction explicitly as Trafodion SQL will end the transaction automatically. Sometimes an error occurs that requires the user-defined transaction to be aborted. Trafodion SQL will automatically abort the transaction and return an error indicating that the transaction was rolled back.

System-Defined Transactions

In some cases, Trafodion SQL defines transactions for you. These transactions are called *system-defined transactions*. Most DML statements initiate transactions implicitly at the start of execution. See [Implicit Transactions](#).

However, even if a transaction is initiated implicitly, you must end a transaction explicitly with the COMMIT WORK statement or the ROLLBACK WORK statement. If AUTOCOMMIT is on, you do not need to end a transaction explicitly.

2.5.2. Rules for DML Statements

If deadlock occurs, the DML statement times out and receives an error.

2.5.3. Effect of AUTOCOMMIT Option

AUTOCOMMIT is an option that can be set in a SET TRANSACTION statement. It specifies whether Trafodion SQL will commit automatically, or roll back if an error occurs, at the end of statement execution. This option applies to any statement for which the system initiates a transaction. See [SET TRANSACTION Statement](#).

If this option is set to ON, Trafodion SQL automatically commits any changes, or rolls back any changes, made to the database at the end of statement execution.

2.5.4. Concurrency

Concurrency is defined by two or more processes accessing the same data at the same time. The degree of concurrency available — whether a process that requests access to data that is already being accessed is given access or placed in a wait queue — depends on the purpose of the access mode (read or update) and the isolation level. Currently, the only isolation level is READ COMMITTED.

Trafodion SQL provides concurrent database access for most operations and controls database access through concurrency control and the mechanism for opening and closing tables. For DML operations, the access option affects the degree of concurrency. See [Data Consistency and Access Options](#).

2.5.5. Transaction Isolation Levels

A transaction has an isolation level that is [READ COMMITTED](#).

READ COMMITTED

This option, which is ANSI compliant, allows your transaction to access only committed data. No row locks are acquired when READ COMMITTED is the specified isolation level.

READ COMMITTED provides the next level of data consistency. A transaction executing with this isolation level does not allow dirty reads, but both non-repeatable reads and phantoms are possible.

READ COMMITTED provides sufficient consistency for any transaction that does not require a repeatable-read capability.

The default isolation level is READ COMMITTED.

2.6. ANSI Compliance and Trafodion SQL Extensions

Trafodion SQL complies most closely with Core SQL 99. Trafodion SQL also includes some features from SQL 99 and part of the SQL 2003 standard, and special Trafodion SQL extensions to the SQL language.

Statements and SQL elements in this manual are ANSI compliant unless specified as Trafodion SQL extensions.

2.6.1. ANSI-Compliant Statements

These statements are ANSI compliant, but some might contain Trafodion SQL extensions:

ALTER TABLE Statement	CALL Statement
COMMIT WORK Statement	CREATE FUNCTION Statement
CREATE PROCEDURE Statement	CREATE ROLE Statement
CREATE SCHEMA Statement	CREATE TABLE Statement
CREATE VIEW Statement	DELETE Statement
DROP FUNCTION Statement	DROP PROCEDURE Statement
DROP ROLE Statement	DROP SCHEMA Statement
DROP TABLE Statement	DROP VIEW Statement
EXECUTE Statement	GRANT Statement
GRANT ROLE Statement	INSERT Statement
MERGE Statement	PREPARE Statement
REVOKE Statement	REVOKE ROLE Statement
ROLLBACK WORK Statement	SELECT Statement
SET SCHEMA Statement	SET TRANSACTION Statement
TABLE Statement	UPDATE Statement

2.6.2. Statements That Are Trafodion SQL Extensions

These statements are Trafodion SQL extensions to the ANSI standard.

ALTER LIBRARY Statement	ALTER USER Statement
BEGIN WORK Statement	CONTROL QUERY CANCEL Statement
CONTROL QUERY DEFAULT Statement	CREATE INDEX Statement
CREATE LIBRARY Statement	DROP INDEX Statement
DROP LIBRARY Statement	EXPLAIN Statement
GET Statement	GET HBASE OBJECTS Statement
GET VERSION OF METADATA Statement	GET VERSION OF SOFTWARE Statement
GRANT COMPONENT PRIVILEGE Statement	INVOKE Statement
LOAD Statement	REGISTER USER Statement
REVOKE COMPONENT PRIVILEGE Statement	SHOWCONTROL Statement
SHOWDDL Statement	SHOWDDL SCHEMA Statement
SHOWSTATS Statement	UNLOAD Statement
UNREGISTER USER Statement	UPDATE STATISTICS Statement

2.6.3. ANSI-Compliant Functions

These functions are ANSI compliant, but some might contain Trafodion SQL extensions:

AVG function	CASE expression
CAST expression	CHAR_LENGTH
COALESCE	COUNT Function
CURRENT	CURRENT_DATE
CURRENT_TIME	CURRENT_TIMESTAMP
CURRENT_USER	EXTRACT
LOWER	MAX
MIN	NULLIF
OCTET_LENGTH	POSITION
SESSION_USER	SUBSTRING
SUM	TRIM

All other functions are Trafodion SQL extensions.

2.7. Trafodion SQL Error Messages

Trafodion SQL reports error messages and exception conditions. When an error condition occurs, Trafodion SQL returns a message number and a brief description of the condition.

Example

Trafodion SQL might display this error message:

```
*** ERROR[1000] A syntax error occurred.
```

The message number is the SQLCODE value (without the sign). In this example, the SQLCODE value is 1000.

Chapter 3. SQL Statements

This section describes the syntax and semantics of Trafodion SQL statements.

Trafodion SQL statements are entered interactively or from script files using a client-based tool, such as the Trafodion Command Interface (TrafCI). To install and configure a client application that enables you to connect to and use a Trafodion database, see the [Trafodion Client Installation Guide](#).

3.1. Categories

The statements are categorized according to their functionality:

- Data Definition Language (DDL) Statements
- Data Manipulation Language (DML) Statements
- Transaction Control Statements
- Data Control and Security Statements
- Stored Procedure and User-Defined Function Statements
- Prepared Statements
- Control Statements
- Object Naming Statements
- SHOW, GET, and EXPLAIN Statements

3.1.1. Data Definition Language (DDL) Statements

Use these DDL statements to create, drop, or alter the definition of a Trafodion SQL schema or object.



DDL statements are not currently supported in transactions. That means that you cannot run DDL statements inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run these statements, AUTOCOMMIT must be turned ON (the default) for the session.

Statement	What It Does
ALTER TABLE Statement	Changes attributes for a table.
ALTER USER Statement	Changes attributes for a user.
CREATE FUNCTION Statement	Registers a user-defined function (UDF) written in C as a function within a Trafodion database.
CREATE INDEX Statement	Creates an index on a table.
CREATE LIBRARY Statement	Registers a library object in a Trafodion database.
CREATE PROCEDURE Statement	Registers a Java method as a stored procedure in Java (SPJ) within a Trafodion database.
CREATE ROLE Statement	Creates a role.
CREATE SCHEMA Statement	Creates a schema in the database.
CREATE TABLE Statement	Creates a table.
CREATE VIEW Statement	Creates a view.
DROP FUNCTION Statement	Removes a user-defined function (UDF) from the Trafodion database.
DROP INDEX Statement	Drops an index.
DROP LIBRARY Statement	Removes a library object from the Trafodion database and also removes the library file referenced by the library object.
DROP PROCEDURE Statement	Removes a stored procedure in Java (SPJ) from the Trafodion database.
DROP ROLE Statement	Drops a role.
DROP SCHEMA Statement	Drops a schema from the database.
DROP TABLE Statement	Drops a table.
DROP VIEW Statement	Drops a view.
REGISTER USER Statement	Registers a user in the SQL database, associating the user's login name with a database user name.
UNREGISTER USER Statement	Removes a database user name from the SQL database.

3.1.2. Data Manipulation Language (DML) Statements

Use these DML statements to delete, insert, select, or update rows in one or more tables:

Statement	What It Does
DELETE Statement	Deletes rows from a table or view.
INSERT Statement	Inserts data into tables and views.
MERGE Statement	Either performs an upsert operation (that is, updates a table if the row exists or inserts into a table if the row does not exist) or updates (merges) matching rows from one table to another.
SELECT Statement	Retrieves data from tables and views.
TABLE Statement	Equivalent to the query specification <code>SELECT * FROM table</code>
UPDATE Statement	Updates values in columns of a table or view.
UPSERT Statement	Updates a table if the row exists or inserts into a table if the row does not exist.
VALUES Statement	Displays the results of the evaluation of the expressions and the results of row subqueries within the row value constructors.

3.1.3. Transaction Control Statements

Use these statements to specify user-defined transactions and to set attributes for the next transaction:

Statement	What It Does
BEGIN WORK Statement	Starts a transaction.
COMMIT WORK Statement	Commits changes made during a transaction and ends the transaction.
ROLLBACK WORK Statement	Undoes changes made during a transaction and ends the transaction.
SET TRANSACTION Statement	Sets attributes for the next SQL transaction — whether to automatically commit database changes.

3.1.4. Data Control and Security Statements

Use these statements to register users, create roles, and grant and revoke privileges:

Statement	What It Does
ALTER USER Statement	Changes attributes associated with a user who is registered in the database.
CREATE ROLE Statement	Creates an SQL role.
DROP ROLE Statement	Deletes an SQL role.
GRANT Statement	Grants access privileges on an SQL object or an SQL object's columns to specified users or roles.
GRANT COMPONENT PRIVILEGE Statement	Grants one or more component privileges to a user or role.
GRANT ROLE Statement	Grants one or more roles to a user.
REGISTER USER Statement	Registers a user in the SQL database, associating the user's login name with a database user name.
REVOKE Statement	Revokes access privileges on an SQL object from specified users or roles.
REVOKE COMPONENT PRIVILEGE Statement	Removes one or more component privileges from a user or role.
REVOKE ROLE Statement	Removes one or more roles from a user.
UNREGISTER USER Statement	Removes a database user name from the SQL database.

3.1.5. Stored Procedure and User-Defined Function Statements

Use these statements to create and execute stored procedures in Java (SPJs) or create user-defined functions (UDFs) and to modify authorization to access libraries or to execute SPJs or UDFs:

Statement	What It Does
CALL Statement	Initiates the execution of a stored procedure in Java (SPJ) in a Trafodion database.
CREATE FUNCTION Statement	Registers a user-defined function (UDF) written in C as a function within a Trafodion database.
CREATE LIBRARY Statement	Registers a library object in a Trafodion database.
CREATE PROCEDURE Statement	Registers a Java method as a stored procedure in Java (SPJ) within a Trafodion database.
DROP FUNCTION Statement	Removes a user-defined function (UDF) from the Trafodion database.
DROP LIBRARY Statement	Removes a library object from the Trafodion database and also removes the library file referenced by the library object.
DROP PROCEDURE Statement	Removes a stored procedure in Java (SPJ) from the Trafodion database.
GRANT Statement	Grants privileges for accessing a library object or executing an SPJ or UDF to specified users.
REVOKE Statement	Revokes privileges for accessing a library object or executing an SPJ or UDF from specified users. UDF from specified users.

3.1.6. Prepared Statements

Use these statements to prepare and execute an SQL statement:

Statement	What It Does
EXECUTE Statement	Executes an SQL statement previously compiled by a PREPARE statement.
PREPARE Statement	Compiles an SQL statement for later use with the EXECUTE statement in the same session.

3.1.7. Control Statements

Use these statements to control the execution, default options, plans, and performance of DML statements:

Statement	What It Does
CONTROL QUERY CANCEL Statement	Cancels an executing query that you identify with a query ID.
CONTROL QUERY DEFAULT Statement	Changes a default attribute to influence a query plan.

3.1.8. Object Naming Statements

Use this statements to specify default ANSI names for the schema:

Statement	What It Does
SET SCHEMA Statement	Sets the default ANSI schema for unqualified object names for the current session.

3.1.9. SHOW, GET, and EXPLAIN Statements

Use these statements to display information about database objects or query execution plans:

Statement	What It Does
EXPLAIN Statement	Displays information contained in the query execution plan.
GET Statement	Displays the names of database objects, components, component privileges, roles, or users that exist in the Trafodion instance.
GET HBASE OBJECTS Statement	Displays a list of HBase objects through an SQL interface
GET VERSION OF METADATA Statement	Displays the version of the metadata in the Trafodion instance and indicates if the metadata is current.
GET VERSION OF SOFTWARE Statement	Displays the version of the Trafodion software that is installed on the system and indicates if it is current.
INVOKE Statement	Generates a record description that corresponds to a row in the specified table or view.
SHOWCONTROL Statement	Displays the CONTROL QUERY DEFAULT attributes in effect.
SHOWDDL Statement	Describes the DDL syntax used to create an object as it exists in the metadata, or it returns a description of a user, role, or component in the form of a GRANT statement.
SHOWDDL SCHEMA Statement	Displays the DDL syntax used to create a schema as it exists in the metadata and shows the authorization ID that owns the schema.
SHOWSTATS Statement	Displays the histogram statistics for one or more groups of columns within a table. These statistics are used to devise optimized access plans.

3.2. ALTER SEQUENCE Statement

The ALTER SEQUENCE Statement changes the future behavior of exiting sequence, including INCREMENT, MAXVALUE, CACHE and CYCLE.

Multiple options can be concurrently specified and separated by a space. Any options not altered will retain their previous settings.

ALTER SEQUENCE is a Trafodion SQL extension.

For more information, see [CREATE SEQUENCE Statement](#) or [DROP SEQUENCE Statement](#).

```
ALTER SEQUENCE [[catalog-name.]schema-name.]sequence  
[INCREMENT BY integer]  
[MAXVALUE integer | NO MAXVALUE]  
[CACHE integer]  
[CYCLE | NO CYCLE]
```

3.2.1. Syntax Description of ALTER SEQUENCE

The options above serve the same purposes as they serve when you create a sequence. For more information, see [CREATE SEQUENCE Statement](#).

NOTE:

- START WITH, MINVALUE, NO CACHE and DATA TYPE cannot be changed. Instead, drop and recreate the sequence specifying the desired options.
- The unused preallocated values will be lost if a sequence is altered.
- Some sequence values will be skipped if you change the INCREMENT BY before the first reference to seqnum(SEQUENCE, next).

3.2.2. Considerations for ALTER SEQUENCE

To issue an ALTER SEQUENCE statement, one of the following must be true:

- You are DB ROOT.
- You have the ALTER or ALTER_SEQUENCE component privilege for the SQL_OPERATIONS component.

3.2.3. Examples of ALTER SEQUENCE

The following statement changes the MAXVALUE and CACHE for the sequence named `employee_seq`, which is created in [Examples of CREATE SEQUENCE](#).

```
ALTER SEQUENCE employee_seq  
MAXVALUE 20000  
CACHE 30
```

3.3. ALTER TABLE Statement

The ALTER TABLE statement changes a Trafodion SQL table. See [Tables](#).



DDL statements are not currently supported in transactions. That means that you cannot run this statement inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run this statement, AUTOCOMMIT must be turned ON (the default) for the session.

```
ALTER TABLE name alter-action
```

alter-action is:

```
ADD [ IF NOT EXISTS ][COLUMN] column-definition
| ADD [CONSTRAINT constraint-name] table-constraint
| DROP CONSTRAINT constraint-name [RESTRICT]
| RENAME TO new-name
| DROP COLUMN [ IF EXISTS ] column-name
```

column-definition is:

```
column-name data-type
([DEFAULT default]
[[constraint constraint-name] column-constraint])
```

data-type is:

```
char[acter] [(length)[characters]]
[CHARACTER SET char-set-name]
[UPSHIFT] [[not] casespecific]
| char[acter] varying (length)
[character set char-set-name]
[upshift] [[not] casespecific]
| varchar (length) [character set char-set-name]
[upshift] [[not] casespecific]
| numeric [(precision [,scale])] [signed|unsigned]
| nchar [(length) [character set char-set-name]
[upshift] [[not] casespecific]
| nchar varying(length) [character set char-set-name]
[upshift] [[not] casespecific]
| smallint [signed|unsigned]
| int[eger] [signed|unsigned]
| largeint
| dec[imal] [(precision [,scale])] [signed|unsigned]
| float [(precision)]
| real
| double precision
| date
| time [(time-precision)]
```

```
| timestamp [(timestamp-precision)]  
| interval { start-field to end-field | single-field }
```

default is:

```
literal  
| null  
| currentdate  
| currenttime  
| currenttimestamp }
```

column-constraint is:

```
not null  
| unique  
| check (condition)  
| references ref-spec
```

table-constraint is:

```
unique (column-list)  
| check (condition)  
| foreign key (column-list) references ref-spec
```

ref-spec is:

```
referenced-table [(column-list)]
```

column-list is:

```
column-name[, column-name]...
```

3.3.1. Syntax Description of ALTER TABLE

- *name*

specifies the current name of the object. See [Database Object Names](#).

- ADD [COLUMN] *column-definition*

adds a column to *table*.

The clauses for the *column-definition* are:

- *column-name*

specifies the name for the new column in the table. *column-name* is an SQL identifier. *column-name* must be unique among column names in the table. If the column name is a Trafodion SQL reserved word, you must delimit it by enclosing it in double quotes. For example: "sql".myview. See [Identifiers](#).

- *data-type*

specifies the data type of the values that can be stored in *column-name*. See [Data Types](#) If a default is not specified, NULL is used.

- DEFAULT *default*

specifies a default value for the column or specifies that the column does not have a default value. You can declare the default value explicitly by using the DEFAULT clause, or you can enable null to be used as the default by omitting both the DEFAULT and NOT NULL clauses. If you omit the DEFAULT clause and specify NOT NULL, Trafodion SQL returns an error. For existing rows of the table, the added column takes on its default value.

If you set the default to the datetime value CURRENT_DATE, CURRENT_TIME, or CURRENT_TIMESTAMP, Trafodion SQL uses January 1, 1 A.D. 12:00:00.000000 as the default date and time for the existing rows.

For any row that you add after the column is added, if no value is specified for the column as part of the add row operation, the column receives a default value based on the current timestamp at the time the row is added.

- `[[constraint-name] column-constraint]`

specifies a name for the column or table constraint. *constraint-name* must have the same schema as *table* and must be unique among constraint names in its schema. if you omit the schema portions of the name you specify in *constraint-name*, trafodion sql expands the constraint name by using the schema for *table*. see [database object names](#).

if you do not specify a constraint name, trafodion sql constructs an sql identifier as the name for the constraint in the schema for *table*. the identifier consists of the fully qualified table name concatenated with a system-generated unique identifier. for example, a constraint on table a.b.c might be assigned a name such as a.b.c_123..._01....

- *column-constraint* options:

- `not null`

is a column constraint that specifies that the column cannot contain nulls. if you omit not null, nulls are allowed in the column. if you specify both not null and no default, then each row inserted in the table must include a value for the column. see [null](#).

- `unique`

is a column constraint that specifies that the column cannot contain more than one occurrence of the same value. if you omit unique, duplicate values are allowed unless the column is part of the primary key. columns that you define as unique must be specified as not null.

- `check (condition)`

is a constraint that specifies a condition that must be satisfied for each row in the table. see [search condition](#). you cannot refer to the current_date, current_time, or current_timestamp function in a check constraint, and you cannot use subqueries in a check constraint.

- `references ref-spec`

specifies a references column constraint. the maximum combined length of the columns for a references constraint is 2048 bytes.

- `ref-spec` is:

`referenced-table [(column-list)]`

`referenced-table` is the table referenced by the foreign key in a referential constraint. `referenced-table` cannot be a view. `referenced-table` cannot be the same as `table`. `referenced-table` corresponds to the foreign key in the `table`.

`column-list` specifies the column or set of columns in the `referenced-table` that corresponds to the foreign key in `table`. the columns in the column list associated with references must be in the same order as the columns in the column list associated with foreign key. if `column-list` is omitted, the referenced table's primary key columns are the referenced columns.

a table can have an unlimited number of referential constraints, and you can specify the same foreign key in more than one referential constraint, but you must define each referential constraint separately. you cannot create self-referencing foreign key constraints.

- `add [constraint constraint-name] table-constraint`

adds a constraint to the table and optionally specifies `constraint-name` as the name for the constraint. the new constraint must be consistent with any data already present in the table.

- constraint *constraint-name*

specifies a name for the column or table constraint. *constraint-name* must have the same schema as *table* and must be unique among constraint names in its schema. if you omit the schema portions of the name you specify in *constraint-name*, trafodion sql expands the constraint name by using the schema for table. see [database object names](#).

if you do not specify a constraint name, trafodion sql constructs an sql identifier as the name for the constraint in the schema for table. the identifier consists of the fully qualified table name concatenated with a system-generated unique identifier. for example, a constraint on table a.b.c might be assigned a name such as a.b.c_123..._01....

- *table-constraint* options:

- unique (*column-list*)

is a table constraint that specifies that the column or set of columns cannot contain more than one occurrence of the same value or set of values.

column-list cannot include more than one occurrence of the same column. in addition, the set of columns that you specify on a unique constraint cannot match the set of columns on any other unique constraint for the table or on the primary key constraint for the table. all columns defined as unique must be specified as not null.

a unique constraint is enforced with a unique index. if there is already a unique index on *column-list*, trafodion sql uses that index. if a unique index does not exist, the system creates a unique index.

- check (*condition*)

is a constraint that specifies a condition that must be satisfied for each row in the table. see [search condition](#). you cannot refer to the current_date, current_time, or current_timestamp function in a check constraint, and you cannot use subqueries in a check constraint.

- foreign key (*column-list*) references *ref-spec* not enforced

is a table constraint that specifies a referential constraint for the table, declaring that a column or set of columns (called a foreign key) in *table* can contain only values that match those in a column or set of columns in the table specified in the references clause. however, because not enforced is specified, this relationship is not checked.

the two columns or sets of columns must have the same characteristics (data type, length, scale, precision). without the foreign key clause, the foreign key in *table* is the column being defined; with the foreign key clause, the foreign key is the column or set of columns specified in the foreign key clause. for information about *ref-spec*, see [references ref-spec not enforced](#).

- `drop constraint constraint-name [restrict]`

drops a constraint from the table.

if you drop a constraint, trafodion sql drops its dependent index if trafodion sql originally created the same index. if the constraint uses an existing index, the index is not dropped.

- `constraint constraint-name`

specifies a name for the column or table constraint. *constraint-name* must have the same schema as *table* and must be unique among constraint names in its schema. if you omit the schema portions of the name you specify in *constraint-name*, trafodion sql expands the constraint name by using the schema for table. see [database object names](#).

if you do not specify a constraint name, trafodion sql constructs an sql identifier as the name for the constraint in the schema for table. the identifier consists of the fully qualified table name concatenated with a system-generated unique identifier. for example, a constraint on table a.b.c might be assigned a name such as a.b.c_123..._01....

- `rename to new-name`

changes the logical name of the object within the same schema.

- `new-name`

specifies the new name of the object after the rename to operation occurs.

- `add if not exists column-definition`

adds a column to *table* if it does not already exist in the table.

the clauses for the *column-definition* are the same as described in `add [column] column-definition`.

- `drop column [if exists] column-name`

drops the specified column from *table*, including the column's data. you cannot drop a primary key column.

3.3.2. Considerations for ALTER TABLE

Effect of Adding a Column on View Definitions

The addition of a column to a table has no effect on existing view definitions. Implicit column references specified by `SELECT *` in view definitions are replaced by explicit column references when the definition clauses are originally evaluated.

Authorization and Availability Requirements

`ALTER TABLE` works only on user-created tables.

Required Privileges

To issue an `ALTER TABLE` statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the table.
- You have the `ALTER` or `ALTER_TABLE` component privilege for the `SQL_OPERATIONS` component.

Privileges Needed to Create a Referential Integrity Constraint

To create a referential integrity constraint (that is, a constraint on the table that refers to a column in another table), one of the following must be true:

- You are DB ROOT.
- You are the owner of the referencing and referenced tables.
- You have these privileges on the referencing and referenced table:
 - For the referencing table, you have the `ALTER` or `ALTER_TABLE` component privilege for the `SQL_OPERATIONS` component.
 - For the referenced table, you have the `REFERENCES` (or `ALL`) privilege on the referenced table through your user name or through a granted role.

If the constraint refers to the other table in a query expression, you must also have `SELECT` privileges on the other table.

3.3.3. Example of ALTER TABLE

This example adds a column:

```
ALTER TABLE persnl.project
  ADD COLUMN projlead
    NUMERIC (4) UNSIGNED
```

3.4. ALTER USER Statement

The ALTER USER statement changes attributes associated with a user who is registered in the database.

ALTER USER is a Trafodion SQL extension.

```
ALTER USER database-username alter-action[, alter-action]
alter-action is:
  SET EXTERNAL NAME directory-service-username
  | SET { ONLINE | OFFLINE }
```

3.4.1. Syntax Description of ALTER USER

- *database-username*

is the name of a currently registered database user.

- SET EXTERNAL NAME

changes the name that identifies the user in the directory service. This is also the name the user specifies when connecting to the database.

- *directory-service-username*

specifies the new name of the user in the directory service.

- *directory-service-username* is a regular or delimited case-insensitive identifier. See [Case-Insensitive Delimited Identifiers](#).

- SET { ONLINE | OFFLINE }

changes the attribute that controls whether the user is allowed to connect to the database.

- ONLINE

specifies that the user is allowed to connect to the database.

- OFFLINE

specifies that the user is not allowed to connect to the database.

3.4.2. Considerations for ALTER USER

Only a user with user administrative privileges (that is, a user who has been granted the MANAGE_USERS component privilege) can do the following:

- Set the EXTERNAL NAME for any user
- Set the ONLINE | OFFLINE attribute for any user

Initially, DB_ROOT is the only database user who has been granted the MANAGE_USERS component privilege.

3.4.3. Examples of ALTER USER

- To change a user's external name:

```
ALTER USER ajones SET EXTERNAL NAME "Americas\ArturoJones";
```

- To change a user's attribute to allow the user to connect to the database:

```
ALTER USER ajones SET ONLINE;
```

3.5. BEGIN WORK Statement

The BEGIN WORK statement enables you to start a transaction explicitly—where the transaction consists of the set of operations defined by the sequence of SQL statements that begins immediately after BEGIN WORK and ends with the next COMMIT or ROLLBACK statement. See [Transaction Management](#). BEGIN WORK will raise an error if a transaction is currently active.

BEGIN WORK is a Trafodion SQL extension.

```
BEGIN WORK
```

3.5.1. Considerations for BEGIN WORK

BEGIN WORK starts a transaction. COMMIT WORK or ROLLBACK WORK ends a transaction.

3.5.2. Example of BEGIN WORK

Group three separate statements—two INSERT statements and an UPDATE statement—that update the database within a single transaction:

```
--- This statement initiates a transaction.  
BEGIN WORK;  
  
--- SQL operation complete.  
  
INSERT INTO sales.orders VALUES (125, DATE '2008-03-23', DAT '2008-03-30', 75, 7654);  
  
--- 1 row(s) inserted.  
  
INSERT INTO sales.odetail VALUES (125, 4102, 25000, 2);  
  
--- 1 row(s) inserted.  
  
UPDATE invent.partloc SET qty_on_hand = qty_on_hand - 2  
WHERE partnum = 4102 AND loc_code = 'G45';  
  
--- 1 row(s) updated.  
  
--- This statement ends a transaction.  
COMMIT WORK;  
  
--- SQL operation complete.
```

3.6. CALL Statement

The CALL statement invokes a stored procedure in Java (SPJ) in a Trafodion SQL database.

```
CALL procedure-ref ([argument-list])  
  
procedure-ref is:  
  [[catalog-name.]schema-name.]procedure-name  
  
argument-list is:  
  sql-expression[, sql-expression]...
```

3.6.1. Syntax Description of CALL

- *procedure-ref*

specifies an ANSI logical name of the form:

```
[[_catalog-name_.]schema-name.]procedure-name
```

where each part of the name is a valid sql identifier with a maximum of 128 characters. for more information, see [identifiers](#) and [database object names](#).

if you do not fully qualify the procedure name, trafodion sql qualifies it according to the schema of the current session.

- *argument-list*

accepts arguments for in, in-out, or out parameters. the arguments consist of sql expressions, including dynamic parameters, separated by commas:

```
sql-expression{, sql-expression}...
```

each expression must evaluate to a value of one of these data types:

- character value
- date-time value
- numeric value

interval value expressions are disallowed in SPJs. for more information, see [input parameter arguments](#) and [output parameter arguments](#).

do not specify result sets in the argument list.

3.6.2. Considerations for CALL

Usage Restrictions

You can use a CALL statement as a stand-alone SQL statement in applications or command-line interfaces, such as TrafCI. You cannot use a CALL statement inside a compound statement or with row sets.

Required Privileges

To issue a CALL statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the stored procedure.
- You have the EXECUTE (or ALL) privileges, either directly through your username or through a granted role. For more information, see the [GRANT Statement](#).

When the stored procedure executes, it executes as the Trafodion ID.

Input Parameter Arguments

You pass data to an SPJ by using IN or INOUT parameters. For an IN parameter argument, use one of these SQL expressions:

- Literal
- SQL function (including CASE and CAST expressions)
- Arithmetic or concatenation operation
- Scalar subquery
- Dynamic parameter (for example, ?) in an application
- Named (for example, ?param) or unnamed (for example, ?) parameter in TrafCI

For an INOUT parameter argument, you can use only a dynamic, named, or unnamed parameter. For more information, see [Expressions](#).

Output Parameter Arguments

An SPJ returns values in OUT and INOUT parameters. Output parameter arguments must be dynamic parameters in an application (for example, ?) or named or unnamed parameters in DCI (for example, ?param or ?). Each calling application defines the semantics of the OUT and INOUT parameters in its environment.

Data Conversion of Parameter Arguments

Trafodion SQL performs an implicit data conversion when the data type of a parameter argument is compatible with but does not match the formal data type of the stored procedure. For stored procedure input values, the conversion is from the actual argument value to the formal parameter type. For stored procedure output values, the conversion is from the actual output value, which has the data type of the formal parameter, to the declared type of the dynamic parameter.

Null Input and Output

You can pass a null value as input to or output from an SPJ, provided that the corresponding Java data type of the parameter supports nulls. If a null is input or output for a parameter that does not support nulls, Trafodion SQL returns an error.

Transaction Semantics

The CALL statement automatically initiates a transaction if no active transaction exists. However, the failure of a CALL statement does not always automatically abort the transaction.

3.6.3. Examples of CALL

- In TrafCI, execute an SPJ named MONTHLYORDERS, which has one IN parameter represented by a literal and one OUT parameter represented by an unnamed parameter, ?:

```
CALL sales.monthlyorders(3,?);
```

- This CALL statement executes a stored procedure, which accepts one IN parameter (a date literal), returns one OUT parameter (a row from the column, NUM_ORDERS), and returns two result sets:

```
CALL sales.ordersummary('01/01/2001', ?);
```

NUM_ORDERS

```
-----
13
```

ORDERNUM	NUM_PARTS	AMOUNT	ORDER_DATE	LAST_NAME
100210	4	19020.00	2006-04-10	HUGHES
100250	4	22625.00	2006-01-23	HUGHES
101220	4	45525.00	2006-07-21	SCHNABL
200300	3	52000.00	2006-02-06	SCHAEFFER
200320	4	9195.00	2006-02-17	KARAJAN
200490	2	1065.00	2006-03-19	WEIGL

```
-----
100210      4      19020.00 2006-04-10 HUGHES
100250      4      22625.00 2006-01-23 HUGHES
101220      4      45525.00 2006-07-21 SCHNABL
200300      3      52000.00 2006-02-06 SCHAEFFER
200320      4      9195.00 2006-02-17 KARAJAN
200490      2      1065.00 2006-03-19 WEIGL
```

.

.

.

--- 13 row(s) selected.

ORDERNUM	PARTNUM	UNIT_PRICE	QTY_ORDERED	PARTDESC
100210	2001	1100.00	3	GRAPHIC PRINTER,M1
100210	2403	620.00	6	DAISY PRINTER,T2
100210	244	3500.00	3	PC GOLD, 30 MB
100210	5100	150.00	10	MONITOR BW, TYPE 1
100250	6500	95.00	10	DISK CONTROLLER
100250	6301	245.00	15	GRAPHIC CARD, HR

```
-----
100210      2001    1100.00      3  GRAPHIC PRINTER,M1
100210      2403    620.00      6  DAISY PRINTER,T2
100210      244     3500.00      3  PC GOLD, 30 MB
100210      5100    150.00     10  MONITOR BW, TYPE 1
100250      6500    95.00      10  DISK CONTROLLER
100250      6301    245.00     15  GRAPHIC CARD, HR
```

.

.

.

--- 70 row(s) selected.

--- SQL operation complete.

3.7. COMMIT WORK Statement

The COMMIT WORK statement commits any changes to objects made during the current transaction and ends the transaction. See [Transaction Management](#).

WORK is an optional keyword that has no effect.

COMMIT WORK issued outside of an active transaction generates error 8605.

```
COMMIT [WORK]
```

3.7.1. Considerations for COMMIT WORK

BEGIN WORK starts a transaction. COMMIT WORK or ROLLBACK WORK ends a transaction.

3.7.2. Example of COMMIT WORK

Suppose that your application adds information to the inventory. You have received 24 terminals from a new supplier and want to add the supplier and update the quantity on hand. The part number for the terminals is 5100, and the supplier is assigned supplier number 17. The cost of each terminal is \$800.

The transaction must add the order for terminals to PARTSUPP, add the supplier to the SUPPLIER table, and update QTY_ON_HAND in PARTLOC. After the INSERT and UPDATE statements execute successfully, you commit the transaction, as shown:

```
-- This statement initiates a transaction.  
BEGIN WORK;  
  
--- SQL operation complete.  
  
-- This statement inserts a new entry into PARTSUPP.  
INSERT INTO invent.partsupp  
VALUES (5100, 17, 800.00, 24);  
  
--- 1 row(s) inserted.  
  
-- This statement inserts a new entry into SUPPLIER.  
INSERT INTO invent.supplier  
VALUES (17, 'Super Peripherals', '751 Sanborn Way',  
'Santa Rosa', 'California', '95405');  
  
--- 1 row(s) inserted.  
  
-- This statement updates the quantity in PARTLOC.  
UPDATE invent.partloc  
SET qty_on_hand = qty_on_hand + 24  
WHERE partnum = 5100 AND loc_code = 'G43';  
  
--- 1 row(s) updated.  
  
-- This statement ends a transaction.  
COMMIT WORK;  
  
--- SQL operation complete.
```

3.8. CONTROL QUERY CANCEL Statement

The CONTROL QUERY CANCEL statement cancels an executing query that you identify with a query ID. You can execute the CONTROL QUERY CANCEL statement in a client-based tool like TrafCI or through any ODBC or JDBC application.

CONTROL QUERY CANCEL is a Trafodion SQL extension.

```
CONTROL QUERY CANCEL QID query-id [COMMENT 'comment-text']
```

3.8.1. Syntax Description of CONTROL QUERY CANCEL

- *query-id*

specifies the query ID of an executing query, which is a unique identifier generated by the SQL compiler.

- 'comment-text'

specifies an optional comment to be displayed in the canceled query's error message.

3.8.2. Considerations for CONTROL QUERY CANCEL

Benefits of CONTROL QUERY CANCEL

For many queries, the CONTROL QUERY CANCEL statement allows the termination of the query without stopping the master executor process (MXOSRVR). This type of cancellation has these benefits over standard ODBC/JDBC cancel methods:

- An ANSI-defined error message is returned to the client session, and SQLSTATE is set to HY008.
- Important cached objects persist after the query is canceled, including the master executor process and its compiler, the compiled statements cached in the master, and the compiler's query cache and its cached metadata and histograms.
- The client does not need to reestablish its connection, and its prepared statements are preserved.
- When clients share connections using a middle-tier application server, the effects of canceling one client's executing query no longer affect other clients sharing the same connection.

Restrictions on CONTROL QUERY CANCEL

Some executing queries may not respond to a CONTROL QUERY CANCEL statement within a 60-second interval. For those queries, Trafodion SQL stops their ESP processes if there are any. If this action allows the query to be canceled, you will see all the benefits listed above.

If the executing query does not terminate within 120 seconds after the CONTROL QUERY CANCEL statement is issued, Trafodion SQL stops the master executor process, terminating the query and generating a lost connection error. In this case, you will not see any of the benefits listed above. Instead, you will lose your connection and will need to reconnect and re-prepare the query. This situation often occurs with the CALL, DDL, and utility statements and rarely with other statements.

The CONTROL QUERY CANCEL statement does not work with these statements:

- Unique queries, which operate on a single row and a single partition
- Queries that are not executing, such as a query that is being compiled
- CONTROL QUERY DEFAULT, BEGIN WORK, COMMIT WORK, ROLLBACK WORK, and EXPLAIN statements
- Statically compiled metadata queries
- Queries executed in anomalous conditions, such as queries without runtime statistics or without a query ID

Required Privileges

To issue a CONTROL QUERY CANCEL statement, one of the following must be true:

- You are DB ROOT.
- You own (that is, issued) the query.
- You have the QUERY_CANCEL component privilege for the SQL_OPERATIONS component.

3.8.3. Example of CONTROL QUERY CANCEL

This CONTROL QUERY CANCEL statement cancels a specified query and provides a comment concerning the cancel operation:

```
control query cancel qid  
MXID11000010941212288634364991407000000003806U3333300_156016_S1 comment  
'Query is consuming too many resources.';
```

In a separate session, the client that issued the query will see this error message indicating that the query has been canceled:

```
>>execute s1;  
  
*** ERROR[8007] The operation has been canceled. Query is consuming too many resources.
```

3.9. CONTROL QUERY DEFAULT Statement

The CONTROL QUERY DEFAULT statement changes the default settings for the current process. You can execute the CONTROL QUERY DEFAULT statement in a client-based tool like TrafCI or through any ODBC or JDBC application.

CONTROL QUERY DEFAULT is a Trafodion SQL extension.

```
{ CONTROL QUERY DEFAULT | CQD } control-default-option  
control-default-option is:  
    attribute {'attr-value' | RESET}
```

3.9.1. Syntax Description of CONTROL QUERY DEFAULT

- *attribute*

is a character string that represents an attribute name. For descriptions of these attributes, see the [Trafodion Control Query Default \(CQD\) Reference Guide](#).

- *attr-value*

is a character string that specifies an attribute value. You must specify *attr-value* as a quoted string—even if the value is a number.

- RESET

specifies that the attribute that you set by using a CONTROL QUERY DEFAULT statement in the current session is to be reset to the value or values in effect at the start of the current session.

3.9.2. Considerations for CONTROL QUERY DEFAULT

Scope of CONTROL QUERY DEFAULT

The result of the execution of a CONTROL QUERY DEFAULT statement stays in effect until the current process terminates or until the execution of another statement for the same attribute overrides it.

CQDs are applied at compile time, so CQDs do not affect any statements that are already prepared. For example:

```
PREPARE x FROM SELECT * FROM t;
CONTROL QUERY DEFAULT SCHEMA 'myschema';
EXECUTE x;                                -- uses the default schema SEABASE
SELECT * FROM t2;                          -- uses MYSCHHEMA;
PREPARE y FROM SELECT * FROM t3;
CONTROL QUERY DEFAULT SCHEMA 'seabase';
EXECUTE y;                                -- uses MYSCHHEMA;
```

3.9.3. Examples of CONTROL QUERY DEFAULT

- Increase the cache refresh time for the histogram cache to two hours (7,200 minutes).

```
CONTROL QUERY DEFAULT CACHE_HISTOGRAMS_REFRESH_INTERVAL '7200';
```

- Reset the CACHE_HISTOGRAMS_REFRESH_INTERVAL attribute to its initial value in the current process:

```
CONTROL QUERY DEFAULT CACHE_HISTOGRAMS_REFRESH_INTERVAL RESET;
```

3.10. CREATE FUNCTION Statement

The CREATE FUNCTION statement registers a user-defined function (UDF) written in C as a function within a Trafodion database. Currently, Trafodion supports the creation of *scalar UDFs*, which return a single value or row when invoked. Scalar UDFs are invoked as SQL expressions in the SELECT list or WHERE clause of a SELECT statement.



DDL statements are not currently supported in transactions. That means that you cannot run this statement inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run this statement, AUTOCOMMIT must be turned ON (the default) for the session.

```

CREATE FUNCTION function-ref ([parameter-declaration[, parameter-declaration]...])
  {RETURN | RETURNS}
    (return-parameter-declaration[, return-parameter-declaration]...)
  EXTERNAL NAME 'character-string-literal'
  LIBRARY [[catalog-name.]schema-name.]library-name
  [language c]
  [parameter style sql]
  [no sql]
  [not deterministic | deterministic]
  [final call | no final call]
  [no state area | state area size]
  [no parallelism | allow any parallelism]

function-ref is:
  [[catalog-name.]schema-name.]function-name

parameter-declaration is:
  [in] [sql-parameter-name] sql-datatype

return-parameter-declaration is:
  [out] [sql-parameter-name] sql-datatype

```

3.10.1. Syntax Description of CREATE FUNCTION

- *function-ref* ([parameter-declaration[,parameter-declaration]...])

specifies the name of the function and any SQL parameters that correspond to the signature of the external function.

- *function-ref*

specifies an ANSI logical name of the form:

[[_catalog-name_.]schema-name.]*function-name*

where each part of the name is a valid sql identifier with a maximum of 128 characters. for more information, see [identifiers](#) and [database object names](#).

specify a name that is unique and does not exist for any procedure or function in the same schema.

if you do not fully qualify the function name, trafodion sql qualifies it according to the schema of the current session.

- *parameter-declaration*

specifies an sql parameter that corresponds to the signature of the external function:

[in] [*sql-parameter-name*] *sql-datatype*

- in

specifies that the parameter passes data to the function.

- *sql-parameter-name*

specifies an sql identifier for the parameter. for more information, see [identifiers](#).

- *sql-datatype*

specifies an sql data type that corresponds to the data type of the parameter in the signature of the external function. *sql-datatype* is one of the supported sql data types in trafodion. see [data types](#).

- {return | returns} (*return-parameter-declaration*[, *return-parameter-declaration*]...)

specifies the type of output of the function.

- *return-parameter-declaration*

specifies an sql parameter for an output value:

```
[out] [sql-parameter-name] sql-datatype
```

- *out*

specifies that the parameter accepts data from the function.

- *sql-parameter-name*

specifies an sql identifier for the return parameter. for more information, see [identifiers](#).

- *sql-datatype*

specifies an sql data type for the return parameter. *sql-datatype* is one of the supported sql data types in trafodion. see [data types](#).

- external name '*method-name*'

specifies the case-sensitive name of the external function's method.

- library [*_catalog-name_*.]*schema-name*.*library-name*

specifies the ANSI logical name of a library containing the external function. if you do not fully qualify the library name, trafodion sql qualifies it according to the schema of the current session.

- language c

specifies that the external function is written in the c language. this clause is optional.

- parameter style sql

specifies that the run-time conventions for arguments passed to the external function are those of the sql language.

this clause is optional.

- `no sql`

specifies that the function does not perform sql operations. this clause is optional.

- `deterministic | not deterministic`

specifies whether the function always returns the same values for out parameters for a given set of argument values (deterministic, the default behavior) or does not return the same values (not deterministic). if the function is deterministic, trafodion sql is not required to execute the function each time to produce results; instead, trafodion sql caches the results and reuses them during subsequent executions, thus optimizing the execution.

- `final call | no final call`

specifies whether or not a final call is made to the function. a final call enables the function to free up system resources. the default is final call.

- `no state area | state area size`

specifies whether or not a state area is allocated to the function. *size* is an integer denoting memory in bytes. acceptable values range from 0 to 16000. the default is no state area.

- `no parallelism | allow any parallelism`

specifies whether or not parallelism is applied when the function is invoked. the default is allow any parallelism.

3.10.2. Considerations for CREATE FUNCTION

Required Privileges

To issue a CREATE FUNCTION statement, one of the following must be true:

- You are DB ROOT.
- You are creating the function in a shared schema, and you have the USAGE (or ALL) privilege on the library that will be used in the creation of the function. The USAGE privilege provides you with read access to the library's underlying library file.
- You are the private schema owner and have the USAGE (or ALL) privilege on the library that will be used in the creation of the function. The USAGE privilege provides you with read access to the library's underlying library file.
- You have the CREATE or CREATE_ROUTINE component level privilege for the SQL_OPERATIONS component and have the USAGE (or ALL) privilege on the library that will be used in the creation of the function. The USAGE privilege provides you with read access to the library's underlying library file.



In this case, if you create a function in a private schema, it will be owned by the schema owner.

3.10.3. Examples of CREATE FUNCTION

- This CREATE FUNCTION statement creates a function that adds two integers:

```
create function add2 (int, int)
    returns (total_value int)
    external name 'add2'
    library myudflib;
```

- This CREATE FUNCTION statement creates a function that returns the minimum, maximum, and average values of five input integers:

```
create function mma5 (int, int, int, int, int)
    returns (min_value int, max_value int, avg_value int)
    external name 'mma5'
    library myudflib;
```

- This CREATE FUNCTION statement creates a function that reverses an input string of at most 32 characters:

```
create function reverse (varchar(32))
    returns (reversed_string varchar(32))
    external name 'reverse'
    library myudflib;
```

3.11. CREATE INDEX Statement

The CREATE INDEX statement creates an SQL index based on one or more columns of a table or table-like object.

CREATE INDEX is a Trafodion SQL extension.

 DDL statements are not currently supported in transactions. That means that you cannot run this statement inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run this statement, AUTOCOMMIT must be turned ON (the default) for the session.

```
CREATE [VOLATILE | UNIQUE] INDEX index ON table
  (column-name [ASC[ENDING] | DESC[ENDING]]
  [,column-name [ASC[ENDING] | DESC[ENDING]]]...)
  [HBASE_OPTIONS (hbase-options-list)]
  [SALT LIKE TABLE]

hbase-options-list is:
  hbase-option = 'value'[, hbase-option = 'value']...
```

3.11.1. Syntax Description of CREATE INDEX

- VOLATILE

The CREATE VOLATILE INDEX statement creates an SQL index with a lifespan that is limited to the SQL session that the index is created. Volatile indexes are dropped automatically when the session ends. See [Indexes](#).

- UNIQUE

The CREATE UNIQUE INDEX statement creates a unique index on a table and enforces uniqueness for the indexed field, that is, it imposes the restriction that any duplicate column values are disallowed and must be eliminated before creating a unique index on a column.

Unique index not only improves the query performance, but also provides data integrity checking. The constraint is checked when rows of the table are inserted or updated.



Multiple NULL values are treated as duplicate values for a column which can contain only one NULL value.

- *index*

is an SQL identifier that specifies the simple name for the new index. You cannot qualify *index* with its schema name. Indexes have their own name space within a schema, so an index name might be the same as a table or constraint name. However, no two indexes in a schema can have the same name.

- *table*

is the name of the table for which to create the index. See [Database Object Names](#).

- *column-name* [ASC[ENDING] | DESC[ENDING]] [, *column-name* [ASC[ENDING] | DESC[ENDING]]]...

specifies the columns in *table* to include in the index. The order of the columns in the index need not correspond to the order of the columns in the table.

ASCENDING or DESCENDING specifies the storage and retrieval order for rows in the index. The default is ASCENDING.

Rows are ordered by values in the first column specified for the index. If multiple index rows share the same value for the first column, the values in the second column are used to order the rows, and so forth. If duplicate index rows occur in a non-unique index, their order is based on the sequence specified for the columns of the key of the underlying table. For ordering (but not for other purposes), nulls are greater than other values.

- HBASE_OPTIONS (*hbase-option* = 'value' [, *hbase-option* = 'value']...)

a list of HBase options to set for the index. These options are applied independently of any HBase options set for the index's table.

- *hbase-option* = 'value'

is one of the these HBase options and its assigned value:

HBase Option	Accepted Values ¹
BLOCKCACHE	'true' 'false'
BLOCKSIZE	*65536'('positive-integer'
BLOOMFILTER	'NONE' 'ROW' 'ROWCOL'
CACHE_BLOOMS_ON_WRITE	'true' 'false'
CACHE_DATA_ON_WRITE	'true' 'false'
CACHE_INDEXES_ON_WRITE	'true' 'false'
COMPACT	'true' 'false'
COMPACT_COMPRESSION	'GZ' 'LZ4' 'LZO' 'NONE' 'SNAPPY'
COMPRESSION	'GZ' 'LZ4' 'LZO' 'NONE' 'SNAPPY'
DATA_BLOCK_ENCODING	'DIFF' 'FAST_DIFF' 'NONE' 'PREFIX'
DURABILITY	'USE_DEFAULT' 'SKIP_WAL' 'ASYNC_WAL' 'SYNC_WAL' 'FSYNC_WAL'

HBase Option	Accepted Values ¹
EVICT_BLOCKS_ON_CLOSE	'true' 'false'
IN_MEMORY	'true' 'false'
KEEP_DELETED_CELLS	'true' 'false'
MAX_FILESIZE	'positive-integer'
MAX VERSIONS	'1' 'positive-integer'
MEMSTORE_FLUSH_SIZE	'positive-integer'
MIN VERSIONS	'0' 'positive-integer'
PREFIX_LENGTH_KEY	'positive-integer', which should be less than maximum length of the key for the table. It applies only if the SPLIT_POLICY is KeyPrefixRegionSplitPolicy.
REPLICATION_SCOPE	'0' '1'
SPLIT_POLICY	'org.apache.hadoop.hbase.regionserver.ConstantSizeRegionSplitPolicy' 'org.apache.hadoop.hbase.regionserver.IncreasingToUpperBoundRegionSplitPolicy' 'org.apache.hadoop.hbase.regionserver.KeyPrefixRegionSplitPolicy'
TTL	'-1' (forever) 'positive-integer'

¹ Values in boldface are default values.

- SALT LIKE TABLE

causes the index to use the same salting scheme (that is, `SALT USING num PARTITIONS [ON (column[, column]...)]`) as its base table.

3.11.2. Considerations for CREATE INDEX

Indexes are created under a single transaction. When an index is created, the following steps occur:

- Transaction begins (either a user-started transaction or a system-started transaction).
- Rows are written to the metadata.
- Physical labels are created to hold the index (as non audited).
- The base table is locked for read shared access which prevents inserts, updates, and deletes on the base table from occurring.
- The index is loaded by reading the base table for read uncommitted access using side tree inserts.



A side tree insert is a fast way of loading data that can perform specialized optimizations because the partitions are not audited and empty.

- After load is complete, the index audit attribute is turned on and it is attached to the base table (to bring the index online).
- The transaction is committed, either by the system or later by the requester.

If the operation fails after basic semantic checks are performed, the index no longer exists and the entire transaction is rolled back even if it is a user-started transaction.

Authorization and Availability Requirements

An index always has the same security as the table it indexes.

CREATE INDEX locks out INSERT, DELETE, and UPDATE operations on the table being indexed. If other processes have rows in the table locked when the operation begins, CREATE INDEX waits until its lock request is granted or timeout occurs.

You cannot access an index directly.

Required Privileges

To issue a CREATE INDEX statement, one of the following must be true:

- You are DB ROOT.
- You are creating the table in a shared schema.
- You are the private schema owner.
- You are the owner of the table.
- You have the ALTER, ALTER_TABLE, CREATE, or CREATE_INDEX component privilege for the SQL_OPERATIONS component.



In this case, if you create an index in a private schema, it will be owned by the schema owner.

Limits on Indexes

For non-unique indexes, the sum of the lengths of the columns in the index plus the sum of the length of the clustering key of the underlying table cannot exceed 2048 bytes.

No restriction exists on the number of indexes per table.

3.11.3. Examples of CREATE INDEX

- This example creates an index on two columns of a table:

```
CREATE INDEX xempname  
ON persnl.employee (last_name, first_name);
```

- This example shows that a volatile index can be created only on a volatile table.

```

SQL>create volatile table test2(c1 int);
--- SQL operation complete.

SQL>create volatile index idx_test2 on test2(c1);
--- SQL operation complete.

SQL>create table test1(c1 int);
--- SQL operation complete.

SQL>create volatile index idx_test1 on test1 (c1);

*** ERROR[4082] Object TEST1 does not exist or is inaccessible. [2017-01-13
11:35:26]

```

- This example shows a unique index can be created on a table which has only one NULL value.

```

SQL>select * from t25;

A          B
-----
1    NULL
2    aaa

--- 2 row(s) selected.

SQL>create unique index idx_t25 on t25(b);
--- SQL operation complete.

SQL>showddl t25;

CREATE TABLE TRAFODION.SEABASE.T25
(
  A          INT DEFAULT NULL NOT SERIALIZED,
  B          CHAR(10) CHARACTER SET ISO88591 COLLATE DEFAULT
DEFAULT NULL NOT SERIALIZED
)
ATTRIBUTES ALIGNED FORMAT;

CREATE UNIQUE INDEX IDX_T25 ON TRAFODION.SEABASE.T25
(
  B ASC
)
ATTRIBUTES ALIGNED FORMAT;

--- SQL operation complete.

```

- This example shows a unique index cannot be created on a table which has multiple NULL values.

```
SQL>select * from t25;

A          B
-----
1  NULL
2  aaa

--- 2 row(s) selected.

SQL>create unique index idx_t25 on t25(b);

*** ERROR[8110] Duplicate rows detected. [2017-01-12 17:17:51]
*** ERROR[1053] Unique index TRAFODION.SEABASE.IDX_T25 could not be created because
the specified column(s) contain duplicate data. [2017-01-12 17:17:51]
```

3.12. CREATE LIBRARY Statement

The CREATE LIBRARY statement registers a library object in a Trafodion database. A library object can be an SPJ's JAR file or a UDF's library file.

CREATE LIBRARY is a Trafodion SQL extension.



DDL statements are not currently supported in transactions. That means that you cannot run this statement inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run this statement, AUTOCOMMIT must be turned ON (the default) for the session.

```
CREATE LIBRARY [ [_catalog-name_.]schema-name.]library-name  
    file 'library-filename'  
    [host name 'host-name']  
    [local file 'host-filename']
```

3.12.1. Syntax Description of CREATE LIBRARY

- [[_catalog-name_.]schema-name.]library-name

specifies the ANSI logical name of the library object, where each part of the name is a valid sql identifier with a maximum of 128 characters. specify a name that is unique and does not exist for libraries in the same schema. if you do not fully qualify the library name, trafodion sq qualifies it according to the schema of the current session. for more information, see [identifiers](#) and [database object names](#).

- `file 'library-filename'`

specifies the full path of a deployed library file, which either an SPJ's jar file or a UDF's library file.

note: make sure to upload the library file to the trafodion cluster and then copy the library file to the same directory on all the nodes in the cluster before running the create library statement. otherwise, you will see an error message indicating that the jar or dll file was not found.

- `host name 'host-name'`

specifies the name of the client host machine where the deployed file resides.

- `local file 'host-filename'`

specifies the path on the client host machine where the deployed file is stored.

3.12.2. Considerations for CREATE LIBRARY

- A library object cannot refer to a library file referenced by another library object. If the *library-filename* is in use by another library object, the CREATE LIBRARY command will fail.
- The *library-filename* must specify an existing file. Otherwise, the CREATE LIBRARY command will fail.
- The CREATE LIBRARY command does not verify that the specified *library-filename* is a valid executable file.
- HOST NAME and LOCAL FILE are position dependent.

Required Privileges

To issue a CREATE LIBRARY statement, one of the following must be true:

- You are DB ROOT.
- You are creating the library in a shared schema and have the MANAGE_LIBRARY privilege.
- You are the private schema owner and have the MANAGE_LIBRARY privilege.
- You have the CREATE or CREATE_LIBRARY component privilege for the SQL_OPERATIONS component and have the MANAGE_LIBRARY privilege.



In this case, if you create a library in a private schema, it will be owned by the schema owner.

3.12.3. Examples of CREATE LIBRARY

- This CREATE LIBRARY statement registers a library named SALESLIB in the SALES schema for a JAR file (SPJs):

```
CREATE LIBRARY sales.saleslib FILE '/opt/home/trafodion/spjjars/Sales.jar';
```

- This CREATE LIBRARY statement registers a library named MYUDFS in the default schema for a library file (UDFs):

```
CREATE LIBRARY myudfs FILE $UDFLIB;
```

3.13. CREATE PROCEDURE Statement

The CREATE PROCEDURE statement registers a Java method as a stored procedure in Java (SPJ) within a Trafodion database.



DDL statements are not currently supported in transactions. That means that you cannot run this statement inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run this statement, AUTOCOMMIT must be turned ON (the default) for the session.

```

CREATE PROCEDURE procedure-ref([sql-parameter-list])
  EXTERNAL NAME 'java-method-name [java-signature]'
  LIBRARY [[catalog-name.]schema-name.]library-name
  [external security external-security-type]
  language java
  parameter style java
  [no sql | contains sql | modifies sql data | reads sql data]
  [dynamic result sets integer]
  [transaction required | no transaction required]
  [deterministic | not deterministic]
  [no isolate | isolate]

procedure-ref is:
  [[catalog-name.]schema-name.]procedure-name

sql-parameter-list is:
  sql-parameter[, sql-parameter]...

sql-parameter is:
  [parameter-mode] [sql-identifier] sql-datatype

parameter-mode is:
  in
  | out
  | inout

java-method-name is:
  [package-name.]class-name.method-name

java-signature is:
  ([java-parameter-list])

java-parameter-list is:
  java-datatype[, java-datatype]...

external-security-type is:
  definer
  | invoker

```



delimited variables in this syntax diagram are case-sensitive. case-sensitive variables include *java-method-name*, *java-signature*, and *class-file-path*, and any delimited part of the *procedure-ref*. the remaining syntax is not case-sensitive.

3.13.1. Syntax Description of CREATE PROCEDURE

- *procedure-ref*([*sql-parameter*[, *sql-parameter*]...])

specifies the name of the stored procedure in Java (SPJ) and any SQL parameters that correspond to the signature of the SPJ method.

- *procedure-ref*

specifies an ANSI logical name of the form:

[[_catalog-name_.]schema-name.]procedure-name

where each part of the name is a valid SQL identifier with a maximum of 128 characters. For more information, see [identifiers](#) and [database object names](#).

specify a name that is unique and does not exist for any procedure or function in the same schema. Trafodion does not support the overloading of procedure names. That is, you cannot register the same procedure name more than once with different underlying SPJ methods.

If you do not fully qualify the procedure name, then Trafodion qualifies it according to the schema of the current session.

- *sql-parameter*

specifies an SQL parameter that corresponds to the signature of the SPJ method:

[*parameter-mode*] [*sql-identifier*] *sql-datatype*

- *parameter-mode*

specifies the mode *in*, *out*, or *inout* of a parameter. The default is *in*.

- *in*

specifies a parameter that passes data to an SPJ.

- `out`

specifies a parameter that accepts data from an SPJ. The parameter must be an array.

- `inout`

specifies a parameter that passes data to and accepts data from an SPJ. The parameter must be an array.

- `sql-identifier`

specifies an SQL identifier for the parameter. For more information, see [Identifiers](#).

- `sql-datatype`

specifies an SQL data type that corresponds to the Java parameter of the SPJ method.

`sql-datatype` can be:

sql data type	maps to java data type...
<code>char[acter]</code>	
<code>char[acter] varying</code>	<code>java.lang.string</code>
<code>varchar</code>	
<code>pic[tur]e] x¹</code>	
<code>nchar</code>	
<code>nchar varying</code>	
<code>national char[acter]</code>	
<code>national char[acter] varying</code>	
<code>date</code>	<code>java.sql.date</code>
<code>time</code>	<code>java.sql.time</code>
<code>timestamp</code>	<code>java.sql.timestamp</code>
<code>dec²</code>	<code>java.math.BigDecimal</code>
<code>pic[tur]e] s9³</code>	
<code>numeric (including numeric with a precision greater than eighteen)²</code>	
<code>smallint²</code>	<code>short</code>
<code>int²</code>	<code>int or java.lang.Integer⁴</code>
<code>largeint²</code>	<code>long or java.lang.Long⁴</code>
<code>float</code>	<code>double or java.lang.Double⁴</code>
<code>real</code>	<code>float or java.lang.Float⁴</code>
<code>double precision</code>	<code>double or java.lang.Double⁴</code>

1. the Trafodion database stores `pic x` as a `char` data type.
2. numeric data types of SQL parameters must be signed, which is the default in the Trafodion database.
3. the Trafodion database stores `pic s9` as a `decimal` or `numeric` data type.

4. by default, the sql data type maps to a java primitive type. the sql data type maps to a java wrapper class only if you specify the wrapper class in the java signature of the external name clause.

for more information, see [data types](#).

- **external name '*java-method-name* [*java-signature*]'**

- *java-method-name*

specifies the case-sensitive name of the SPJ method of the form:

class-name.method-name

The Java method must exist in a Java class file, *class-name.class*, within a library registered in the database. The Java method must be defined as `public` and `static` and have a return type of `void`.

If the class file that contains the SPJ method is part of a package, then you must also specify the package name. If you do not specify the package name, the create procedure statement fails to register the SPJ.

- *java-signature*

specifies the signature of the SPJ method and consists of:

([*java-datatype* [, *java-datatype*]...])

The Java signature is necessary only if you want to specify a Java wrapper class (for example, `java.lang.integer`) instead of a java primitive data type (for example, `int`). An SQL data type maps to a Java primitive data type by default.

The Java signature is case-sensitive and must be placed within parentheses, such as (`java.lang.integer`, `java.lang.integer`). The signature must specify each of the parameter data types in the order they appear in the Java method definition within the class file. Each Java data type that corresponds to an out or inout parameter must be followed by empty square brackets ([]), such as `java.lang.integer[]`.

- `java-datatype`
Specifies a mappable Java data type. For the mapping of the Java data types to SQL data types, see `sql-datatype`.
- `library [[_catalog-name_.]schema-name.]library-name`
specifies the ANSI logical name of a library containing the SPJ method. If you do not fully qualify the library name, then Trafodion qualifies it according to the schema of the current session.
- `external security external-security-type`
determines the privileges, or rights, that users have when executing (or calling) the SPJ. An SPJ can have one of these types of external security:
 - `invoker` determines that users can execute, or invoke, the stored procedure using the privileges of the user who invokes the stored procedure. This behavior is referred to as *invoker rights* and is the default behavior if external security is not specified. Invoker rights allow a user who has the execute privilege on the SPJ to call the SPJ using his or her existing privileges. In this case, the user must be granted privileges to access the underlying database objects on which the SPJ operates.

 Granting a user privileges to the underlying database objects gives the user direct access to those database objects, which could pose a risk to more sensitive or critical data to which users should not have access. For example, an SPJ might operate on a subset of the data in an underlying database object but that database object might contain other more sensitive or critical data to which users should not have access.
 - `definer` determines that users can execute, or invoke, the stored procedure using the privileges of the user who created the stored procedure. This behavior is referred to as *definer rights*. The advantage of definer rights is that users are allowed to manipulate data by invoking the stored procedure without having to be granted privileges to the underlying database objects. That way, users are restricted from directly accessing or manipulating more sensitive or critical data in the database. However, be careful about the users to whom you grant execute privilege on an SPJ with definer external security because those users will be able to execute the SPJ without requiring privileges to the underlying database objects.

- `language java`

specifies that the external user-defined routine is written in the Java language.

- `parameter style java`

specifies that the run-time conventions for arguments passed to the external user-defined routine are those of the Java language.

- `no sql`

specifies that the SPJ cannot perform SQL operations.

- `contains sql | modifies sql data | reads sql data`

specifies that the SPJ can perform SQL operations. All these options behave the same as `contains sql`, meaning that the SPJ can read and modify SQL data. Use one of these options to register a method that contains SQL statements. If you do not specify an SQL access mode, then the default is `contains sql`.

- `dynamic result sets integer`

specifies the maximum number of result sets that the SPJ can return. This option is applicable only if the method signature contains a `java.sql.ResultSet[]` object. If the method contains a result set object, then the valid range is 1 to 255 inclusive. The actual number of result sets returned by the SPJ method can be fewer than or equal to this number. If you do not specify this option, then the default value is 0 (zero), meaning that the SPJ does not return result sets.

- `transaction required | no transaction required`

determines whether the SPJ must run in a transaction inherited from the calling application (`transaction required`, the default option) or whether the SPJ runs without inheriting the calling application's transaction (`no transaction required`). Typically, you want the stored procedure to inherit the transaction from the calling application. However, if the SPJ method does not access the database or if you want the stored procedure to manage its own transactions, then you should set the stored procedure's transaction attribute to no transaction required. For more information, see [Effects of the transaction attribute on SPJs](#).

- `deterministic | not deterministic`

specifies whether the SPJ always returns the same values for out and inout parameters for a given set of argument values (`deterministic`) or does not return the same values (`not deterministic`, the default option). If you specify `deterministic`, Trafodion is not required to call the SPJ each time to produce results; instead, Trafodion caches the results and reuses them during subsequent calls, thus optimizing the CALL statement.

- `no isolate | isolate`

specifies that the SPJ executes either in the environment of the database server (`no isolate`) or in an isolated environment (`isolate`, the default option). Trafodion allows both options but always executes the SPJ in the UDR server process (`isolate`).

3.13.2. Considerations for CREATE PROCEDURE

Required Privileges

To issue a CREATE PROCEDURE statement, one of the following must be true:

- You are DB ROOT.
- You are creating the procedure in a shared schema, and you have the USAGE (or ALL) privilege on the library that will be used in the creation of the stored procedure. The USAGE privilege provides you with read access to the library's underlying JAR file, which contains the SPJ Java method.
- You are the private schema owner and have the USAGE (or ALL) privilege on the library that will be used in the creation of the stored procedure. The USAGE privilege provides you with read access to the library's underlying JAR file, which contains the SPJ Java method.
- You have the CREATE or CREATE_ROUTINE component level privilege for the SQL_OPERATIONS component and have the USAGE (or ALL) privilege on the library that will be used in the creation of the stored procedure. The USAGE privilege provides you with read access to the library's underlying JAR file, which contains the SPJ Java method.



In this case, if you create a stored procedure in a private schema, it will be owned by the schema owner.

Effects of the Transaction Attribute on SPJs

Transaction Required

Using Transaction Control Statements or Methods

If you specify TRANSACTION REQUIRED (the default option), a CALL statement automatically initiates a transaction if there is no active transaction. In this case, you should not use transaction control statements (or equivalent JDBC transaction methods) in the SPJ method. Transaction control statements include COMMIT WORK and ROLLBACK WORK, and the equivalent JDBC transaction methods are `Connection.commit()` and `Connection.rollback()`. If you try to use transaction control statements or methods in an SPJ method when the stored procedure's transaction attribute is set to TRANSACTION REQUIRED, then the transaction control statements or methods in the SPJ method are ignored, and the Java virtual machine (JVM) does not report any errors or warnings. When the stored procedure's transaction attribute is set to TRANSACTION REQUIRED, then you should rely on the transaction control statements or methods in the application that calls the stored procedure and allow the calling application to manage the transactions.

Committing or Rolling Back a Transaction

If you do not use transaction control statements in the calling application, then the transaction initiated by the CALL statement might not automatically commit or roll back changes to the database. When AUTOCOMMIT is ON (the default setting), the database engine automatically commits or rolls back any changes made to the database at the end of the CALL statement execution. However, when AUTOCOMMIT is OFF, the current transaction remains active until the end of the client session or until you explicitly commit or roll back the transaction. To ensure an atomic unit of work when calling an SPJ, use the COMMIT WORK statement in the calling application to commit the transaction when the CALL statement succeeds, and use the ROLLBACK WORK statement to roll back the transaction when the CALL statement fails.

No Transaction Required

In some cases, you might not want the SPJ method to inherit the transaction from the calling application. Instead, you might want the stored procedure to manage its own transactions or to run without a transaction. Not inheriting the calling application's transaction is useful in these cases:

- The stored procedure performs several long-running operations, such as multiple DDL or table maintenance operations, on the database. In this case, you might want to commit those operations periodically from within the SPJ method to avoid locking tables for a long time.
- The stored procedure performs certain SQL operations that must run without an active transaction. For example, INSERT, UPDATE, and DELETE statements with the WITH NO ROLLBACK option are rejected when a transaction is already active, as is the case when a stored procedure inherits a transaction from the calling application. The PURGEDATA utility is also rejected when a transaction is already active.
- The stored procedure does not access the database. In this case, the stored procedure does not need to inherit the transaction from the calling application. By setting the stored procedure's transaction attribute to NO TRANSACTION REQUIRED, you can avoid the overhead of the calling application's transaction being propagated to the stored procedure.

In these cases, you should set the stored procedure's transaction attribute to NO TRANSACTION REQUIRED when creating the stored procedure.

If you specify NO TRANSACTION REQUIRED and if the SPJ method creates a JDBC default connection, that connection will have autocommit enabled by default. You can either use the autocommit transactions or disable autocommit (`conn.setAutoCommit(false);`) and use the JDBC transaction methods, `Connection.commit()` and `Connection.rollback()`, to commit or roll back work where needed.

3.13.3. Examples of CREATE PROCEDURE

- This CREATE PROCEDURE statement registers an SPJ named LOWERPRICE, which does not accept any arguments:

```
SET SCHEMA SALES;

CREATE PROCEDURE lowerprice()
  EXTERNAL NAME 'Sales.lowerPrice'
  LIBRARY saleslib
  LANGUAGE JAVA
  PARAMETER STYLE JAVA
  MODIFIES SQL DATA;
```

Because the procedure name is not qualified by a catalog and schema, Trafodion qualifies it according to the current session settings, where the catalog is TRAFODION (by default) and the schema is set to SALES. Since the procedure needs to be able to read and modify SQL data, MODIFIES SQL DATA is specified in the CREATE PROCEDURE statement.

To call this SPJ, use this CALL statement:

```
CALL lowerprice();
```

The LOWERPRICE procedure lowers the price of items with 50 or fewer orders by 10 percent in the database.

- This CREATE PROCEDURE statement registers an SPJ named TOTALPRICE, which accepts three input parameters and returns a numeric value, the total price to an INOUT parameter:

```
CREATE PROCEDURE trafodion.sales.totalprice(IN qty NUMERIC (18),
                                             IN rate VARCHAR (10),
                                             inout price NUMERIC (18,2))
  EXTERNAL NAME 'Sales.totalPrice'
  LIBRARY sales.saleslib
  LANGUAGE JAVA
  PARAMETER STYLE JAVA
  NO SQL;
```

To call this SPJ in TrafCI, use these statements:

```
SET PARAM ?p 10.00;
CALL sales.totalprice(23, 'standard', ?p);

p
-----
253.97

--- SQL operation complete.
```

Since the procedure does not read and modify any SQL data, NO SQL is specified in the CREATE PROCEDURE statement.

- This CREATE PROCEDURE statement registers an SPJ named MONTHLYORDERS, which accepts an integer value for the month and returns the number of orders:

```
CREATE PROCEDURE sales.monthlyorders(IN INT, OUT number INT)
    EXTERNAL NAME 'Sales.numMonthlyOrders (int, java.lang.Integer[])'
    LIBRARY sales.saleslib
    LANGUAGE JAVA
    PARAMETER STYLE JAVA
    READS SQL DATA;
```

Because the OUT parameter is supposed to map to the Java wrapper class, `java.lang.Integer`, you must specify the Java signature in the EXTERNAL NAME clause. To invoke this SPJ, use this CALL statement:

```
CALL sales.monthlyorders(3, ?);

ORDERNUM
-----
4

--- SQL operation complete.
```

- This CREATE PROCEDURE statement registers an SPJ named ORDERSUMMARY, which accepts a date (formatted as a string) and returns information about the orders on or after that date.

```
CREATE PROCEDURE sales.ordersummary(IN on_or_after_date VARCHAR (20),
                                     OUT num_orders LARGEINT)
EXTERNAL NAME 'Sales.orderSummary (int, long[])'
LIBRARY sales.saleslib
EXTERNAL SECURITY invoker
LANGUAGE JAVA
PARAMETER STYLE JAVA
READS SQL DATA
DYNAMIC RESULT SETS 2;
```

To invoke this SPJ, use this CALL statement:

```
CALL trafodion.sales.ordersummary('01-01-2014', ?);
```

The ORDERSUMMARY procedure returns this information about the orders on or after the specified date, 01-01-2014:

NUM_ORDERS

13

ORDERNUM	NUM_PARTS	AMOUNT	ORDER_DATE	LAST_NAME
100210	4	19020.00	2014-04-10	HUGHES
100250	4	22625.00	2014-01-23	HUGHES
101220	4	45525.00	2014-07-21	SCHNABL
...

--- 13 row(s) selected.

ORDERNUM	PARTNUM	UNIT_PRICE	QTY_ORDERED	PARTDESC
100210	244	3500.00	3	PC GOLD, 30 MB
100210	2001	1100.00	3	GRAPHIC PRINTER,M1
100210	2403	620.00	6	DAISY PRINTER,T2
...

--- 70 row(s) selected.

--- SQL operation complete.

3.14. CREATE ROLE Statement

The CREATE ROLE statement creates an SQL role. See [Roles](#).

```
CREATE ROLE role-name [ WITH ADMIN grantor ]  
grantor is:  
    database-username
```

3.14.1. Syntax Description of CREATE ROLE

- *role-name*

is an SQL identifier that specifies the new role. *role-name* is a regular or delimited case-insensitive identifier. See [Case-Insensitive Delimited Identifiers](#). *role-name* cannot be an existing role name, and it cannot be a registered database username. However, *role-name* can be a configured directory-service username.

- WITH ADMIN *grantor*

specifies a role owner other than the current user. This is an optional clause.

- *grantor*

specifies a registered database username to whom you assign the role owner.

3.14.2. Considerations for CREATE ROLE

- To create a role, you must either be DB ROOT or have been granted the MANAGE_ROLES component privilege for SQL_OPERATIONS.
- PUBLIC, SYSTEM, NONE, and database user names beginning with DB are reserved. You cannot specify a _role-name with any such name.

Role Ownership

You can give role ownership to a user by specifying the user in the WITH ADMIN *grantor* clause with the *grantor* as the user.

The role owner can perform these operations:

- Grant and revoke the role to users.
- Drop the role.

Role ownership is permanent. After you create the role, the ownership of the role cannot be changed or assigned to another user.

3.14.3. Examples of CREATE ROLE

- To create a role and assign the current user as the role owner:

```
CREATE ROLE clerks;
```

- To create a role and assign another user as the role owner:

```
CREATE ROLE sales WITH ADMIN cmiller;
```

3.15. CREATE SCHEMA Statement

The CREATE SCHEMA statement creates a schema in the database. See [Schemas](#).



DDL statements are not currently supported in transactions. That means that you cannot run DDL statements inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run these statements, AUTOCOMMIT must be turned ON (the default) for the session.

```
CREATE [schema-class] SCHEMA [IF NOT EXISTS] schema-clause

schema-class is:
[ PRIVATE | SHARED ]

schema-clause is:
{ schema-name [AUTHORIZATION authid] | AUTHORIZATION authid }
```

3.15.1. Syntax Description of CREATE SCHEMA

- *schema-class*

indicates whether access to the schema is restricted to the authorization ID by default (PRIVATE) or whether any database user may add objects to the schema (SHARED). The default class is PRIVATE.



Schemas created in Trafodion Release 0.9 or earlier are SHARED schemas.

- IF NOT EXISTS

creates the schema if it does not already exist. If omitted, then an error will be raised if the schema already exists.

- *schema-name*

is a name for the new schema and is an SQL identifier that specifies a unique name that is not currently a schema name. This parameter is optional. However, if you do not specify a schema name, you must specify the authorization clause. If a schema name is not provided, the authorization ID is used for the schema name. If the authorization ID name matches an existing schema, the CREATE SCHEMA command fails.

- *authid*

is the name of the database user or role will own and administer the schema. If this clause is not present, the current user becomes the schema owner.

3.15.2. Considerations for CREATE SCHEMA

Reserved Schema Names

Schema names that begin with a leading underscore (_) are reserved for future use.

AUTHORIZATION Clause

The AUTHORIZATION clause is optional. If you omit this clause, the current user becomes the schema owner.



An authorization ID is assigned to a schema name even if authorization is not enabled for the Trafodion database. However, no enforcement occurs unless authorization is enabled.

The schema owner can perform operations on the schema and on objects within the schema. For example:

- Alter DDL of objects
- Drop the schema
- Drop objects
- Manage objects with utility commands such as UPDATE STATISTICS and PURGEDATA

Who Can Create a Schema

The privilege to create a schema is controlled by the component privilege CREATE_SCHEMA for the SQL_OPERATIONS component. By default, this privilege is granted to PUBLIC, but it can be revoked by DB ROOT.

When authorization is initialized, these authorization IDs are granted the CREATE_SCHEMA privilege:

- PUBLIC
- DB ROOT
- DB ROOTROLE

DB ROOT or anyone granted the DB_ROOTROLE role can grant the CREATE_SCHEMA privilege.

3.15.3. Examples of CREATE SCHEMA

- This example creates a private schema named MYSCHHEMA, which will be owned by the current user:

```
CREATE SCHEMA myschema;
```

- This example creates a shared schema and designates CliffG as the schema owner:

```
CREATE SHARED SCHEMA hockey_league AUTHORIZATION "CliffG";
```

- This example creates a private schema and designates the role DBA as the schema owner:

```
CREATE PRIVATE SCHEMA contracts AUTHORIZATION DBA;
```

Users with the role DBA granted to them can grant access to objects in the CONTRACTS schema to other users and roles.

- This example creates a schema named JSMITH:

```
CREATE PRIVATE SCHEMA AUTHORIZATION JSmith;
```

3.16. CREATE SEQUENCE Statement

The CREATE SEQUENCE Statement produces an automatic ascending sequence of numeric values, which can be used by multiple users as primary key values. For example, to generate only odd numbers in a sequence, you can create a sequence defined with START WITH=1, INCREMENT BY=2.

Multiple options can be concurrently specified and separated by a space.

There are two expressions can be used with sequence:

- `seqnum(SEQUENCE, current)`: get the current value which is returned from the sequence on the current session rather than the current value of the sequence.

For example, a sequence object called `employee_seq` which starts with 1 and caches up to 25 with only three users.

If User A calls `seqnum(SEQUENCE, current)`, it will return 1 and reserve from 1 to 25, and User B immediately calls `seqnum(SEQUENCE, current)` and it will return 26 and reserve from 26 to 51, then User C immediately calls `seqnum(SEQUENCE, current)` and it will return 51 and reserve from 51 to 75.

Now, if User A immediately calls `seqnum(SEQUENCE, next)`, it will return 2 rather than 76. 76 will be returned if User A immediately calls `seqnum(SEQUENCE, next)` after achieving 25 where the cache for User A is exhausted.

- `seqnum(SEQUENCE, next)`: advance the sequence and retrieve the next value. For an ascending sequence, this value is increasing.

NOTE:

- It always returns the initial value of the sequence by calling `seqnum(SEQUENCE, current)` or `seqnum(SEQUENCE, next)` for the first time.
- It returns a new incremented value of the sequence with each subsequent reference to `seqnum(SEQUENCE, next)`.

CREATE SEQUENCE is a Trafodion SQL extension.

For more information, see [DROP SEQUENCE Statement](#) or [ALTER SEQUENCE Statement](#).

```
CREATE SEQUENCE [[catalog-name.]schema-name.]sequence
[START WITH integer]
[INCREMENT BY integer]
[MAXVALUE integer | NOMAXVALUE]
[MINVALUE integer]
[CACHE integer | NO CACHE]
[CYCLE | NO CYCLE]
[DATA TYPE]
```

By default, it is an ascending sequence that starts with 1, increments by 1, has cache value of 25 and the maximum value of $2^{63}-2$, does not cycle and belongs to LARGEINT data type.

3.16.1. Syntax Description of CREATE SEQUENCE

- [[catalog-name.]schema-name.]sequence

Specifies the name of the sequence to be created, with optional catalog and schema name, where each part of the name is a valid sql identifier with a maximum of 128 characters.

The name should be unique and does not exist for any session in the same schema. Trafodion does not support the overloading of session names. That is, you cannot register the same session name more than once.

If you do not fully qualify the session name, Trafodion qualifies it according to the schema of the current session. For more information, see [Identifiers](#) and [Database Object Names](#).

- START WITH

Specifies the initial value. This value can only be positive, and must be greater than or equal to MINVALUE (if NO CACHE is specified) and less than MAXVALUE.



If the initial value is beyond the range specified by MINVALUE or MAXVALUE, an error will be raised.

If not specified, the START WITH defaults to 1. For an ascending sequence, this value is MINVALUE.

- INCREMENT BY

Specifies the increment value between consecutive sequence values.



This value can only be positive, so that Trafodion only supports ascending sequence. The value must be smaller than or equal to the difference between MAXVALUE and MINVALUE.

If not specified, the INCREMENT BY defaults to 1.

- MAXVALUE

Specifies the maximum value where an ascending sequence stops generating values or cycles. The default is $2^{63}-2$.

The MAXVALUE of a sequence depends on the maximum value supported by the data type, and you can also specify a MAXVALUE within the range.

NOTE:

- An error is returned if MAXVALUE is beyond supported range, or if subsequent value is generated for an ascending sequence when the MAXVALUE is exceeded with NO CYCLE specified.
- MAXVALUE might not be same as the actual maximum value that the sequence generated if the INCREAMENT BY is a value other than 1. For example, when a sequence is specified with START WITH 3, INCREMENT 4 and MAXVALUE 12 will return a maximum value of 11.
- NONMAXVALUE

If NOMAXVALUE is specified, for an ascending sequence, the MAXVALUE is the value you specified or the maximum value supported by the data type.

- MINVALUE

Specifies the minimum value where an ascending sequence cycles after hitting the maximum limit. The default is 1.

The MINVALUE of a sequence depends on the minimum value supported by the data type, and you can also specify a MINVALUE within the range.

If MINVALUE and START WITH are not specified, for an ascending sequence, the MINVALUE defaults to 1.

- CYCLE

Specifies that the sequence exhausts its range and wraps around after reaching its MAXVALUE.

If specified, for an ascending sequence, it restarts from MINVALUE after reaching MAXVALUE.

- NOCYCLE

Specifies that the sequence cannot cycle once the MAXVALUE is reached, and throws an exception when generating subsequent value if the limit is exceeded.

NOCYCLE is the default.

- CACHE

Specifies the range of upcoming successive values preallocated and stored in memory for speeding up future request.

The default CACHE value is 25.

The minimum CACHE value is 2.

The CACHE value must be less than or equal to the value determined by following formula:

```
(MAXVALUE - START WITH + 1) / INCREMENT BY
```

The sequence cache will be repopulated when the cache is exhausted.



The unused preallocated values will be lost and leave unintended gaps if unexpected shutdown occurs or the sequence object is manually restarted, Trafodion will continue to cache new values from where it left off, so that the same value will never appear twice unless CYCLE is specified.

- NOCACHE

Specifies the values of the sequence are not preallocated, which lowers the risk of losing values even if it might cause performance degradation. In this case, every request for a new value will be synchronously updated in the system table.

If both CACHE and NOCACHE are not specified, it will cache 25 values by default.

- DATA TYPE

A sequence can be specified as following data types:

Type	Minimum value	Maximum value
UNSIGNED SMALLINT	1	$2^{16}-1$
UNSIGHED INTEGER	1	$2^{32}-1$
LARGEINT	1	$2^{63}-2$

If not specified, the default data type is LARGEINT.

3.16.2. Considerations for CREATE SEQUENCE

To issue a CREATE SEQUENCE statement, one of the following must be true:

- You are DB ROOT.
- You are creating the sequence in a shared schema.
- You are the private schema owner.
- You have the CREATE or CREATE_SEQUENCE component privilege for the SQL_OPERATIONS component.



In this case, if you create a sequence in a private schema, it will be owned by the schema owner.

3.16.3. Examples of CREATE SEQUENCE

The following statement creates a sequence named `employee_seq`, that starts with 1, increments by 1, has maximum value of 10000, does not cycle, caches 20 at a time and belongs to UNSIGNED SMALLINT.

```
CREATE SEQUENCE    employee_seq
START WITH        1
INCREMENT BY     1
MAXVALUE         10000
NOCYCLE
CACHE             20
UNSIGNED SMALLINT
```

The first reference to `seqnum(employee_seq, next)` will return 10000, and the second reference will return 10001. Each subsequent reference will return a value 1 greater than the previous value.

3.17. CREATE TABLE Statement

The CREATE TABLE statement creates a Trafodion SQL table, which is a mapping of a relational SQL table to an HBase table. The CREATE VOLATILE TABLE statement creates a temporary Trafodion SQL table that exists only during an SQL session. The CREATE TABLE AS statement creates a table based on the data attributes of a SELECT query and populates the table using the data returned by the SELECT query. See [Tables](#).



DDL statements are not currently supported in transactions. That means that you cannot run this statement inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run this statement, AUTOCOMMIT must be turned ON (the default) for the session.

```
CREATE [VOLATILE] TABLE [IF NOT EXISTS] table
  table-spec
  [SALT USING num PARTITIONS [ON (column[, column]...)]]]
  [STORE BY {PRIMARY KEY | (key-column-list)}]
  [HBASE_OPTIONS (hbase-options-list)]
  [LOAD IF EXISTS | NO LOAD]
  [AS select-query]
```

```
CREATE [VOLATILE] TABLE [IF NOT EXISTS] table
  like-spec
  [SALT USING num PARTITIONS [ON (column[, column]...)]]
```

Note: Support for SALT on CREATE TABLE LIKE is added in Trafodion release 2.1.

table-spec is:
 (table-element [,table-element]...)

table-element is:
 column-definition
 | [CONSTRAINT constraint-name] table-constraint

column-definition is:
 column data-type
 [DEFAULT default | NO DEFAULT]
 [[constraint constraint-name] column-constraint]...

```

data-type is:
  char[acter] [(length [characters])]
    [character set char-set-name]
    [upshift] [[not]casespecific]
  | char[acter] varying (length [characters])
    [character set char-set-name]
    [upshift] [[not]casespecific]
  | varchar (length) [character set char-set-name]
    [upshift] [[not]casespecific]
  | nchar (length) [characters] [upshift] [[not]casespecific]
  | nchar varying(length [characters]) [upshift] [[not] casespecific]
  | numeric [(precision [,scale])] [signed|unsigned]
  | smallint [signed|unsigned]
  | int[eger] [signed|unsigned]
  | largeint
  | dec[imal] [(precision [,scale])] [signed|unsigned]
  | float [(precision)]
  | real
  | double precision
  | date
  | time [(time-precision)]
  | timestamp [(timestamp-precision)]
  | interval { start-field to end-field | single-field }

default is:
  literal
  | null
  | currentdate
  | currenttime
  | currenttimestamp

column-constraint is:
  not null
  | unique
  | primary key [asc[ending] | desc[ending]]
  | CHECK (condition)
  | REFERENCES ref-spec

table-constraint is:
  UNIQUE (column-list)
  | PRIMARY KEY (key-column-list)
  | CHECK (condition)
  | FOREIGN KEY (column-list) REFERENCES ref-spec

ref-spec is:
  referenced-table [(column-list)]

```

```

column-list is:
    column-name [,column-name]...

key-column-list is:
    column-name [ASC[ENDING] | DESC[ENDING]]
    [,column-name [ASC[ENDING] | DESC[ENDING]]]...

like-spec is:
    LIKE source-table [include-option]...

hbase-options-list is:
    hbase-option = 'value'[, hbase-option = 'value']]...

```

3.17.1. Syntax Description of CREATE TABLE

- VOLATILE

specifies a volatile table, which is a table limited to the session that creates the table. After the session ends, the

- IF NOT EXISTS

creates an HBase table if it does not already exist when the table is created. This option does not apply to volatile tables.

- *table*

specifies the ANSI logical name of the table. See [Database Object Names](#). This name must be unique among names of tables and views within its schema.



Avoid using table names that begin with "TRAF_SAMPLE_", as Trafodion SQL assumes that such tables are persistent sample tables. See also [Incremental Update Statistics](#).

- SALT USING *num* PARTITIONS [ON (*column*[, *column*]...)]

pre-splits the table into multiple regions when the table is created. Salting adds a hash value of the row key as a key prefix, thus avoiding hot spots for sequential keys. The number of partitions that you specify can be a function of the number of region servers present in the HBase cluster. You can specify a number from 2 to 1024. If you do not specify columns, the default is to use all primary key columns.

If SALT is specified with LIKE, then this specification overrides that of the *source-table*. Note: this is a new feature in Trafodion 2.1. In earlier releases, the SALT clause is ignored if specified with LIKE.

- STORE BY { PRIMARY KEY | (*key-column-list*) }

specifies a set of columns on which to base the clustering key. The clustering key determines the order of rows within the physical file that holds the table. The storage order has an effect on how you can partition the object.

- PRIMARY KEY

bases the clustering key on the primary key columns.

- *key-column-list*

bases the clustering key on the columns in the *key-column-list*. The key columns in *key-column-list* must be specified as NOT NULL and must be the same as the primary key columns that are defined on the table. If STORE BY is not specified, then the clustering key is the PRIMARY KEY.

- HBASE_OPTIONS (*hbase-option* = 'value' [, *hbase-option* = 'value']...)

a list of HBase options to set for the table.

- *hbase-option* = 'value'

is one of the these HBase options and its assigned value:

HBase Option	Accepted Values ¹
BLOCKCACHE	'true' 'false'
BLOCKSIZE	'65536' ' <i>positive-integer</i> '
BLOOMFILTER	'NONE' 'ROW' 'ROWCOL'
CACHE_BLOOMS_ON_WRITE	'true' 'false'
CACHE_DATA_ON_WRITE	'true' 'false'
CACHE_INDEXES_ON_WRITE	'true' 'false'
COMPACT	'true' 'false'
COMPACT_COMPRESSION	'GZ' 'LZ4' 'LZO' 'NONE' 'SNAPPY'
COMPRESSION	'GZ' 'LZ4' 'LZO' 'NONE' 'SNAPPY'
DATA_BLOCK_ENCODING	'DIFF' 'FAST_DIFF' 'NONE' 'PREFIX'
DURABILITY	'USE_DEFAULT' 'SKIP_WAL' 'ASYNC_WAL' 'SYNC_WAL' 'FSYNC_WAL'
EVICT_BLOCKS_ON_CLOSE	'true' 'false'
IN_MEMORY	'true' 'false'
KEEP_DELETED_CELLS	'true' 'false'
MAX_FILESIZE	' <i>positive-integer</i> '
MAX VERSIONS	'1' ' <i>positive-integer</i> '
MEMSTORE_FLUSH_SIZE	' <i>positive-integer</i> '
MIN VERSIONS	'0' ' <i>positive-integer</i> '

HBase Option	Accepted Values ¹
PREFIX_LENGTH_KEY	'positive-integer', which should be less than maximum length of the key for the table. It applies only if the SPLIT_POLICY is KeyPrefixRegionSplitPolicy.
REPLICATION_SCOPE	'0' '1'
SPLIT_POLICY	'org.apache.hadoop.hbase.regionserver.ConstantSizeRegionSplitPolicy' 'org.apache.hadoop.hbase.regionserver.IncreasingToUpperBoundRegionSplitPolicy' 'org.apache.hadoop.hbase.regionserver.KeyPrefixRegionSplitPolicy'
TTL	'-1' (forever) 'positive-integer'

1. Values in boldface are default values.

- LOAD IF EXISTS

loads data into an existing table. Must be used with AS *select-query*. See [Considerations For LOAD IF EXISTS and NO LOAD options of CREATE TABLE AS](#).

- NO LOAD

creates a table with the CREATE TABLE AS statement, but does not load data into the table. See [Considerations for LOAD IF EXISTS and NO LOAD options of CREATE TABLE AS](#).

- AS *select-query*

specifies a select query which is used to populate the created table. A select query can be any SQL select statement.

- *column data-type*

specifies the name and data type for a column in the table. At least one column definition is required in a CREATE TABLE statement.

- *column* is an SQL identifier. *column* must be unique among column names in the table. If the name is a Trafodion SQL reserved word, you must delimit it by enclosing it in double quotes. Such delimited parts are case-sensitive. For example: "join".
- *data-type* is the data type of the values that can be stored in *column*. A default value must be of the same type as the column, including the character set for a character column. See "Data Types" Data type also includes case specific information, such as UPSHIFT.
- [NOT] CASESPECIFIC

specifies that the column contains strings that are not case specific. The default is CASESPECIFIC. Comparison between two values is done in a case insensitive way only if both are case insensitive. This applies to comparison in a binary predicate, LIKE predicate, and POSITION/REPLACE string function searches.

- DEFAULT *default* | NO DEFAULT

specifies a default value for the column or specifies that the column does not have a default value. See [DEFAULT Clause](#).

- CONSTRAINT *constraint-name*

specifies a name for the column or table constraint. *constraint-name* must have the same schema as *table* and must be unique among constraint names in its schema. If you omit the schema portions of the name you specify in *constraint-name*, Trafodion SQL expands the constraint name by using the schema for *table*. See [Constraint Names](#) and [Database Object Names](#).

- NOT NULL

is a column constraint that specifies that the column cannot contain nulls. If you omit NOT NULL, nulls are allowed in the column. If you specify both NOT NULL and NO DEFAULT, each row inserted in the table must include a value for the column. See [Null](#).

- `UNIQUE`, or, `UNIQUE (column-list)`

is a column or table constraint, respectively, that specifies that the column or set of columns cannot contain more than one occurrence of the same value or set of values. If you omit `UNIQUE`, duplicate values are allowed unless the column or set of columns is the `PRIMARY KEY`.

- *column-list* cannot include more than one occurrence of the same column. In addition, the set of columns that you specify on a `UNIQUE` constraint cannot match the set of columns on any other `UNIQUE` constraint for the table or on the `PRIMARY KEY` constraint for the table. All columns defined as unique must be specified as `NOT NULL`.

A `UNIQUE` constraint is enforced with a unique index. If there is already a unique index on *column-list*, Trafodion SQL uses that index. If a unique index does not exist, the system creates a unique index.

- `PRIMARY KEY [ASC[ENDING] | DESC[ENDING]], or, PRIMARY KEY (key-column-list)`

is a column or table constraint, respectively, that specifies a column or set of columns as the primary key for the table. *key-column-list* cannot include more than one occurrence of the same column.

`ASCENDING` and `DESCENDING` specify the direction for entries in one column within the key. The default is `ASCENDING`.

The `PRIMARY KEY` value in each row of the table must be unique within the table. A `PRIMARY KEY` defined for a set of columns implies that the column values are unique and not null. You can specify `PRIMARY KEY` only once on any `CREATE TABLE` statement.

Trafodion SQL uses the primary key as the clustering key of the table to avoid creating a separate, unique index to implement the primary key constraint.

A `PRIMARY KEY` constraint is required in Trafodion SQL.

- `CHECK (condition)`

is a constraint that specifies a condition that must be satisfied for each row in the table. See [Search Condition](#).

You cannot refer to the CURRENT_DATE, CURRENT_TIME, or CURRENT_TIMESTAMP function in a CHECK constraint, and you cannot use subqueries in a CHECK constraint.

- `REFERENCES ref-spec`

specifies a REFERENCES column constraint. The maximum combined length of the columns for a REFERENCES constraint is 2048 bytes.

ref-spec is:

`referenced-table [(column-list)]`

- *referenced-table* is the table referenced by the foreign key in a referential constraint. *referenced-table* cannot be a view. *referenced-table* cannot be the same as *table*. *referenced-table* corresponds to the foreign key in the *table*.
- *column-list* specifies the column or set of columns in the *referenced-table* that corresponds to the foreign key in *table*. The columns in the column list associated with REFERENCES must be in the same order as the columns in the column list associated with FOREIGN KEY. If *column-list* is omitted, the referenced table's PRIMARY KEY columns are the referenced columns.

A table can have an unlimited number of referential constraints, and you can specify the same foreign key in more than one referential constraint, but you must define each referential constraint separately. You cannot create self-referencing foreign key constraints.

- `FOREIGN KEY (column-list) REFERENCES ref-spec`

is a table constraint that specifies a referential constraint for the table, declaring that a column or set of columns (called a foreign key) in *table* can contain only values that match those in a column or set of columns in the table specified in the REFERENCES clause.

The two columns or sets of columns must have the same characteristics (data type, length, scale, precision). Without the FOREIGN KEY clause, the foreign key in *table* is the column being defined; with the FOREIGN KEY clause, the foreign key is the column or set of columns specified in the FOREIGN KEY clause. For information about *ref-spec*, see REFERENCES *ref-spec*.

- `LIKE source-table [include-option]...`

directs Trafodion SQL to create a table like the existing table, *source-table*, omitting constraints (with the exception of the NOT NULL and PRIMARY KEY constraints) and partitions unless the *include-option* clauses are specified.

- `source-table`

is the ANSI logical name for the existing table and must be unique among names of tables and views within its schema.

- `include-option`

- `WITH CONSTRAINTS`

directs Trafodion SQL to use constraints from *source-table*. Constraint names for *table* are randomly generated unique names.

When you perform a CREATE TABLE LIKE, whether or not you include the WITH CONSTRAINTS clause, the target table will have all the NOT NULL column constraints that exist for the source table with different constraint names.

- `WITH PARTITIONS`

directs Trafodion SQL to use partition definitions from *source-table*. Each new table partition resides on the same volume as its original *source-table* counterpart. The new table partitions do not inherit partition names from the original table. Instead, Trafodion SQL generates new names based on the physical file location.

If you specify the LIKE clause and the SALT USING *num* PARTITIONS clause, you cannot specify WITH PARTITIONS.

- `WITHOUT DIVISION`

directs Trafodion SQL to not use divisioning from *source-table*. If this clause is omitted, then the *table* will have the same divisioning as the *source-table*.

- `WITHOUT SALT`

directs Trafodion SQL to not use salting for *table*. If this clause is omitted, and no SALT clause is specified, the *table* will have the same divisioning as the *source-table*.

This option cannot be specified if a SALT clause is also specified.

3.17.2. Considerations for CREATE TABLE

The following subsections provide considerations for various CREATE TABLE options:

Authorization and Availability Requirements

Required Privileges

To issue a CREATE TABLE statement, one of the following must be true:

- You are DB ROOT.
- You are creating the table in a shared schema.
- You are the private schema owner.
- You have the CREATE or CREATE_TABLE component privilege for the SQL_OPERATIONS component.



In this case, if you create a table in a private schema, it will be owned by the schema owner.

Privileges Needed to Create a Referential Integrity Constraint

To create a referential integrity constraint (that is, a constraint on the table that refers to a column in another table), one of the following must be true:

- You are DB ROOT.
- You are the owner of the referencing and referenced tables.
- You have these privileges on the referencing and referenced table:
 - For the referencing table, you have the CREATE or CREATE_TABLE component privilege for the SQL_OPERATIONS component.
 - For the referenced table, you have the REFERENCES (or ALL) privilege on the referenced table through your username or through a granted role.

If the constraint refers to the other table in a query expression, you must also have SELECT privileges on the other table.

Considerations for CREATE VOLATILE TABLE

- Volatile temporary tables are closely linked to the session. Their name space is unique across multiple concurrent sessions, and therefore allow multiple sessions to use the same volatile temporary table names simultaneously without any conflicts.
- Volatile tables support creation of indexes. Volatile index can be created only on volatile table.
- Volatile tables are partitioned by the system. The number of partitions is limited to four partitions by default. The partitions will be distributed across the cluster. The default value is four partitions regardless of the system configuration.
- UPDATE STATISTICS is not supported for volatile tables. If you need statistics, you must use a non-volatile table instead.
- Volatile tables can be created and accessed using one-part, two-part, or three-part names. However, you must use the same name (one part, two part, or three part) for any further DDL or DML statements on the created volatile table. See [Examples of CREATE TABLE](#).
- Trafodion SQL allows users to explicitly specify primary key and STORE BY clauses on columns that contain null values.

- Trafodion SQL does not require that the first column in a volatile table contain not null values and be the primary key. Instead, Trafodion SQL attempts to partition the table, if possible, using an appropriate suitable key column as the primary and partitioning key. For more information, see [How Trafodion SQL Selects Suitable Keys for Volatile Tables](#).

Restrictions for CREATE VOLATILE TABLE

These items are not supported for volatile tables:

- ALTER statement
- User constraints
- Creating views
- Creating non-volatile indexes on a volatile table or a volatile index on a non-volatile table
- CREATE TABLE LIKE operations

How Trafodion SQL Supports Nullable Keys for Volatile Tables

- Allows nullable keys in primary key, STORE BY, and unique constraints.
- A null value is treated as the highest value for that column.
- A null value is equal to other null values and only one value is allowed for that column.

How Trafodion SQL Selects Suitable Keys for Volatile Tables

Trafodion SQL searches for the first suitable column in the list of columns of the table being created. Once the column is located, the table is partitioned on it. The searched columns in the table might be explicitly specified (as in a CREATE TABLE statement) or implicitly created (as in a CREATE TABLE AS SELECT statement).

The suitable key column is selected only if no primary key or STORE BY clause has been specified in the statement. If any of these clauses have been specified, they are used to select the key columns.

Trafodion SQL follows these guidelines to search for and select suitable keys:

- A suitable column can be a nullable column.
- Certain data types in Trafodion SQL cannot be used as a partitioning key. Currently, this includes any floating point columns (REAL, DOUBLE PRECISION, and FLOAT).
- Trafodion SQL searches for a suitable column according to this predefined order:
 - Numeric columns are chosen first, followed by fixed CHAR, DATETIME, INTERVAL, and VARCHAR data types.
 - Within numeric data types, the order is binary NUMERIC (LARGEINT, INTEGER, SMALLINT), and DECIMAL.
 - An unsigned column is given preference over a signed column.
 - A non-nullable column is given preference over a nullable column.
 - If all data types are the same, the first column is selected.
- If a suitable column is not located, the volatile table becomes a non-partitioned table with a system-defined SYSKEY as its primary key.
- If a suitable column is located, it becomes the partitioning key where the primary key is *suitable_column*, SYSKEY. This causes the table to be partitioned while preventing the duplicate key and null-to-non-null errors.

The list below shows the order of precedence, from low to high, of data types when Trafodion SQL searches for a suitable key. A data type appearing later has precedence over previously-appearing data types. Data types that do not appear in the list below cannot be chosen as a key column.

Precedence of Data Types (From Low to High):

- VARCHAR
- INTERVAL
- DATETIME
- CHAR(ACTER)
- DECIMAL (signed, unsigned)
- SMALLINT (signed, unsigned)
- INTEGER (signed,unsigned)
- LARGEINT (signed only)

Creating Nullable Constraints in a Volatile Table

These examples show the creation of nullable constraints (primary key, STORE BY, and unique) in a volatile table:

```
create volatile table t (a int, primary key(a));
create volatile table t (a int, store by primary key);
create volatile table t (a int unique);
```

Creating a Volatile Table With a Nullable Primary Key

This example creates a volatile table with a nullable primary key:

```
>>create volatile table t (a int, primary key(a));
--- SQL operation complete.
```

Only one unique null value is allowed:

```
>>insert into t values (null);  
--- 1 row(s) inserted.  
  
>>insert into t values (null);  
  
*** ERROR[8102] The operation is prevented by a unique constraint.  
--- 0 row(s) inserted.
```

Examples for Selecting Suitable Keys for Volatile Tables

These examples show the order by which Trafodion SQL selects a suitable key based on the precedence rules described in [How Trafodion SQL Selects Suitable Keys for Volatile Tables](#):

- Selects column a as the primary and partitioning key:

```
create volatile table t (a int);
```

- Selects column b because int has a higher precedence than char:

```
create volatile table t (a char(10), b int);
```

- Selects column b because not null has precedence over nullable columns:

```
create volatile table t (a int, b int not null);
```

- Selects column b because int has precedence over decimal:

```
create volatile table t (a decimal(10), b int);
```

- Selects the first column, a, because both columns have the same data type:

```
create volatile table t (a int not null, b int not null);
```

- Selects column b because char has precedence over date:

```
create volatile table t (a date, b char(10));
```

- Selects column b because the real data type is not part of the columns to be examined:

```
create volatile table t (a real, b date);
```

- Does not select any column as the primary/partitioning key. SYSKEY is used automatically.

```
create volatile table t (a real, b double precision not null);
```

Similar examples would be used for CREATE TABLE AS SELECT queries.

Considerations for CREATE TABLE ... LIKE

The CREATE TABLE LIKE statement does not create views, owner information, or privileges for the new table based on the source table. Privileges associated with a new table created by using the LIKE specification are defined as if the new table is created explicitly by the current user.

CREATE TABLE ... LIKE and File Attributes

CREATE TABLE ... LIKE creates a table like another table, with the exception of file attributes. File attributes include COMPRESSION, and so on. If you do not include the attribute value as part of the CREATE TABLE ... LIKE command, SQL creates the table with the default value for the attributes and not the value from the source object. For example, to create a table like another table that specifies compression, you must specify the compression attribute value as part of the CREATE TABLE... LIKE statement. In the following example, the original CREATE TABLE statement creates a table without compression. However, in the CREATE TABLE ... LIKE statement, compression is specified.

```
-- Original Table create table NPTEST

(FIRST_NAME CHAR(12) CHARACTER SET ISO88591 COLLATE DEFAULT NO DEFAULT NOT NULL
, LAST_NAME CHAR(24) CHARACTER SET ISO88591 COLLATE DEFAULT NO DEFAULT NOT NULL
, ADDRESS CHAR(128) CHARACTER SET ISO88591 COLLATE DEFAULT DEFAULT NULL
, ZIP INT DEFAULT 0
, PHONE CHAR(10) CHARACTER SET ISO88591 COLLATE DEFAULT DEFAULT NULL
, SSN LARGEINT NO DEFAULT NOT NULL
, INFO1 CHAR(128) CHARACTER SET ISO88591 COLLATE DEFAULT DEFAULT NULL
, INFO2 CHAR(128) CHARACTER SET ISO88591 COLLATE DEFAULT DEFAULT NULL
, primary key (SSN,first_name,last_name)
)

max table size 512

-- CREATE TABLE LIKE

create table LSCE002 like NPTEST ATTRIBUTE compression type hardware;
```

Considerations for CREATE TABLE AS

These considerations apply to CREATE TABLE AS:

- Access to the table built by CREATE TABLE AS will be a full table scan because a primary and clustering key cannot be easily defined.
- Compile time estimates and runtime information is not generated for CREATE TABLE AS tables.
- You cannot manage CREATE TABLE AS tables using WMS compile time or runtime rules.
- You cannot specify a primary key for a CREATE TABLE AS table without explicitly defining all the columns in the CREATE TABLE statement.
- You cannot generate an explain plan for a CREATE TABLE AS ...INSERT/SELECT statement. You can, however, use the EXPLAIN plan for a CREATE TABLE AS ... INSERT/SELECT statement if you use the NO LOAD option.
- You cannot use the ORDER BY clause in a CREATE TABLE AS statement. The compiler transparently orders the selected rows to improve the efficiency of the insert.

Considerations for LOAD IF EXISTS and NO LOAD options of CREATE TABLE AS

The LOAD IF EXISTS option in a CREATE TABLE AS statement causes data to be loaded into an existing table. If you do not specify the LOAD IF EXISTS option and try to load data into an existing table, the CREATE TABLE AS statement fails to execute. Use the LOAD IF EXISTS option with the AS clause in these scenarios:

- Running CREATE TABLE AS without re-creating the table. The table must be empty. Otherwise, the CREATE TABLE AS statement returns an error. Delete the data in the table by using a DELETE statement before issuing the CREATE TABLE AS statement.
- Using CREATE TABLE AS to incrementally add data to an existing table. You must start a user-defined transaction before issuing the CREATE TABLE AS statement. If you try to execute the CREATE TABLE AS statement without starting a user-defined transaction, an error is returned, stating that data already exists in the table. With a user-defined transaction, newly added rows are rolled back if an error occurs.

The NO LOAD option in a CREATE TABLE AS statement creates a table with the CREATE TABLE AS statement, but does not load data into the table. The option is useful if you must create a table to review its structure and to analyze the SELECT part of the CREATE TABLE AS statement with the EXPLAIN statement. You can also use EXPLAIN to analyze the implicated INSERT/SELECT part of the CREATE TABLE AS ... NO LOAD statement. For example:

```
CREATE TABLE ttgt NO LOAD AS (SELECT ...);
```

3.17.3. Trafodion SQL Extensions to CREATE TABLE

This statement is supported for compliance with ANSI SQL:1999 Entry Level. Trafodion SQL extensions to the CREATE TABLE statement are ASCENDING, DESCENDING, and PARTITION clauses. CREATE TABLE LIKE is also an extension.

3.17.4. Examples of CREATE TABLE

- This example creates a table. The clustering key is the primary key.

```
CREATE TABLE SALES.ODETAIL
( ordernum NUMERIC (6) UNSIGNED NO DEFAULT NOT NULL, partnum NUMERIC (4)
UNSIGNED NO DEFAULT NOT NULL, unit_price NUMERIC (8,2) NO DEFAULT NOT
NULL, qty_ordered NUMERIC (5) UNSIGNED NO DEFAULT NOT NULL,
PRIMARY KEY (ordernum, partnum) );
```

- This example creates a table like the JOB table with the same constraints:

```
CREATE TABLE PERSNL.JOB_CORPORATE LIKE PERSNL.JOB WITH CONSTRAINTS;
```

- This is an example of NOT CASESPECIFIC usage:

```
CREATE TABLE T (a char(10) NOT CASESPECIFIC, b char(10));
INSERT INTO T values ('a', 'A');
```

- A row is not returned in this example. Constant 'A' is case sensitive, whereas column 'a' is insensitive.

```
SELECT * FROM T WHERE a = 'A';
```

- The row is returned in this example. Both sides are case sensitive.

```
SELECT * FROM T WHERE a = 'A' (not casespecific);
```

- The row is returned in this example. A case sensitive comparison is done because column 'b' is case sensitive.

```
SELECT * FROM T WHERE b = 'A';
```

- The row is returned in this example. A case sensitive comparison is done because column 'b' is case sensitive.

```
SELECT * FROM T WHERE b = 'A' (not casespecific);
```

Examples of CREATE TABLE AS

This section shows the column attribute rules used to generate and specify the column names and data types of the table being created.

- If *column-attributes* are not specified, the select list items of the select-query are used to generate the column names and data attributes of the created table. If the select list item is a column, then it is used as the name of the created column. For example:

```
create table t as select a,b from t1
```

Table t has 2 columns named (a,b) and the same data attributes as columns from table t1.

- If the select list item is an expression, it must be renamed with an AS clause. An error is returned if expressions are not named. For example:

```
create table t as select a+1 as c from t1
```

Table t has 1 column named (c) and data attribute of (a+1)

```
create table t as select a+1 from t1
```

An error is returned, expression must be renamed.

- If *column-attributes* are specified and contains *datatype-info*, then they override the attributes of the select items in the select query. These data attributes must be compatible with the corresponding data attributes of the select list items in the select-query.

```
create table t(a int) as select b from t1
```

Table t has one column named "a" with data type "int".

```
create table t(a char(10)) as select a+1 b from t1;
```

An error is returned because the data attribute of column "a", a char, does not match the data attribute of the select list item "b" a numeric.

- If *column-attributes* are specified and they only contain *column-name*, then the specified column-name override any

name that was derived from the select query.

```
create table t(c,d) as select a,b from t1
```

Table t has 2 columns, c and d, which has the data attributes of columns a and b from table t1.

- If *column-attributes* are specified, then they must contain attributes corresponding to all select list items in the *select-query*. An error is returned, if a mismatch exists.

```
create table t(a int) as select b,c from t1
```

An error is returned. Two items need to be specified as part of the table-attributes.

- The *column-attributes* must specify either the *column-name datatype-info* pair or just the *column-name* for all columns. You cannot specify some columns with just the name and others with name and data type.

```
create table t(a int, b) as select c,d from t1
```

An error is returned.

In the following example, table t1 is created. Table t2 is created using the CREATE TABLE AS syntax without table attributes:

```
CREATE TABLE t1 (c1 int not null primary key, c2 char(50));  
CREATE TABLE t2 (c1 int, c2 char (50) UPSHIFT NOT NULL) AS SELECT * FROM t1;
```

3.18. CREATE VIEW Statement

The CREATE VIEW statement creates a Trafodion SQL view. See [Views](#).



DDL statements are not currently supported in transactions. That means that you cannot run this statement inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run this statement, AUTOCOMMIT must be turned ON (the default) for the session.

```
CREATE [OR REPLACE] VIEW view
[(column-name [,column-name ...])
 AS query-expr [order-by-clause]
[WITH CHECK OPTION]
```

3.18.1. Syntax Description of CREATE VIEW

- OR REPLACE

creates a view if one does not exist or replaces a view if a view of the same name exists. The view being replaced might have the same view definition or a different view definition.

- *view*

specifies the ANSI logical name of the view. See [Database Object Names](#). This name must be unique among names of tables and views within its schema.

- (*column-name* [,*column-name*]...)

specifies names for the columns of the view. Column names in the list must match one-for-one with columns in the table specified by *query-expr*.

If you omit this clause, columns in the view have the same names as the corresponding columns in *query-expr*. You must specify this clause if any two columns in the table specified by *query-expr* have the same name or if any column of that table does not have a name. For example, this query expression `SELECT MAX(salary), AVG(salary) AS average_salary FROM employee` the first column does not have a name.

No two columns of the view can have the same name; if a view refers to more than one table and the select list refers to columns from different tables with the same name, you must specify new names for columns that would otherwise have duplicate names.

- `AS query-expr`

specifies the columns for the view and sets the selection criteria that determines the rows that make up the view. For information about character string literals, see [Character String Literals](#). For the syntax and syntax description of *query-expr*, see [SELECT Statement](#). The CREATE VIEW statement provides this restriction with regard to the *query-expr* syntax: [ANY_N_], [FIRST N] select list items are not allowed in a view.

- `order-by-clause`

specifies the order in which to sort the rows of the final result table. For the syntax and syntax description of the *order-by-clause*, see [SELECT Statement](#). The CREATE VIEW statement restricts the *order-by-clause* with regard to the *access-clause* and *mode-clause*. The *access-mode* and *mode-clause* cannot follow the *order-by-clause*.

- `WITH CHECK OPTION`

specifies that no row can be inserted or updated in the database through the view unless the row satisfies the view definition—that is, the search condition in the WHERE clause of the query expression must evaluate to true for any row that is inserted or updated. This option is only allowed for updatable views.

If you omit this option, a newly inserted row or an updated row need not satisfy the view definition, which means that such a row can be inserted or updated in the table but does not appear in the view. This check is performed each time a row is inserted or updated.

`WITH CHECK OPTION` does not affect the query expression; rows must always satisfy the view definition.

3.18.2. Considerations for CREATE VIEW

- If you specify CREATE OR REPLACE VIEW:
 - A new view is created if a view of the same name does not exist.
 - If a view of same name exists, the old view definition is dropped, and a view with a new definition is created. No check will be done to see if the new view is identical to the view it is replacing. The CREATE OR REPLACE VIEW command will unilaterally drop the old view definition and replace it with the new view definition.
 - The privileges granted on the old view will be re-granted on the new view. If the re-grant of privileges fails, the CREATE OR REPLACE VIEW operation fails.
 - When CREATE OR REPLACE VIEW replaces an existing view, any dependent views will be dropped.
- You can specify GROUP BY using ordinals to refer to the relative position within the SELECT list. For example, GROUP BY 3, 2, 1.
- Dynamic parameters are not allowed.

Effect of Adding a Column on View Definitions

The addition of a column to a table has no effect on any existing view definitions or conditions included in constraint definitions. Any implicit column references specified by SELECT * in view or constraint definitions are replaced by explicit column references when the definition clauses are originally evaluated.

Authorization and Availability Requirements

To issue a CREATE VIEW statement, you must have SELECT privileges on the objects underlying the view or be the owner of the objects underlying the view, and one of the following must be true:

- You are DB ROOT.
- You are creating the view in a shared schema.
- You are the private schema owner.
- You have the CREATE or CREATE_VIEW component privilege for the SQL_OPERATIONS component.



In this case, if you create a view in a private schema, it will be owned by the schema owner.

When you create a view on a single table, the owner of the view is automatically given all privileges WITH GRANT OPTION on the view. However, when you create a view that spans multiple tables, the owner of the view is given only

SELECT privileges WITH GRANT OPTION. If you try to grant privileges to another user on the view other than SELECT, you will receive a warning that you lack the grant option for that privilege.

Updatable and Non-Updatable Views

Single table views can be updatable. Multi-table views cannot be updatable.

To define an updatable view, a query expression must also meet these requirements:

- It cannot contain a JOIN, UNION, or EXCEPT clause.
- It cannot contain a GROUP BY or HAVING clause.
- It cannot directly contain the keyword DISTINCT.
- The FROM clause must refer to exactly one table or one updatable view.
- It cannot contain a WHERE clause that contains a subquery.
- The select list cannot include expressions or functions or duplicate column names.

ORDER BY Clause Guidelines

The ORDER BY clause can be specified in the SELECT portion of a CREATE VIEW definition. Any SELECT syntax that is valid when the SELECT portion is specified on its own is also valid during the view definition. An ORDER BY clause can contain either the column name from the SELECT list or from *select-list-index*.

When a DML statement is issued against the view, the rules documented in the following sections are used to apply the ORDER BY clause.

When to Use ORDER BY

An ORDER BY clause is used in a view definition only when the clause is under the root of the Select query that uses that view. If the ORDER BY clause appears in other intermediate locations or in a subquery, it is ignored.

Consider this CREATE VIEW statement:

```
create view v as select a from t order by a; select * from v x, v y;
```

Or this INSERT statement:

```
insert into t1 select * from v;
```

In these two examples, the ORDER BY clause is ignored during DML processing because the first appears as part of a derived table and the second as a subquery selects, both created after the view expansion.

If the same query is issued using explicit derived tables instead of a view, a syntax error is returned:

```
select * from (select a from t order by a) x, (select a from t order by a) y;
```

This example returns a syntax error because an ORDER BY clause is not supported in a subquery.

The ORDER BY clause is ignored if it is part of a view and used in places where it is not supported. This is different than returning an error when the same query was written with explicit ORDER BY clause, as is shown in the preceding examples.

ORDER BY in a View Definition With No Override

If the SELECT query reads from the view with no explicit ORDER BY override, the ORDER BY semantics of the view definition are used.

In this example, the ordering column is the one specified in the CREATE VIEW statement:

```
create view v as select * from t order by a Select * from v
```

The SELECT query becomes equivalent to:

```
select * from t order by a;
```

ORDER BY in a View Definition With User Override

If a SELECT query contains an explicit ORDER BY clause, it overrides the ORDER BY clause specified in the view definition.

For example:

```
create view v as select a,b from t order by a; select * from v order by b;
```

In this example, order by b overrides the order by a specified in the view definition. The SELECT query becomes equivalent to:

```
select a,b from t order by b;
```

Nested View Definitions

In case of nested view definitions, the ORDER BY clause in the topmost view definition overrides the ORDER BY clause of any nested view definitions.

For example:

```
create view v1 as select a,b from t1 order by a;
create view v2 as select a,b from v1 order by b;
select * from v2;
```

In this example, the ORDER BY specified in the definition of view v2 overrides the ORDER BY specified in the definition of view v1.

The SELECT query becomes equivalent to:

```
select a,b from (select a, b from t) x order by b;
```

3.18.3. Examples of CREATE VIEW

- This example creates a view on a single table without a view column list:

```
CREATE VIEW SALES.MYVIEW1 AS
    SELECT ordernum, qty_ordered FROM SALES.ODETAIL;
```

- This example replaces the view, MYVIEW1, with a different view definition:

```
CREATE OR REPLACE VIEW SALES.MYVIEW1 AS
    SELECT ordernum, qty_ordered
        FROM SALES.ODETAIL WHERE unit_price > 100;
```

- This example creates a view with a column list:

```
CREATE VIEW SALES.MYVIEW2
    (v_ordernum, t_partnum) AS SELECT v.ordernum, t.partnum
        FROM SALES.MYVIEW1 v, SALES.ODETAIL t;
```

- This example creates a view from two tables by using an INNER JOIN:

```
CREATE VIEW MYVIEW4 (v_ordernum, v_partnum) AS
    SELECT od.ordernum, p.partnum
        FROM SALES.ODETAIL OD INNER JOIN SALES.PARTS P
            ON od.partnum = p.partnum;
```

Vertical Partition Example

This example creates three logical vertical partitions for a table, vp0, vp1, and vp2 and then creates a view vp to access them.

A view can be used to obtain a composite representation of a set of closely related tables. In the following example tables vp0, vp1 and vp2 all have a key column a. This key column is known to contain identical rows for all three tables. The three tables vp0, vp1 and vp2 also contain columns b, c and d respectively. We can create a view vp that combines these three tables and provides the interface of columns a, b, c and d belonging to a single object.

Trafodion SQL has the ability to eliminate redundant joins in a query. Redundant joins occur when:

- Output of join contains expressions from only one of its two children
- Every row from this child will match one and only one row from the other child

Suppose tables A and B denote generic tables. To check if the rule "every row from this child will match one and only one row from the other child" is true, Trafodion SQL uses the fact that the join of Table A with table or subquery B preserves all the rows of A if the join predicate contains an equi-join predicate that references a key of B, and one of the following is true: The join is a left outer join where B is the inner table. In this example, for the join between vp0 and vp1, vp0 fills the role of table A and vp1 fills the role of table B. For the join between vp1 and vp2, vp1 fills the role of table A and vp2 fills the role of table B.

The view vp shown in this example uses left outer joins to combine the three underlying tables. Therefore, if the select list in a query that accesses vp does not contain column d from vp2 then the join to table vp2 in the view vp will not be performed.

```

create table vp0(a integer not null, b integer, primary key(a));
create table vp1(a integer not null, c integer, primary key(a));
create table vp2(a integer not null, d integer, primary key(a));

create view vp(a,b,c,d) as
  select vp0.a, b, c, d
  from vp0
  left outer join vp1 on vp0.a=vp1.a
  left outer join vp2 on vp0.a=vp2.a;

select a, b from vp; -- reads only vp0
select a, c from vp; -- reads vp0 and vp1
select d from vp; -- reads vp0 and vp2

```

3.19. DELETE Statement

The DELETE statement is a DML statement that deletes a row or rows from a table or an updatable view. Deleting rows from a view deletes the rows from the table on which the view is based. DELETE does not remove a table or view, even if you delete the last row in the table or view.

Trafodion SQL provides searched DELETE—deletes rows whose selection depends on a search condition.

For the searched DELETE form, if no WHERE clause exists, all rows are deleted from the table or view.

Searched DELETE is:

```
DELETE FROM table

[WHERE search-condition ]
[[for] access-option access]

access-option is:
read committed
```

3.19.1. Syntax Description of DELETE

- *table*

names the user table or view from which to delete rows. *table* must be a base table or an updatable view. To refer to a table or view, use the ANSI logical name. See [Database Object Names](#).

- WHERE *search-condition*

specifies a search condition that selects rows to delete. Within the search condition, any columns being compared are columns in the table or view being deleted from. See [Search Condition](#)

If you do not specify a search condition, all rows in the table or view are deleted.

- [FOR] *access-option ACCESS*

specifies the access option required for data used to evaluate the search condition. See [Data Consistency and Access Options](#).

- `READ` `COMMITTED

specifies that any data used to evaluate the search condition must come from committed rows.

The default access option is the isolation level of the containing transaction.

3.19.2. Considerations for DELETE

Authorization Requirements

DELETE requires authority to read and write to the table or view being deleted from and authority to read tables or views specified in subqueries used in the search condition.

Transaction Initiation and Termination

The DELETE statement automatically initiates a transaction if no transaction is active. Otherwise, you can explicitly initiate a transaction with the BEGIN WORK statement. When a transaction is started, the SQL statements execute within that transaction until a COMMIT or ROLLBACK is encountered or an error occurs.

Isolation Levels of Transactions and Access Options of Statements

The isolation level of an SQL transaction defines the degree to which the operations on data within that transaction are affected by operations of concurrent transactions. When you specify access options for the DML statements within a transaction, you override the isolation level of the containing transaction. Each statement then executes with its individual access option.

3.19.3. Examples of DELETE

- Remove all rows from the JOB table:

```
DELETE FROM persnl.job;
--- 10 row(s) deleted.
```

- Remove from the table ORDERS any orders placed with sales representative 220 by any customer except customer number 1234:

```
DELETE FROM sales.orders
WHERE salesrep = 220 AND custnum <> 1234;
--- 2 row(s) deleted.
```

- Remove all suppliers not in Texas from the table PARTSUPP:

```
DELETE FROM invent.partsupp WHERE suppnum IN  
  (SELECT suppnum FROM samdbc.cat.invent.supplier WHERE state <> 'TEXAS');  
  
--- 41 row(s) deleted.
```

This statement achieves the same result:

```
DELETE FROM invent.partsupp WHERE suppnum NOT IN  
  SELECT suppnum FROM samdbc.cat.invent.supplier WHERE state = 'TEXAS';  
  
--- 41 row(s) deleted.
```

- This is an example of a self-referencing DELETE statement, where the table from which rows are deleted is scanned in a subquery:

```
delete from table1 where a in (select a from table1 where b > 200)
```

3.20. DROP FUNCTION Statement

The DROP FUNCTION statement removes a user-defined function (UDF) from the Trafodion database.



DDL statements are not currently supported in transactions. That means that you cannot run this statement inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run this statement, AUTOCOMMIT must be turned ON (the default) for the session.

```
DROP FUNCTION [[catalog-name.]schema-name.]function-name
```

3.20.1. Syntax Description of DROP FUNCTION

- *[[_catalog-name_.]schema-name_.]function-name*

specifies the ANSI logical name of the function, where each part of the name is a valid sql identifier with a maximum of 128 characters. specify the name of a function that has already been registered in the schema. if you do not fully qualify the function name, trafodion sql qualifies it according to the schema of the current session. for more information, see [identifiers](#) and [database object names](#).

3.20.2. Considerations for DROP FUNCTION

Required Privileges

To issue a DROP FUNCTION statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the function.
- You have the DROP or DROP_ROUTINE component privilege for SQL_OPERATIONS component.

3.20.3. Examples of DROP FUNCTION

- This DROP FUNCTION statement removes the function named ADD2 from the default schema:

```
DROP FUNCTION add2;
```

- This DROP FUNCTION statement removes the function named MMA5 from the default schema:

```
DROP PROCEDURE mma5;
```

- This DROP FUNCTION statement removes the function named REVERSE from the default schema:

```
DROP PROCEDURE reverse;
```

3.21. DROP INDEX Statement

The DROP INDEX statement drops a Trafodion SQL index. See [Indexes](#). DROP INDEX is a Trafodion SQL extension.



DDL statements are not currently supported in transactions. That means that you cannot run this statement inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run this statement, AUTOCOMMIT must be turned ON (the default) for the session.

```
DROP [VOLATILE] INDEX index
```

3.21.1. Syntax Description of DROP INDEX

- *index*

is the index to drop.

For information, see [Database Object Names](#).

3.21.2. Considerations for DROP INDEX

Required Privileges

To issue a DROP INDEX statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the index or the table associated with the index.
- You have the DROP or DROP_INDEX component privilege for the SQL_OPERATIONS component.

3.21.3. Examples of DROP INDEX

- This example drops an index:

```
DROP INDEX myindex;
```

- This example drops a volatile index:

```
DROP VOLATILE INDEX vindex;
```

3.22. DROP LIBRARY Statement

The DROP LIBRARY statement removes a library object from the Trafodion database and also removes the library file referenced by the library object.

DROP LIBRARY is a Trafodion SQL extension.



DDL statements are not currently supported in transactions. That means that you cannot run this statement inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run this statement, AUTOCOMMIT must be turned ON (the default) for the session.

```
DROP LIBRARY [[catalog-name.]schema-name.]library-name [restrict | cascade]
```

3.22.1. Syntax Description of DROP LIBRARY

- `[[_catalog-name_.]schema-name_.]library-name`

specifies the ANSI logical name of the library object, where each part of the name is a valid sql identifier with a maximum of 128 characters. specify the name of a library object that has already been registered in the schema. if you do not fully qualify the library name, trafodion sql qualifies it according to the schema of the current session. for more information, see [identifiers](#) and [database object names](#).

- `[restrict | cascade]`

if you specify restrict, the drop library operation fails if any stored procedures in java (spjs) or user-defined functions (UDFs) were created based on the specified library.

if you specify cascade, any such dependent procedures or functions are removed as part of the drop library operation.

the default value is restrict.

3.22.2. Considerations for DROP LIBRARY

- RESTRICT requires that all procedures and functions that refer to the library object be dropped before you drop the library object. CASCADE automatically drops any procedures or functions that are using the library.
- If the library filename referenced by the library object does not exist, Trafodion SQL issues a warning.

Required Privileges

To issue a DROP LIBRARY statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the library.
- You have the DROP or DROP_LIBRARY component privilege for the SQL_OPERATIONS component.

3.22.3. Examples of DROP LIBRARY

- This DROP LIBRARY statement removes the library named SALESLIB from the SALES schema, removes the Sales2.jar file referenced by the library, and drops any stored procedures in Java (SPJs) that were created based on this library:

```
DROP LIBRARY sales.saleslib CASCADE;
```

- This DROP LIBRARY statement removes the library named MYUDFS from the default schema and removes the \$TMUDFS library file referenced by the library:

```
DROP LIBRARY myudfs RESTRICT;
```

RESTRICT prevents the DROP LIBRARY operation from dropping any user-defined functions (UDFs) that were created based on this library. If any UDFs were created based on this library, the DROP LIBRARY operation fails.

3.23. DROP PROCEDURE Statement

The DROP PROCEDURE statement removes a stored procedure in Java (SPJ) from the Trafodion database.



DDL statements are not currently supported in transactions. That means that you cannot run this statement inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run this statement, AUTOCOMMIT must be turned ON (the default) for the session.

```
DROP PROCEDURE [ [catalog-name.]schema-name.]procedure-name
```

3.23.1. Syntax Description of DROP PROCEDURE

- *[[_catalog-name_.]schema-name.]procedure-name*

specifies the ANSI logical name of the stored procedure in java (SPJ), where each part of the name is a valid sql identifier with a maximum of 128 characters. specify the name of a procedure that has already been registered in the schema. if you do not fully qualify the procedure name, trafodion sql qualifies it according to the schema of the current session.

for more information, see [identifiers](#) and [database object names](#).

3.23.2. Considerations for DROP PROCEDURE

Required Privileges

To issue a DROP PROCEDURE statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the procedure.
- You have the DROP or DROP_ROUTINE component privilege for SQL_OPERATIONS component.

3.23.3. Examples of DROP PROCEDURE

- This DROP PROCEDURE statement removes the procedure named LOWERPRICE from the SALES schema:

```
DROP PROCEDURE sales.lowerprice;
```

- This DROP PROCEDURE statement removes the procedure TOTALPRICE from the default schema for the session, which is the SALES schema:

```
SET SCHEMA sales;
DROP PROCEDURE totalprice;
```

3.24. DROP ROLE Statement

The DROP ROLE statement deletes an SQL role. See [Roles](#).

```
DROP ROLE role-name
```

3.24.1. Syntax Description of DROP ROLE

- *role-name*

is an existing role name. The role cannot be dropped if any of the following are true:

- Any privileges are granted to the role.
- The role is granted to any users.
- The role owns any schemas.

3.24.2. Considerations for DROP ROLE

- To drop a role, you must own the role or have user administrative privileges for the role. You have user administrative privileges for the role if you have been granted the MANAGE_ROLES component privilege. Initially, DB ROOT is the only database user who has been granted the MANAGE_ROLES component privilege.
- Role names beginning with DB are reserved and can only be dropped by DB ROOT.
- You can determine all users to whom a role has been granted by using the SHOWDDL ROLE statement. See the [SHOWDDL Statement](#).

Before You Drop a Role

Before dropping a role, follow these guidelines:

- You must revoke all privileges granted to the role.
- You must revoke the role from all users to whom it was granted.
- You must drop all schemas the role is a manager (or owner) of.

You can determine all users to whom a role has been granted with the SHOWDDL statement. See the [SHOWDDL Statement](#).

Active Sessions for the User

When you revoke a role from a user, then the change in privileges is automatically propagated to and detected by active sessions. There is no need for users to disconnect from and reconnect to a session to see the updated set of privileges.

3.24.3. Examples of DROP ROLE

- To drop a role:

```
DROP ROLE clerks;
```

- To drop a role with dependent privileges:

```
-- User administrator creates a role:  
CREATE ROLE clerks;  
  
-- User administrator grants privileges on a table to the role:  
GRANT ALL PRIVILEGES ON TABLE invent.partloc TO clerks;  
  
-- User administrator grants the role to a user:  
GRANT ROLE clerks TO JSmith;  
  
-- JSmith creates a view based upon the granted privilege:  
CREATE VIEW invent.partlocView (partnum, loc_code)  
AS SELECT partnum, loc_code FROM invent.partloc;  
  
-- If the user administrator attempts to drop the role, this  
-- would fail because of the view created based on  
-- the granted privilege.  
-- To successfully drop the role, the dependent view  
-- and grant must be removed first. For this example:  
-- 1. JSmith drops the view:  
DROP VIEW invent.partlocView;  
  
-- 2. User administrator revokes the role from the user:  
REVOKE ROLE clerks FROM JSmith;  
  
-- 3. User administrator revokes all privileges the role has been granted  
REVOKE ALL ON invent.partloc FROM clerks;  
  
-- 4. User administrator drops the role:  
DROP ROLE clerks;  
  
-- The DROP ROLE operation succeeds.
```

3.25. DROP SCHEMA Statement

The DROP SCHEMA statement drops a schema from the database. See [Schemas](#).



DDL statements are not currently supported in transactions. That means that you cannot run DDL statements inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run these statements, AUTOCOMMIT must be turned ON (the default) for the session.

```
DROP SCHEMA [ IF EXISTS ] schema-name [ RESTRICT | CASCADE ]
```

3.25.1. Syntax Description of DROP SCHEMA

- *schema-name*

is the name of the schema to delete.

- IF EXISTS

drops the schema if it exists. If omitted, an error is raised if the schema doesn't exist.

- RESTRICT

If you specify RESTRICT, an error is reported if the specified schema is not empty. The default is RESTRICT.

- CASCADE

If you specify CASCADE, objects in the specified schema and the schema itself are dropped. Any objects in other schemas that were dependent on objects in this schema are dropped as well.

3.25.2. Considerations for DROP SCHEMA

Authorization Requirements

To drop a schema, one of the following must be true:

- You are the owner of the schema.
- You have been granted the role that owns the schema.
- You have been granted the DROP_SCHEMA privilege.

3.25.3. Example of DROP SCHEMA

- This example drops an empty schema:

```
DROP SCHEMA sales;
```

3.26. DROP SEQUENCE Statement

The DROP SEQUENCE Statement removes a sequence from the Trafodion database.



DDL statements are not currently supported in transactions. That means that you cannot run DDL statements inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run these statements, AUTOCOMMIT must be turned ON (the default) for the session.

If you want to change the initial value of a sequence, you can drop and then recreate a sequence with the same name and different START WITH value.

DROP SEQUENCE is a Trafodion SQL extension.

For more information, see [CREATE SEQUENCE Statement](#) or [ALTER SEQUENCE Statement](#).

```
DROP SEQUENCE [[catalog-name.]schema-name.]sequence
```

3.26.1. Syntax Description of DROP SEQUENCE

- `[[catalog-name.]schema-name.]sequence`

Specifies the name of the sequence to be dropped, with optional catalog and schema name, where each part of the name is a valid sql identifier with a maximum of 128 characters.

3.26.2. Considerations for DROP SEQUENCE

To issue a DROP SEQUENCE statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the sequence.
- You have the DROP or DROP_SEQUENCE component privilege for the SQL_OPERATIONS component.

3.26.3. Examples of DROP SEQUENCE

The following statement drops the sequence named `employee_seq`, which is created in [Examples of CREATE SEQUENCE](#).

```
DROP SEQUENCE employee_seq
```

3.27. DROP TABLE Statement

The DROP TABLE statement deletes a Trafodion SQL table and its dependent objects such as indexes and constraints.

See [Tables](#).

 DDL statements are not currently supported in transactions. That means that you cannot run this statement inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run this statement, AUTOCOMMIT must be turned ON (the default) for the session.

```
DROP [VOLATILE] TABLE [IF EXISTS] table [RESTRICT|CASCADE]
```

3.27.1. Syntax Description of DROP TABLE

- **VOLATILE**

specifies that the table to be dropped is a volatile table.

- **IF EXISTS**

drops the HBase table if it exists. This option does not apply to volatile tables.

- *table*

is the name of the table to delete.

- **RESTRICT**

If you specify RESTRICT and the table is referenced by another object, the specified table cannot be dropped. The default is RESTRICT.

- **CASCADE**

If you specify CASCADE, the table and all objects referencing the table (such as a view) are dropped.

3.27.2. Considerations for DROP TABLE

Authorization Requirements

To issue a DROP TABLE statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the table.
- You have the DROP or DROP_TABLE component privilege for the SQL_OPERATIONS component.

3.27.3. Examples of DROP TABLE

- This example drops a table:

```
DROP TABLE mysch.mytable;
```

- This example drops a volatile table:

```
DROP VOLATILE TABLE vtable;
```

3.28. DROP VIEW Statement

The DROP VIEW statement deletes a Trafodion SQL view. See [Views](#).



DDL statements are not currently supported in transactions. That means that you cannot run this statement inside a user-defined transaction (BEGIN WORK...COMMIT WORK) or when AUTOCOMMIT is OFF. To run this statement, AUTOCOMMIT must be turned ON (the default) for the session.

```
DROP VIEW view [RESTRICT|CASCADE]
```

3.28.1. Syntax Description of DROP VIEW

- *view*

is the name of the view to delete.

- RESTRICT

If you specify RESTRICT, you cannot drop the specified view if it is referenced in the query expression of any other view or in the search condition of another object's constraint. The default is RESTRICT.

- CASCADE

If you specify CASCADE, any dependent objects are dropped.

3.28.2. Considerations for DROP VIEW

Authorization Requirements

To issue a DROP VIEW statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the view.
- You have the DROP or DROP_VIEW component privilege for the SQL_OPERATIONS component.

3.28.3. Example of DROP VIEW

- This example drops a view:

```
DROP VIEW mysch.myview;
```

3.29. Execute Statement

The EXECUTE statement executes an SQL statement previously compiled by a PREPARE statement in a Trafodion Command Interface (TrafCI) session.

```
EXECUTE statement-name
  [ USING param [,param]... ]  
  
param is:
  ?param-name | literal-value
```

3.29.1. Syntax Description of EXECUTE

- *statement-name*

is the name of a prepared SQL statement—that is, the statement name used in the PREPARE statement. *statement-name* is an SQL identifier. See [Identifiers](#).

- USING *param* [,*param*]...

param is: ?*param-name* | *literal-value*

specifies values for unnamed parameters (represented by ?) in the prepared statement in the form of either a parameter name (?*param-name*) or a literal value (*literal-value*). The data type of a parameter value must be compatible with the data type of the associated parameter in the prepared statement.

Parameter values (*param*) are substituted for unnamed parameters in the prepared statement by position—the i-th value in the USING clause is the value for the i-th parameter in the statement. If fewer parameter values exist in the USING clause than unnamed parameters in the PREPARE statement, Trafodion SQL returns an error. If more parameter values exist in the USING clause than the unnamed parameters in the PREPARE statement, Trafodion SQL issues warning 15019.

The USING clause does not set parameter values for named parameters (represented by `?param-name`) in a prepared statement. To set parameter values for named parameters, use the SET PARAM command. For more information, see the [Trafodion Command Interface Guide](#).

- `?param-name`

The value for a `?param-name` must be previously specified with the SET PARAM command. The *param-name* is case-sensitive. For information about the SET PARAM command, see the [Trafodion Command Interface Guide](#).

- `literal-value`

is a numeric or character literal that specifies the value for the unnamed parameter.

If *literal-value* is a character literal and the target column type is character, you do not have to enclose it in single quotation marks. Its data type is determined from the data type of the column to which the literal is assigned. If the *literal-value* contains leading or trailing spaces, commas, or if it matches any parameter names that are already set, enclose the *literal-value* in single quotes.

See the [PREPARE Statement](#). For information about the SET PARAM command, see the [Trafodion Command Interface Guide](#).

3.29.2. Considerations for EXECUTE

Scope of EXECUTE

A statement must be compiled by PREPARE before you EXECUTE it, but after it is compiled, you can execute the statement multiple times without recompiling it. The statement must have been compiled during the same TrafCI session as its execution.

3.29.3. Examples of EXECUTE

- Use PREPARE to compile a statement once, and then execute the statement multiple times with different parameter values. This example uses the SET PARAM command to set parameter values for named parameters (represented by `?param-name`) in the prepared statement.

```
SQL>prepare findemp from
+>select * from persnl.employee
+>where salary > ?sal and jobcode = ?job;

--- SQL command prepared.

SQL>set param ?sal 40000.00;
SQL>set param ?job 450;
SQL>execute findemp;

EMPNUM FIRST_NAME          LAST_NAME          DEPTNUM JOBCODE SALARY
-----  -----          -----          -----  -----  -----
 232  THOMAS              SPINNER           4000    450  45000.00

--- 1 row(s) selected.

SQL>set param ?sal 20000.00;
SQL>set param ?job 300;
SQL>execute findemp;

EMPNUM FIRST_NAME          LAST_NAME          DEPTNUM JOBCODE SALARY
-----  -----          -----          -----  -----  -----
 75   TIM                  WALKER            3000    300  32000.00
 89   PETER                SMITH            3300    300  37000.40
...
--- 13 row(s) selected.
```

- Specify literal values in the USING clause of the EXECUTE statement for unnamed parameters in the prepared statement:

```

SQL>prepare findemp from
+>select * from persnl.employee
+>where salary > ? and jobcode = ?;

--- SQL command prepared.

SQL>execute findemp using 40000.00,450;

EMPNUM FIRST_NAME      LAST_NAME      DEPTNUM JOBCODE SALARY
-----  -----  -----  -----  -----
 232 THOMAS           SPINNER       4000    450  45000.00

--- 1 row(s) selected.

SQL>execute findemp using 20000.00, 300;

EMPNUM FIRST_NAME      LAST_NAME      DEPTNUM JOBCODE SALARY
-----  -----  -----  -----  -----
 75  TIM              WALKER        3000    300  32000.00
 89  PETER            SMITH         3300    300  37000.40
...
--- 13 row(s) selected.

```

- Use SET PARAM to assign a value to a parameter name and specify both the parameter name and a literal value in the EXECUTE USING clause:

```

SQL>prepare findemp from
+>select * from persnl.employee
+>where salary > ? and jobcode = ?;

--- SQL command prepared.
SQL>set param ?Salary 40000.00;
SQL>execute findemp using ?Salary, 450;

EMPNUM FIRST_NAME      LAST_NAME      DEPTNUM JOBCODE SALARY
-----  -----  -----  -----  -----
 232 THOMAS           SPINNER       4000    450  45000.00

```

3.30. EXPLAIN Statement

The EXPLAIN statement helps you to review query execution plans. You can use the EXPLAIN statement anywhere you can execute other SQL statements (for example, SELECT). For more information on the EXPLAIN function, see [EXPLAIN Function](#).

EXPLAIN is a Trafodion SQL extension.

```
EXPLAIN [OPTIONS { 'f' }] { FOR QID query-id | FOR QID CURRENT | prepared-stmt-name |
query-text }
```

Plans displayed by the EXPLAIN statement are ordered from top (root operator) to bottom (leaf operators).

3.30.1. Syntax Description of EXPLAIN

- *f*

Provides the simple, basic information contained in the query execution plan. This information is formatted for readability and limited to 79 characters (one line) per operator. See [Formatted \[OPTIONS 'f'\] Considerations](#).

- *CURRENT*

provide information for the latest compiled query.

- *query-id*

specifies the query ID of a prepared or executing query, which is a unique identifier generated by the SQL compiler.

- *prepared-stmt-name*

an SQL identifier containing the name of a statement already prepared in this session. An SQL identifier is case-insensitive (will be in uppercase) unless it is double-quoted. It must be double-quoted if it contains blanks, lowercase letters, or special characters. It must start with a letter. When you refer to the prepared query in a SELECT statement, you must use uppercase.

Note: A few non-reserved words that can be used for prepared statement names cannot be used directly in EXPLAIN. For example, 'EXPLAIN access;' results in a syntax error. You can still use the name, however, by using a delimited identifier. That is, specify the name in upper case, surrounded by double-quotes. For example, 'EXPLAIN "ACCESS";' will work.

- *query-text*

specifies the text of a query.

3.30.2. Considerations for EXPLAIN

Required Privileges

To issue an EXPLAIN statement, one of the following must be true:

- You are DB ROOT.
- You own (that is, issued) the query specified in the EXPLAIN statement.
- You have the SHOW component privilege for the SQL_OPERATIONS component. The SHOW component privilege is granted to PUBLIC by default.

Obtaining EXPLAIN Plans While Queries Are Running

Trafodion SQL provides the ability to capture an EXPLAIN plan for a query at any time while the query is running with the FOR QID option. By default, this behavior is disabled for a Trafodion database session.



Enable this feature before you start preparing and executing queries.

After the feature is enabled, use the FOR QID option in an EXPLAIN statement to get the query execution plan of a running query.

The EXPLAIN function or statement returns the plan that was generated when the query was prepared. EXPLAIN with the FOR QID option retrieves all the information from the original plan of the executing query. The plan is available until the query finishes executing and is removed or deallocated.

Case Considerations

In most cases, words in the commands can be in uppercase or lowercase. The options letter must be single quoted and in lowercase.

Number Considerations

Costs are given in a generic unit of effort. They show relative costs of an operation.

When trailing decimal digits are zero, they are dropped. For example, 6.4200 would display as 6.42 and 5.0 would display as 5, without a decimal point.

Formatted [OPTIONS 'f'] Considerations

The formatted option is the simplest option. It provides essential, brief information about the plan and shows the operators and their order within the query execution plan.

OPTIONS 'f' formats the EXPLAIN output into these fields:

LC	Left child sequence number
RC	Right child sequence number
OP	The sequence number of the operator in the query plan
OPERATOR	The operator type
OPT	Query optimizations that were applied
DESCRIPTION	Additional information about the operator
CARD	Estimated number of rows returned by the plan. CARDINALITY and ROWS_OUT are the same.

This example uses OPTIONS 'f':

```
>>explain options 'f' for qid
MXID11002015016212343685134956677000000000206U3333300_652_xx;
```

LC	RC	OP	OPERATOR	OPT	DESCRIPTION	CARD
1	.	2	root			1.00E+000
.	.	1	hbase_aggr			1.00E+000
--- SQL operation complete.						

To use the EXPLAIN statement with a prepared statement, first prepare the query. Then use the EXPLAIN statement:

```
PREPARE q FROM SELECT * FROM REGION;
```

```
EXPLAIN options 'f' q;
```

EXPLAIN can also be used with the query text directly:

```
EXPLAIN options 'f' SELECT * FROM REGION;
```

3.31. GET Statement

The GET statement displays the names of database objects, components, component privileges, roles, or users that exist in the Trafodion instance.

GET is a Trafodion SQL extension.

```
GET option
option is:
COMPONENT PRIVILEGES ON component-name [FOR auth-name]
| COMPONENTS
| FUNCTIONS FOR LIBRARY [[catalog-name.]schema-name.]library-name
| functions [in schema [catalog-name.]schema-name]
| libraries [in schema [catalog-name.]schema-name]
| procedures for library [[catalog-name.]schema-name.]library-name
| procedures [in schema [catalog-name.]schema-name]
| roles [for user database-username]
| schemas [in catalog catalog-name]
| schemas for [user | role] authorization-id
| tables [in schema [catalog-name.]schema-name]
| users [for role role-name]
| views [in schema [catalog-name.]schema-name]
| views on table [[catalog-name.]schema-name.]table-name
```

3.31.1. Syntax Description of GET

- COMPONENT PRIVILEGES ON *component-name*

displays the names of the component privileges available for the specified component.

- COMPONENT PRIVILEGES ON *component-name* FOR *auth-name*

displays the component privileges that have been granted to the specified authorization name for the specified component. The *auth-name* is either a registered database username or an existing role name and can be a regular or delimited case-insensitive identifier. See [Case-Insensitive Delimited Identifiers](#).

- COMPONENTS

displays a list of all the existing components.

- **FUNCTIONS**

displays the names of all the user-defined functions (UDFs) in the catalog and schema of the current session. By default, the catalog is TRAFODION, and the schema is SEABASE.

- **FUNCTIONS FOR LIBRARY [[_catalog-name_.]schema-name .]library-name**

displays the UDFs that reference the specified library.

- **functions in schema schema-name**

displays the names of all the UDFs in the specified schema.

- **libraries**

displays the names of all the libraries in the catalog and schema of the current session. by default, the catalog is trafodion, and the schema is seabase.

- **libraries in schema schema-name**

displays the libraries in the specified schema.

- **procedures**

displays the names of all the procedures in the catalog and schema of the current session. by default, the catalog is trafodion, and the schema is seabase.

- **procedures for library [[_catalog-name_.]schema-name .]library-name**

displays the procedures that reference the specified library.

- **procedures in schema schema-name**

displays the names of all the procedures in the specified schema.

- **roles**

displays a list of all the existing roles.

- **roles for user database-username**

displays all the roles that have been granted to the specified database user. the *database-username* can be a regular or delimited case-insensitive identifier. see [case-insensitive delimited identifiers](#).

- **schemas**

displays the names of all the schemas in the catalog of the current session. by default, the catalog is `trafodion`.

- **schemas in catalog *catalog-name***

displays the names of all the schemas in the specified catalog. for the *catalog-name*, you can specify only `trafodion`.

- **schemas for [user | role] *authorization-id***

displays all the schemas managed (or owned) by a specified user or role.

- **`*authorization-id***

is the name of a user or role. you may specify either user or role for users or roles.

- **tables**

displays the names of all the tables in the catalog and schema of the current session. by default, the catalog is `trafodion`, and the schema is `seabase`.

- **tables in schema *schema-name***

displays the names of all the tables in the specified schema.

- **users**

displays a list of all the registered database users.

- **users for role *role-name***

displays all the database users who have been granted the specified role. the *role-name* can be a regular or delimited case-insensitive identifier. see [case-insensitive delimited identifiers](#).

- `views`

displays the names of all the views in the catalog and schema of the current session. by default, the catalog is `trafodion`, and the schema is `seabase`.

- `views in schema schema-name`

displays the names of all the views in the specified schema. for the `catalog-name`, you can specify only `trafodion`.

- `views on table [[_catalog-name_.]schema-name.]table-name`

displays the names of all the views that were created for the specified table. if you do not qualify the table name with catalog and schema names, get uses the catalog and schema of the current session. for the `catalog-name`, you can specify only `trafodion`.

3.31.2. Considerations for GET

The GET COMPONENT PRIVILEGES, GET COMPONENTS, GET ROLES FOR USER, and GET USERS FOR ROLE statements work only when authentication and authorization are enabled in Trafodion. For more information, see http://trafodion.incubator.apache.org/docs/provisioning_guide/index.html#enable-security [Enable Secure Trafodion].



The GET statement displays delimited object names in their internal format. For example, the GET statement returns the delimited name "my ""table"" as my "table".

Required Privileges

To issue a GET statement, one of the following must be true:

- You are DB ROOT.
- You have the SHOW component privilege for the SQL_OPERATIONS component. The SHOW component privilege is granted to PUBLIC by default.

3.31.3. Examples of GET

- This GET statement displays the names of all the schemas in the catalog of the current session, which happens to be the TRAFODION catalog:

```
GET SCHEMAS;
```

- This GET statement displays the names of all the schemas in the specified catalog, TRAFODION:

```
GET SCHEMAS IN CATALOG TRAFODION;
```

- This GET statement displays the names of schemas owned by DB ROOT:

```
GET SCHEMAS FOR USER DB ROOT;
```

- This GET statement displays the names of all the tables in the catalog and schema of the current session, which happens to be TRAFODION.SEABASE:

```
GET TABLES;
```

- This GET statement displays the names of all the tables in the specified schema, SEABASE2, in the TRAFODION catalog:

```
GET TABLES IN SCHEMA SEABASE2;
```

- This GET statement displays the names of all the views in the catalog and schema of the current session, which happens to be TRAFODION.SEABASE:

```
GET VIEWS;
```

- This GET statement displays the names of all the views in the specified schema, SEABASE2, the TRAFODION catalog:

```
GET VIEWS IN SCHEMA SEABASE2;
```

- This GET statement displays the names of all the views that were created for the specified table, T, in the TRAFODION.SEABASE schema:

```
GET VIEWS ON TABLE T;
```

- This GET statement displays the names of the libraries in the catalog and schema of the current session, which happens to be TRAFODION.SEABASE:

```
GET LIBRARIES;
```

- This GET statement displays the names of the libraries in the TRAFODION.MD schema:

```
GET LIBRARIES IN SCHEMA "_MD_" ;
```

- This GET statement displays the names of procedures registered in the library, TRAFODION.MD.UDR_LIBRARY:

```
GET PROCEDURES FOR LIBRARY "_MD_".UDR_LIBRARY;
```

- This GET statement displays the names of procedures in the TRAFODION.MD schema:

```
GET PROCEDURES IN SCHEMA "_MD_" ;
```

- This GET statement displays the names of procedures in the catalog and schema of the current session, which happens to be TRAFODION.SEABASE:

```
GET PROCEDURES;
```

- This GET statement displays the names of user-defined functions (UDFs) in the catalog and schema of the current session, which happens to be TRAFODION.SEABASE:

```
GET FUNCTIONS;
```

- This GET statement displays the names of UDFs in MYSCHHEMA:

```
GET FUNCTIONS IN SCHEMA MYSCHHEMA;
```

- This GET statement displays the names of UDFs created in the library, TRAFODION.MYSCHEMA.MYUDFS:

```
GET FUNCTIONS FOR LIBRARY MYSCHEMA.MYUDFS;
```

- This GET statement displays a list of all the existing components:

```
get components;
```

- This GET statement displays the names of the component privileges available for the SQL_OPERATIONS component:

```
get component privileges on sql_operations;
```

- This GET statement displays the component privileges that have been granted to the DB ROOT user for the SQL_OPERATIONS component:

```
get component privileges on sql_operations for db root;
```

- This GET statement displays a list of all the existing roles:

```
get roles;
```

- This GET statement displays all the roles that have been granted to the DB ROOT user:

```
get roles for user db root;
```

- This GET statement displays a list of all the registered database users:

```
get users;
```

- This GET statement displays all the database users who have been granted the DB ROOTROLE role:

```
get users for role db rootrole;
```

3.32. GET HBASE OBJECTS Statement

The GET HBASE OBJECTS statement displays a list of HBase objects directly from HBase, not from the Trafodion metadata, and it can be run in any SQL interface, such as the Trafodion Command Interface (TrafCI). This command is equivalent to running a list command from an HBase shell, but without having to start and connect to an HBase shell.

GET HBASE OBJECTS is a Trafodion SQL extension.

```
GET [ USER | SYSTEM | EXTERNAL | ALL } HBASE OBJECTS
```

3.32.1. Syntax Description of GET HBASE OBJECTS

- **USER**

displays a list of the Trafodion user objects.

- **SYSTEM**

displays a list of the Trafodion system objects, such as metadata, repository, privileges, and Distributed Transaction Manager (DTM) tables.

- **EXTERNAL**

displays a list of non-Trafodion objects.

- **ALL**

displays a list of all objects, including user, system, and external objects.

3.32.2. Examples of GET HBASE OBJECTS

- This GET HBASE OBJECTS statement displays the Trafodion user objects in HBase:

```
Trafodion Conversational Interface 1.1.0
(c) Copyright 2015 Apache Software Foundation

>>get user hbase objects;

TRAFFODION.SCH.SB_HISTOGRAMS
TRAFFODION.SCH.SB_HISTOGRAM_INTERVALS
TRAFFODION.SCH.T006T1
TRAFFODION.SCH.T006T2
TRAFFODION.SCH.T006T3
TRAFFODION.SCH.T006T4
TRAFFODION.SCH.T006T5
TRAFFODION.SCH.T006T6
TRAFFODION.SCH.T006T7
TRAFFODION.SCH.T006T8
TRAFFODION.SCH.X1
TRAFFODION.SCH.X2
TRAFFODION.SCH.X3

--- SQL operation complete.
```

- This GET HBASE OBJECTS statement displays the Trafodion system objects in HBase:

```
>>get system hbase objects;

TRAFFODION._DTM_.TLOG0_CONTROL_POINT
...
TRAFFODION._DTM_.TLOG1_LOG_f
TRAFFODION._MD_.AUTHS
TRAFFODION._MD_.COLUMNS
TRAFFODION._MD_.DEFAULTS
TRAFFODION._MD_.INDEXES
TRAFFODION._MD_.KEYS
TRAFFODION._MD_.LIBRARIES
TRAFFODION._MD_.LIBRARIES_USAGE
TRAFFODION._MD_.OBJECTS
TRAFFODION._MD_.OBJECTS_UNIQ_IDX
TRAFFODION._MD_.REF_CONSTRAINTS
TRAFFODION._MD_.ROUTINES
TRAFFODION._MD_.SEQ_GEN TRAFFODION._MD_.TABLES
TRAFFODION._MD_.TABLE_CONSTRAINTS
TRAFFODION._MD_.TEXT
TRAFFODION._MD_.UNIQUE_REF_CONSTR_USAGE
TRAFFODION._MD_.VERSIONS
TRAFFODION._MD_.VIEWS
TRAFFODION._MD_.VIEWS_USAGE
TRAFFODION._REPOS_.METRIC_QUERY_AGGR_TABLE
TRAFFODION._REPOS_.METRIC_QUERY_TABLE
TRAFFODION._REPOS_.METRIC_SESSION_TABLE
TRAFFODION._REPOS_.METRIC_TEXT_TABLE

--- SQL operation complete.
```

- This GET HBASE OBJECTS statement displays the external, non-Trafodion objects in HBase:

```
>>get external hbase objects;

obj1
obj2

--- SQL operation complete.
```

3.33. GET VERSION OF METADATA Statement

The GET VERSION OF METADATA statement displays the version of the metadata in the Trafodion instance and indicates if the metadata is current.

GET VERSION OF METADATA is a Trafodion SQL extension.

```
GET VERSION OF METADATA
```

3.33.1. Considerations for GET VERSION OF METADATA

- If the metadata is compatible with the installed Trafodion software version, the GET VERSION OF METADATA statement indicates that the metadata is current:

```
Current Version 3.0. Expected Version 3.0.  
Metadata is current.
```

- If the metadata is incompatible with the installed Trafodion software version, the GET VERSION OF METADATA statement indicates that you need to upgrade or reinitialize the metadata:

```
Current Version 2.3. Expected Version 3.0.  
Metadata need to be upgraded or reinitialized.
```

3.33.2. Examples of GET VERSION OF METADATA

- This GET VERSION OF METADATA statement displays the metadata version in a Trafodion Release 1.0.0 instance:

```
>> get version of metadata;  
Current Version 3.0. Expected Version 3.0.  
Metadata is current.  
  
--- SQL operation complete.
```

- This GET VERSION OF METADATA statement displays the metadata version in a Trafodion Release 0.9.0 instance:

```
>> get version of metadata;
Current Version 2.3. Expected Version 2.3.
Metadata is current.

--- SQL operation complete.
```

- If the metadata is incompatible with the installed Trafodion software version, you will see this output indicating that you need to upgrade or reinitialize the metadata:

```
get version of metadata;
Current Version 2.3. Expected Version 3.0.
Metadata need to be upgraded or reinitialized.

--- SQL operation complete.
```

3.34. GET VERSION OF SOFTWARE Statement

The GET VERSION OF SOFTWARE statement displays the version of the Trafodion software that is installed on the system and indicates if it is current.

GET VERSION OF SOFTWARE is a Trafodion SQL extension.

```
GET VERSION OF SOFTWARE
```

3.34.1. Considerations for GET VERSION OF SOFTWARE

- If the software on the system is current, the GET VERSION OF SOFTWARE statement displays this output:

```
System Version 1.0.0. Expected Version 1.0.0.  
Software is current.
```

- In rare circumstances where something went wrong with the Trafodion software installation and mismatched objects were installed, the GET VERSION OF SOFTWARE statement displays this output:

```
System Version 0.9.1. Expected Version 1.0.0.  
Version of software being used is not compatible with version of software on the  
system.
```

3.34.2. Examples of GET VERSION OF SOFTWARE

- This GET VERSION OF SOFTWARE statement displays the software version for Trafodion Release 1.0.0:

```
>> get version of software;
System Version 1.0.0. Expected Version 1.0.0.
Software is current.

--- SQL operation complete.
```

- This GET VERSION OF SOFTWARE statement displays the software version for Trafodion Release 0.9.0:

```
get version of software;

System Version 0.9.0. Expected Version 0.9.0.
Software is current.

--- SQL operation complete.
```

- If something went wrong with the Trafodion software installation and if mismatched objects were installed, you will see this output indicating that the software being used is incompatible with the software on the system:

```
get version of software;

System Version 0.9.1. Expected Version 1.0.0.

Version of software being used is not compatible with version of software on the
system.

--- SQL operation complete.
```

3.35. GRANT Statement

The GRANT statement grants access privileges on an SQL object and its columns to specified users or roles. Privileges can be granted on the object, on one or more columns, or both.



This statement works only when authentication and authorization are enabled in Trafodion. For more information, see http://trafodion.incubator.apache.org/docs/provisioning_guide/index.html#enable-security [Enable Secure Trafodion].

```
GRANT {privilege [,privilege]... | ALL [PRIVILEGES] }
  ON [object-type] [schema.]object
  TO {grantee}
  [WITH GRANT OPTION]
  [[GRANTED] BY grantor]

privilege is:
| DELETE
| EXECUTE
| INSERT      [column-list]
| REFERENCES [column-list]
| SELECT      [column-list]
| UPDATE      [column-list]
| USAGE

object-type is:
| FUNCTION
| PROCEDURE
| LIBRARY
| SEQUENCE
| TABLE

grantee is:
| auth-name

grantor is:
| role-name

column-list is:
| (column [,colummn] ...)
```

3.35.1. syntax description of grant

- `privilege [,privilege] ... | all [privileges]`

Specifies the privileges to grant. You can specify these privileges for an object.

<code>DELETE</code>	Can use the delete statement.
<code>EXECUTE</code>	Can execute a stored procedure using a call statement or can execute a user-defined function (UDF).
<code>INSERT [column-list]</code>	Can use the insert statement.
<code>REFERENCES [column-list]</code>	Can create constraints that reference the object.
<code>SELECT [column-list]</code>	Can use the select statement.
<code>UPDATE [column-list]</code>	Can use the update statement on table objects.
<code>USAGE</code>	For libraries, can create procedures and functions on library objects. For sequence generators, can use the sequence in a SQL statement.
<code>ALL</code>	All the applicable privileges. When you specify all for a table or view, this includes the select, delete, insert, references, and update privileges. When the object is a stored procedure or user-defined function (UDF), only the execute privilege is applied. When the object is a library, only the update and usage privileges are applied. When the object is a sequence generator, only the usage privilege is applied.

- `ON [object-type] object`

Specifies an object on which to grant privileges. If none is specified, it defaults to TABLE. See "[Database Object Names](#)" for more details. `object-type` can be:

- `FUNCTION function-name`, where `function-name` is the name of a user-defined function (UDF) in the database.
- `LIBRARY library-name`, where `library-name` is the name of a library object in the database.
- `PROCEDURE procedure-name`, where `procedure-name` is the name of a stored procedure in java (SPJ) registered in the database.
- `SEQUENCE sequence-name`, where `sequence-name` is the name of a sequence object in the database.
- `[TABLE] object`, where `object` is a table or view.
- `TO {grantee ... }`

Specifies the `auth-name` to which you grant privileges.

- `auth-name`

Specifies the name of an authorization id to which you grant privileges. See [authorization ids](#). The authorization id must be a registered database username, an existing role name, or public. the name is a regular or delimited case-insensitive identifier. See [case-insensitive delimited identifiers](#). If you grant a privilege to public, the privilege remains

available to all users, unless it is later revoked from public.

- **WITH GRANT OPTION**

Specifies that the *auth-name* to which a privilege is granted may in turn grant the same privilege to other users or roles.

- **[GRANTED] BY *grantor***

Allows you to grant privileges on behalf of a role. If not specified, the privileges will be granted on your behalf as the current user/grantor.

- ***role-name***

Specifies a role on whose behalf the grant operation is performed. To grant the privileges on behalf of a role, you must be a member of the role, and the role must have the authority to grant the privileges; that is, the role must have been granted the privileges with grant option.

- ***column-list***

Specifies the list of columns to grant the requested privilege to.

3.35.2. Considerations for GRANT

Authorization and Availability Requirements

To grant a privilege on an object, you must have both that privilege and the right to grant that privilege. Privileges can be granted directly to you or to one of the roles you have been granted. You can grant a privilege on an object if you are the owner of the object (by which you are implicitly granted all privileges on the object) or the owner of the schema containing the object, or if you have been granted both the privilege and the WITH GRANT OPTION for the privilege.

If granting privileges on behalf of a role, you must specify the role in the [GRANTED] BY clause. To grant the privileges on behalf of a role, you must be a member of the role, and the role must have the authority to grant the privileges; that is, the role must have been granted the privileges WITH GRANT OPTION.

If you lack authority to grant one or more of the specified privileges, SQL returns a warning (yet does grant the specified privileges for which you do have authority to grant). If you lack authority to grant any of the specified privileges, SQL returns an error.

3.35.3. Examples of GRANT

- To grant column level SELECT and object level DELETE privileges on a table:

```
GRANT SELECT (part_no, part_name), DELETE ON TABLE invent.partloc  
TO "MO.Neill@company.com"; ]
```

- To grant SELECT privileges on a table to a user:

```
GRANT SELECT ON TABLE invent.partloc TO ajones;
```

3.36. GRANT COMPONENT PRIVILEGE Statement

The GRANT COMPONENT PRIVILEGE statement grants one or more component privileges to a user or role. See [Privileges](#) and [Roles](#).

GRANT COMPONENT PRIVILEGE is a Trafodion SQL extension.

 This statement works only when authentication and authorization are enabled in Trafodion. For more information, see http://trafodion.incubator.apache.org/docs/provisioning_guide/index.html#enable-security [Enable Secure Trafodion].

```
GRANT COMPONENT PRIVILEGE {privilege-name [, privilege-name]...}
  ON component-name
  TO grantee
  [WITH GRANT OPTION] [[GRANTED] BY grantor]

grantee is:
  auth-name

grantor is:
  role-name
```

3.36.1. Syntax Description of GRANT COMPONENT PRIVILEGE

- *privilege-name*

specifies one or more component privileges to grant. The comma-separated list can include only privileges within the same component.

Component	Component Privilege	Description
SQL_OPERATIONS	ALTER	Privilege to alter database objects
	ALTER_SCHEMA	Privilege to alter schemas
	ALTER_SEQUENCE	Privilege to alter sequence generators
	ALTER_TABLE	Privilege to alter tables
	ALTER_VIEW	Privilege to alter views
	CREATE	Privilege to create database objects
	CREATE_INDEX	Privilege to create indexes
	CREATE_LIBRARY	Privilege to create libraries in the database
	CREATE_PROCEDURE	Privilege to create stored procedures in Java (SPJs)
	CREATE_ROUTINE	Privilege to create user-defined functions (UDFs), table-mapping functions, and other routines in the database
	CREATE_SCHEMA	Privilege to create schemas in the database

Component	Component Privilege Description
CREATE_SEQUENCE	Privilege to create sequence generators in the database
CREATE_TABLE	Privilege to create tables in the database
CREATE_VIEW	Privilege to create views in the database
DROP	Privilege to drop database objects
DROP_INDEX	Privilege to drop indexes
DROP_LIBRARY	Privilege to drop libraries
DROP PROCEDURE	Privilege to drop stored procedures in Java (SPJs)
DROP ROUTINE	Privilege to drop user-defined functions (UDFs), table-mapping functions, and other routines from the database
DROP_SCHEMA	Privilege to drop schemas
DROP_SEQUENCE	Privilege to drop sequence generators
DROP_TABLE	Privilege to drop tables
DROP_VIEW	Privilege to drop views
MANAGE_COMPONENT	Privilege to perform component commands, such as register, create, and grant privileges
MANAGE_LIBRARY	Privilege to perform library-related commands, such as creating and dropping libraries
MANAGE_LOAD	Privilege to perform LOAD and UNLOAD commands
MANAGE_ROLES	Privilege to create, alter, drop, grant, and revoke roles
MANAGE_STATISTICS	Privilege to update and display statistics
MANAGE_USERS	Privilege to register or unregister users, alter users, and grant or revoke component privileges.
QUERY_ACTIVATE	Privilege to activate and executing query after it has been suspended
QUERY_CANCEL	Privilege to cancel an executing query
QUERY_SUSPEND	Privilege to suspend an executing query
SHOW	Privilege to run EXPLAIN, GET, INVOKE, and SHOW commands. The SHOW privilege has been granted to PUBLIC by default.

- ON *component-name*

specifies a component name on which to grant component privileges. Currently, the only valid component name is SQL_OPERATIONS.

- TO *grantee*

specifies an *auth-name* to which you grant component privileges.

- *auth-name*

specifies the name of an authorization ID to which you grant privileges. See [Authorization IDs](#). The authorization ID must be a registered database username, existing role name, or PUBLIC. The name is a regular or delimited case-insensitive identifier. See [Case-Insensitive Delimited Identifiers](#). If you grant a privilege to PUBLIC, the privilege remains available to all users, unless it is later revoked from PUBLIC.

- WITH GRANT OPTION

specifies that the *auth-name* to which a component privilege is granted may in turn grant the same component privilege to other users or roles.

- [GRANTED] BY *grantor*

allows you to grant component privileges on behalf of a role. If not specified, the privileges will be granted on your behalf as the current user/grantor.

- *role-name*

specifies a role on whose behalf the GRANT COMPONENT PRIVILEGE operation is performed. To grant the privileges on behalf of a role, you must be a member of the role, and the role must have the authority to grant the privileges; that is, the role must have been granted the privileges WITH GRANT OPTION.

3.36.2. Considerations for GRANT COMPONENT PRIVILEGE

- A user or role granted a component privilege WITH GRANT OPTION can grant the same component privilege to other users or roles.
- If all of the component privileges have already been granted, SQL returns an error.
- If one or more component privileges has already been granted, SQL silently ignores the granted privileges and proceeds with the grant operation.

Authorization and Availability Requirements

To grant a component privilege, you must have one of these privileges:

- User administrative privileges (that is, a user who has been granted the MANAGE_USERS component privilege). Initially, DB_ROOT is the only database user who has been granted the MANAGE_USERS component privilege.
- A user other than a user administrator who has the WITH GRANT OPTION for the component privilege.
- A user who was granted a role that has the WITH GRANT OPTION privilege for the component privilege.

3.36.3. Examples of GRANT COMPONENT PRIVILEGE

- Grant a component privilege, CREATE_TABLE, on a component, SQL_OPERATIONS, to SQLUSER1:

```
GRANT COMPONENT PRIVILEGE CREATE_TABLE ON SQL_OPERATIONS TO sqluser1;
```

3.37. GRANT ROLE Statement

The GRANT ROLE statement grants one or more roles to a user. See [Roles](#).



This statement works only when authentication and authorization are enabled in Trafodion. For more information, http://trafodion.incubator.apache.org/docs/provisioning_guide/index.html#enable-security [Enable Secure Trafodion].

```
GRANT ROLE {role-name [,role-name]...}
    TO grantee
grantee is:
    database-username
```

3.37.1. Syntax Description of GRANT ROLE

- *role-name [,role-name] ...*

specifies the existing roles to grant.

- TO *grantee*

specifies the registered database username to whom to grant the roles.

3.37.2. Considerations for GRANT ROLE

- To grant roles to other grantees, you must own the roles or have user administrative privileges for the roles. You have user administrative privileges for roles if you have been granted the MANAGE_ROLES component privilege. Initially, DB ROOT is the only database user who has been granted the MANAGE_ROLES component privilege.
- When you grant a role to a user, the additional privileges are automatically propagated to and detected by active sessions. There is no need for users to disconnect from and reconnect to a session to see the updated set of privileges.
- If any errors occur in processing a GRANT ROLE statement that names multiple roles, then no grants are done.
- If you attempt to grant a role but a grant with the same role and grantee already exists, SQL ignores the request and returns a successful operation.

3.37.3. Examples of GRANT ROLE

- To grant multiple roles to a grantee:

```
GRANT ROLE clerks, sales TO jsmith;
```

3.38. INSERT Statement

The INSERT statement is a DML statement that inserts rows in a table or view.

```
INSERT INTO table [(target-col-list)] insert-source

target-col-list is:
    colname [,colname]...

insert-source is:
    query-expr [order-by-clause] [access-clause] | DEFAULT VALUES
```

3.38.1. Syntax Description of INSERT

- *table*

names the user table or view in which to insert rows. *table* must be a base table or an updatable view.

- *(target-col-list)*

names the columns in the table or view in which to insert values. The data type of each target column must be compatible with the data type of its corresponding source value. Within the list, each target column must have the same position as its associated source value, whose position is determined by the columns in the table derived from the evaluation of the query expression (*query-expr*).

If you do not specify all of the columns in *table* in the *target-col-list*, column default values are inserted into the columns that do not appear in the list. See [Column Default Settings](#).

If you do not specify *target-col-list*, row values from the source table are inserted into all columns in *table*. The order of the column values in the source table must be the same order as that of the columns specified in the CREATE TABLE for *table*. (This order is the same as that of the columns listed in the result table of SHOWDDL *table*.)

- *insert-source*

specifies the rows of values to be inserted into all columns of *table* or, optionally, into specified columns of *table*.

- *query-expr*

For the description of *query-expr*, *order-by-clause*, and *access-clause*, see the [SELECT Statement](#).

- DEFAULT VALUES

is equivalent to a *query-expr* of the form VALUES (DEFAULT, ...). The value of each DEFAULT is the default value

defined in the column descriptor of *colname*, which is contained in the table descriptor of *table*. Each default value is inserted into its column to form a new row. If you specify DEFAULT VALUES, you cannot specify a column list. You can use DEFAULT VALUES only when all columns in *table* have default values.

3.38.2. Considerations for INSERT

Authorization Requirements

INSERT requires authority to read and write to the table or view receiving the data and authority to read tables or views specified in the query expression (or any of its subqueries) in the INSERT statement.

Transaction Initiation and Termination

The INSERT statement automatically initiates a transaction if no transaction is active. Alternatively, you can explicitly initiate a transaction with the BEGIN WORK statement. After a transaction is started, the SQL statements execute within that transaction until a COMMIT or ROLLBACK is encountered or an error occurs. If AUTOCOMMIT is ON, the transaction terminates at the end of the INSERT statement.

Self-Referencing INSERT and BEGIN WORK or AUTOCOMMIT OFF

A self-referencing INSERT statement is one that references, in the statement's *insert-source*, the same table or view into which rows will be inserted (see [Examples of Self-Referencing Inserts](#)). A self-referencing INSERT statement will not execute correctly and an error is raised if either BEGIN WORK or AUTOCOMMIT OFF is used unless the compiler's plan sorts the rows before they are inserted. If you want to use a self-referencing INSERT statement, you should avoid the use of BEGIN WORK or AUTOCOMMIT OFF. For information about AUTOCOMMIT, see the [SET TRANSACTION Statement](#).

Isolation Levels of Transactions and Access Options of Statements

The isolation level of an SQL transaction defines the degree to which the operations on data within that transaction are affected by operations of concurrent transactions. When you specify access options for the DML statements within a transaction, you override the isolation level of the containing transaction. Each statement then executes with its individual access option.

Use of a VALUES Clause for the Source Query Expression

If the query expression consists of the VALUES keyword followed by rows of values, each row consists of a list of value expressions or a row subquery (a subquery that returns a single row of column values). A value in a row can also be a scalar subquery (a subquery that returns a single row consisting of a single column value).

Within a VALUES clause, the operands of a value expression can be numeric, string, datetime, or interval values; however, an operand cannot reference a column (except in the case of a scalar or row subquery returning a value or values in its result table).

Requirements for Inserted Rows

Each row to be inserted must satisfy the constraints of the table or underlying base table of the view. A table constraint is satisfied if the check condition is not false—it is either true or has an unknown value.

Using Compatible Data Types

To insert a row, you must provide a value for each column in the table that has no default value. The data types of the values in each row to be inserted must be compatible with the data types of the corresponding target columns.

Inserting Character Values

Any character string data type is compatible with all other character string data types that have the same character set. For fixed length, an inserted value shorter than the column length is padded on the right with blank characters of the appropriate character set (for example, ISO88591 blanks (HEX20). If the value is longer than the column length, string truncation of non-blank trailing characters returns an error, and the truncated string is not inserted.

For variable length, a shorter inserted value is not padded. As is the case for fixed length, if the value is longer than the column length, string truncation of non-blank trailing characters returns an error, and the truncated string is not inserted.

Inserting Numeric Values

Any numeric data type is compatible with all other numeric data types. If you insert a value into a numeric column that is not large enough, an overflow error occurs. If a value has more digits to the right of the decimal point than specified by the scale for the column definition, the value is truncated.

Inserting Interval Values

A value of interval data type is compatible with another value of interval data type only if the two data types are both year-month or both day-time intervals.

Inserting Date and Time Values

Date, time, and timestamp are the three Trafodion SQL datetime data types. A value with a datetime data type is compatible with another value with a datetime data type only if the values have the same datetime fields.

Inserting Nulls

and inserting values with specific data types, you might want to insert nulls. To insert null, use the keyword NULL. NULL only works with the VALUES clause. Use cast (null as *type*) for select-list.

3.38.3. Examples of INSERT

- Insert a row into the CUSTOMER table without using a *target-col-list*:

```
INSERT INTO sales.customer
VALUES (4777, 'ZYROTECHNIKS', '11211 40TH ST.', 'BURLINGTON', 'MASS.',
'01803', 'A2');
--- 1 row(s) inserted.
```

The column name list is not specified for this INSERT statement. This operation works because the number of values listed in the VALUES clause is equal to the number of columns in the CUSTOMER table, and the listed values appear in the same order as the columns specified in the CREATE TABLE statement for the CUSTOMER table.

By issuing this SELECT statement, this specific order is displayed:

```
SELECT * FROM sales.customer WHERE custnum = 4777;
CUSTNUM      CUSTNAME      STREET          ... POSTCODE CREDIT
-----  -----
4777  ZYROTECHNIKS  11211 40TH ST.  ... 01803    A2
--- 1 row(s) selected.
```

- Insert a row into the CUSTOMER table using a *target-col-list*:

```
INSERT INTO sales.customer
(custnum, custname, street, city, state, postcode)
VALUES (1120, 'EXPERT MAILERS', '5769 N. 25TH PL',
'PHOENIX', 'ARIZONA', '85016');
--- 1 row(s) inserted.
```

Unlike the previous example, the insert source of this statement does not contain a value for the CREDIT column, which has a default value. As a result, this INSERT must include the column name list.

This SELECT statement shows the default value 'C1' for CREDIT:

```
SELECT * FROM sales.customer WHERE custnum = 1120;
```

CUSTNUM	CUSTNAME	STREET	...	POSTCODE	CREDIT
1120	EXPERT MAILERS	5769 N. 25TH PL	...	85016	C1

--- 1 row(s) selected.

- Insert multiple rows into the JOB table by using only one INSERT statement:

```
INSERT INTO persnl.job
VALUES (100,'MANAGER'),
       (200,'PRODUCTION SUPV'),
       (250,'ASSEMBLER'),
       (300,'SALESREP'),
       (400,'SYSTEM ANALYST'),
       (420,'ENGINEER'),
       (450,'PROGRAMMER'),
       (500,'ACCOUNTANT'),
       (600,'ADMINISTRATOR'),
       (900,'SECRETARY');
```

--- 10 row(s) inserted.

- The PROJECT table consists of five columns using the data types numeric, varchar, date, timestamp, and interval.

Insert values by using these types:

```
INSERT INTO persnl.project
VALUES (1000, 'SALT LAKE CITY', DATE '2007-10-02',
        TIMESTAMP '2007-12-21 08:15:00.00', INTERVAL '30' DAY);

--- 1 row(s) inserted.
```

- Suppose that CUSTLIST is a view of all columns of the CUSTOMER table except the credit rating. Insert information from the SUPPLIER table into the CUSTOMER table through the CUSTLIST view, and then update the credit rating:

```
INSERT INTO sales.custlist
  (SELECT * FROM invent.supplier
   WHERE suppnum = 10);

UPDATE sales.customer
  SET credit = 'A4'
 WHERE custnum = 10;
```

You could use this sequence in the following situation. Suppose that one of your suppliers has become a customer. If you use the same number for both the customer and supplier numbers, you can select the information from the SUPPLIER table for the new customer and insert it into the CUSTOMER table through the CUSTLIST view (as shown in the example).

This operation works because the columns of the SUPPLIER table contain values that correspond to the columns of the CUSTLIST view. Further, the credit rating column in the CUSTOMER table is specified with a default value. If you want a credit rating that is different from the default, you must update this column in the row of new customer data.

Examples of Self-Referencing Inserts

- This is an example of a self-referencing insert:

```
insert into table1 select pk+?, b, c from table1
```

- This is an example of a self-referencing insert where the target of the insert, table1, is also used in a subquery of the insert-source:

```
insert into table1
  select a+16, b, c from table2 where table2.b not in
    (select b from table1 where a > 16)
```

The source table is not affected by the insert.

3.39. INVOKE Statement

The INVOKE statement generates a record description that corresponds to a row in the specified table, view, or index. The record description includes a data item for each column in the table, view, or index, including the primary key but excluding the SYSKEY column. It includes the SYSKEY column of a view only if the view explicitly listed the column in its definition.

INVOKE is a Trafodion SQL extension.

```
INVOKE  table-name
```

3.39.1. Syntax Description of INVOKE

- *table-name* _ specifies the name of a table, view, or index for which to generate a record description. See [Database Object Names](#).

3.39.2. Considerations for INVOKE

3.39.3. Required Privileges

To issue an INVOKE statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the table.
- You have the SHOW component privilege for the SQL_OPERATIONS component. The SHOW component privilege is granted to PUBLIC by default.
- You have the SELECT privilege on the target table.

3.39.4. Examples of INVOKE

- This command generates a record description of the table T:

```
SQL> invoke trafodion.seabase.t;
-- Definition of Trafodion table TRAFODION.SEABASE.T
-- Definition current Wed Mar 5 10:36:06 2014
(
    A                      INT NO DEFAULT NOT NULL NOT DROPPABLE
)
PRIMARY KEY (A ASC)

--- SQL operation complete.
```

3.40. MERGE Statement

The MERGE statement:

- Updates a table if the row exists or inserts into a table if the row does not exist. This is upsert functionality.
- Updates (merges) matching rows from one table to another.

```
MERGE INTO table [using-clause]
  on-clause
  { [when-matched-clause] | [when-not-matched-clause] } ...

using-clause is:
  USING (select-query) AS derived-table-name [derived-column-names]

on-clause is:
  ON predicate

when-matched-clause is:
  WHEN MATCHED THEN UPDATE SET set-clause [WHERE predicate]
  WHEN MATCHED THEN DELETE

when-not-matched-clause is:
  WHEN NOT MATCHED THEN INSERT insert-values-list

insert-values-list is:
  [(column1, ..., columnN)] VALUES (value1, ..., valueN)
```

3.40.1. Syntax Description of MERGE

- *table*

is the ANSI logical name for the table.

- ON *predicate*

used to determine if a row is or is not present in the table. The ON predicate must be a predicate on the clustering key of the table if the MERGE has a *when-not-matched-clause*. The clustering key can be a single or multi-column key.

The ON predicate must select a unique row if the MERGE has a *when-not-matched-clause*.

3.40.2. Considerations for MERGE

3.40.3. Upsert Using Single Row

A MERGE statement allows you to specify a set of column values that should be updated if the row is found, and another row to be inserted if the row is not found. The ON predicate must select exactly one row that is to be updated if the MERGE statement has an INSERT clause.

In a MERGE statement, at least one of the clauses *when-matched* or *when-not-matched* must be specified. Note the following:

- If a *when-matched* clause is present and the WHERE predicate in the UPDATE is satisfied, the columns in the SET clause are updated.
- If a *when-matched* clause is present and the WHERE predicate in the UPDATE is not satisfied, the columns in the SET clause are not updated.
- If a *when-matched* clause is present and the UPDATE has no WHERE predicate, the columns in the SET clause are updated.
- If a *when-not-matched* clause is present and columns are explicitly specified in the INSERT clause, the specified values for those columns are inserted. Missing columns are updated using the default values for those columns.

This example updates column b to 20 if the row with key column a with value 10 is found. A new row (10, 30) is inserted if the row is not found in table t.

```
MERGE INTO t ON a = 10
WHEN MATCHED THEN UPDATE SET b = 20
WHEN NOT MATCHED THEN INSERT VALUES (10, 30)
```

This example updates column b to 20 if column a with value 10 is found. If column a with value 10 is not found, nothing is done.

```
MERGE INTO t ON a = 10
WHEN MATCHED THEN UPDATE SET b = 20
```

This example inserts values (10, 30) if column a with value 10 is not found. If column a with value 10 is found, nothing is done.

```
MERGE INTO t ON a = 10
WHEN NOT MATCHED THEN INSERT VALUES (10, 30)
```

Conditional Upsert Using Single Row

In this example, the MERGE statement uses a single-row conditional upsert that inserts one row (keycol, col, seqnum) value if a row with that keycol (parameter-specified) value is not yet in table d. Otherwise, the MERGE statement updates that row's col and seqnum columns if that row's seqnum is higher than the current (parameter-specified) sequence number. If the matching row's seqnum column value is not higher than the current sequence number, then that matched row is not updated.

```
MERGE INTO d ON keycol = ?
WHEN MATCHED THEN UPDATE SET (col, seqnum) = (?, ?) WHERE seqnum < ?
WHEN NOT MATCHED THEN INSERT (keycol, col, seqnum) VALUES (?, ?, ?)
```

The optional WHERE predicate in the *when-matched-then-update* clause is useful when the update is wanted only if the given condition is satisfied. Consider this use case. Suppose object

X is represented as a row in table T. Also, suppose a stream of updates exists for object X. The updates are marked by a sequence number at their source. However, the updates flow through a network which does not guarantee first-in, first-out delivery. In fact, the updates may arrive out-of-order to the database. In this case, the last update (the one with the current highest sequence number) should always win in the database. The MERGE statement shown above can be used to satisfy this use case:

- A stream of updates for table d exists that are sequenced by a sequence number seqnum at their source
- The updates race through the network and may arrive in the database in any order, and
- You want to guarantee that the last update (the one with the highest seqnum) always wins in the database.

Restrictions

- The MERGE statement does not use ESP parallelism.
- A merged table cannot be a view.
- Merge is not allowed if the table has constraints.

- The *on-clause* cannot contain a subquery. This statement is not allowed:

```
MERGE INTO t ON a = (SELECT a FROM t1) WHEN ...
```

- The optional WHERE predicate in the when-matched clause cannot contain a subquery or an aggregate function.

These statements are not allowed:

```
MERGE INTO t ON a = 10
WHEN MATCHED THEN UPDATE SET b=4 WHERE b=(SELECT b FROM t1)
WHEN NOT MATCHED THEN INSERT VALUES (10,30);
```

```
MERGE INTO t ON a=10
WHEN MATCHED THEN UPDATE SET b=4 WHERE b=MAX(b)
WHEN NOT MATCHED THEN INSERT VALUES (10,30);
```

- The UPDATE SET clause in a MERGE statement cannot contain a subquery. This statement is not allowed:

```
MERGE INTO t ON a = 1 WHEN MATCHED THEN UPDATE SET b = (SELECT a FROM t1)
```

- The *insert-values-list* clause in a MERGE statement cannot contain a subquery. This statement is not allowed:

```
MERGE INTO t ON a = 1 WHEN NOT MATCHED THEN INSERT VALUES ((SELECT a FROM t1))
```

- Use of a non-unique *on-clause* for a MERGE update is allowed only if no INSERT clause exists.

```
MERGE INTO t USING (SELECT a,b FROM t1) x ON t.a=x.a
WHEN MATCHED THEN UPDATE SET b=x.b;
```

In this example, t.a=x.a is not a fully qualified unique primary key predicate.

- Use of a non-unique *on-clause* for a MERGE delete is allowed only if no INSERT clause exists.

```
MERGE INTO t USING (SELECT a,b FROM t1) x ON t.a=x.a
WHEN MATCHED THEN DELETE;
```

MERGE From One Table Into Another

The MERGE statement can be used to upsert all matching rows from the source table into the target table. Each row from the source table is treated as the source of a single upsert statement. The *using-clause* contains the *select-query* whose output is used as the source to the MERGE statement.

The source *select-query* must be renamed using the AS clause.

```
MERGE INTO t ON
  USING (_select-query_) AS z(X) ON col = z.X
  WHEN MATCHED THEN . . .
```

For each row selected out of the select-query, the MERGE statement is evaluated. Values selected are used in the *on-clause* to join with the column of the merged table. If the value is found, it is updated. If it is not found, the insert is done. The restrictions are the same as those for <>upsert_using_single_row, Upinsert Using Single Row>.

3.40.4. Examples of MERGE

- This query extracts derived columns a and b from the USING query as derived table z and use each row to join to the merged table t based on the *on-clause*. For each matched row, column b in table t is updated using column b in derived table z. For rows that are not matched, values z.a and z.b are inserted.

```
MERGE INTO t USING
  (SELECT * FROM t1) z(a,b) on a = z.a
  WHEN MATCHED THEN UPDATE SET b = z.b
  WHEN NOT MATCHED THEN INSERT VALUES (z.a, z.b);
```

3.41. PREPARE Statement

The PREPARE statement compiles an SQL statement for later use with the EXECUTE statement in the same Trafodion Command Interface (TrafCI) session.

You can also use PREPARE to check the syntax of a statement without executing the statement in the same TrafCI session.

```
PREPARE statement-name FROM statement
```

3.41.1. Syntax Description of PREPARE

- *statement-name*

is an SQL identifier that specifies a name to be used for the prepared statement. See [Identifiers](#). The statement name should be a character string and not a numeric value. If you specify the name of an existing prepared statement, the new statement overwrites the previous one.

- *statement*

specifies the SQL statement to prepare.

3.41.2. Considerations for PREPARE

Availability of a Prepared Statement

If a PREPARE statement fails, any subsequent attempt to run EXECUTE on the named statement fails. Only the TrafCI session that executes the PREPARE can run EXECUTE on the prepared statement.

The prepared statement is available for running EXECUTE until you terminate the TrafCI session.

A statement must be compiled by PREPARE before you can run EXECUTE on it. However, after the statement is compiled, you can run EXECUTE on the statement multiple times without recompiling the statement.

3.41.3. Examples of PREPARE

- Prepare a SELECT statement, checking for syntax errors:

```
SQL>prepare empsal from
+>select salary from employee
+>where jobcode = 100;

*** ERROR[4082] Table, view or stored procedure TRAFODION.INVENT.EMPLOYEE does not
exist or is inaccessible.
*** ERROR[8822] The statement was not prepared.
SQL>
```

- Prepare a SELECT statement with an unnamed parameter (?) and later run EXECUTE on it:

```
SQL>prepare findsal from
+>select salary from persnl.employee
+>where jobcode = ?;

--- SQL command prepared.

SQL>execute findsal using 450;
SALARY
-----
32000.00
33000.50
40000.00
32000.00
45000.00

--- 5 row(s) selected.
SQL>
```

- Prepare a SELECT statement with a named parameter (*?param-name*) and later run EXECUTE on it:

```
SQL>prepare findsal from
+>select salary from persnl.employee
+>where jobcode = ?job;

--- SQL command prepared.

SQL>set param ?job 450
SQL>execute findsal;

SALARY
-----
32000.00
33000.50
40000.00
32000.00
45000.00

--- 5 row(s) selected.
SQL>
```

For more information, see the [EXECUTE Statement](#).

3.42. REGISTER USER Statement

The REGISTER USER statement registers a user in the SQL database, associating the user's login name with a database username.

REGISTER USER is a Trafodion SQL extension.



The user's login name is also the name by which the user is defined in the directory service, so the syntax description below refers to it as the *directory-service username*.

```
REGISTER USER directory-service-username [ AS database-username ]
```

3.42.1. Syntax Description of REGISTER USER

- *directory-service-username*

is the name that identifies the user in the directory service. This is also the name the user specifies when logging in to a Trafodion database. The *directory-service-username* is a regular or delimited case-insensitive identifier. See [Case-Insensitive Delimited Identifiers](#).

- *database-username*

is a regular or delimited case-insensitive identifier that denotes the username as defined in the database. The database username cannot be identical to a registered database username or an existing role name. However, it can be the same as the directory-service username. If you omit the AS *database-username* clause, the database username will be the same as the directory-service username.

3.42.2. Considerations for REGISTER USER

Who Can Register a User

To register a user, you must have user administrative privileges. You have user administrative privileges if you have been granted the MANAGE_USERS component privilege. Initially, DB ROOT is the only database user who has been granted the MANAGE_USERS component privilege.

Add the User to the Directory Before Registering the User

Add the user to the appropriate directory service before you register the user. Otherwise, REGISTER USER will fail.

AS *database-username* Clause

Use the AS *database-username* clause to assign a database username that is different than the username defined in the directory service. In particular, it is often convenient to assign a database username that is shorter and easier to type than the directory-service username.

For example, if the user logs on as John.Allen.Doe.the.Second@mycompany.com, you might want to assign the user a database username of JDoe.

Database user names are authorization IDs. If you specify a name already assigned to another user or to an existing role, the command will fail. For more information, see [Authorization IDs](#).

Reserved Names

PUBLIC, _SYSTEM, NONE, and database user names beginning with DB are reserved. You cannot register users with any such name.

Username Length

Database user names are limited to 128 characters.

3.42.3. Examples of REGISTER USER

- To register a user and assign a database username different than the user's login name:

```
REGISTER USER "jsmith@company.com" AS jsmith;
```

- To register a user without specifying a database username, so the database username will be the same as the user's login name:

```
REGISTER USER "jsmith@company.com";
```

3.43. REVOKE Statement

The REVOKE statement revokes access privileges on an SQL object from specified users or roles. Privileges can be revoked from the object, from one or more columns, or both.



This statement works only when authentication and authorization are enabled in Trafodion. For more information, http://trafodion.incubator.apache.org/docs/provisioning_guide/index.html#enable-security [Enable Secure Trafodion].

```

REVOKE [GRANT OPTION FOR]
{privilege [,privilege]...| ALL [PRIVILEGES]}
ON [object-type] [schema.]object
FROM {grantee}
[[GRANTED] BY grantor]

privilege is:
| DELETE
| EXECUTE
| INSERT      [column-list]
| REFERENCES  [column-list]
| SELECT      [column-list]
| UPDATE      [column-list]
| USAGE

object-type is:
| FUNCTION
| LIBRARY
| PROCEDURE
| SEQUENCE
| TABLE

grantee is:
auth-name

grantor is:
role-name

column-list is:
(column [,column]...)

```

3.43.1. Syntax Description of REVOKE

- GRANT OPTION FOR

Specifies that the grantee's authority to grant the specified privileges to other users or roles (that is, WITH GRANT OPTION) be revoked. This is an optional clause. When this clause is specified, only the ability to grant the privilege to

another user is revoked.

- *privilege [, privilege] ... | ALL [PRIVILEGES]*

Specifies the privileges to revoke. You can specify these privileges for an object:

DELETE	Revokes the ability to use the DELETE statement.
EXECUTE	Revokes the ability to execute a stored procedure using a CALL statement or revokes the ability
INSERT [column-list]	Revokes the ability to use the INSERT statement.
REFERENCES [column-list]	Revokes the ability to create constraints that reference the object.
SELECT [column-list]	Revokes the ability to use the SELECT statement.
UPDATE [column-list]	Revokes the ability to use the UPDATE statement. to execute a user-defined function (UDF).
USAGE	For libraries, revokes the ability to access a library using the CREATE PROCEDURE or CREATE FUNCTION statement. For sequence generators, revokes the ability to access a sequence in a SQL query.
ALL	Revokes the ability to use all privileges that apply to the object type. When you specify ALL for a table or view, this includes the SELECT, DELETE, INSERT, REFERENCES, and UPDATE privileges. When the object is a stored procedure or user-defined function (UDF), this includes the EXECUTE privilege. When the object is a library, this includes the UPDATE and USAGE privileges. When the object is a sequence generator, only the usage privilege is applied.

- ON [*object-type*] *object*

Specifies an object on which to grant privileges. If none is specified, it defaults to TABLE. See "[Database Object Names](#)" for more details. *object-type* can be:

- FUNCTION *function-name*, where *function-name* is the name of a user-defined function in the database.
 - LIBRARY *library-name*, where *library-name* is the name of a library object in the database.
 - PROCEDURE *procedure-name*, where *procedure-name* is the name of a stored procedure in Java (SPJ) registered in the database.
 - SEQUENCE *sequence-name*, where *sequence-name* is the name of a sequence generator.
 - [TABLE] *object-name*, where *object-name* is the name of a table or view.
- FROM {*grantee* [, *grantee*] ... }

Specifies an *auth-name* from which you revoke privileges.

- *auth-name*

Specifies the name of an authorization ID from which you revoke privileges. See [Authorization IDs](#). The authorization

ID must be a registered database username, existing role name, or PUBLIC. The name is a regular or delimited case-insensitive identifier. See [Case-Insensitive Delimited Identifiers](#).

- [GRANTED] BY *grantor*

Allows you to revoke privileges on behalf of a role. If not specified, the privileges will be revoked on your behalf as the current user/grantor.

- *role-name*

Specifies a role on whose behalf the GRANT operation was performed. To revoke the privileges on behalf of a role, you must be a member of the role, and the role must have the authority to revoke the privileges; that is, the role must have been granted the privileges WITH GRANT OPTION.

- *column-list*

Specifies the list of columns to revoke the requested privilege from.

3.43.2. Considerations for REVOKE

Authorization and Availability Requirements

You can revoke privileges for which you are the grantor, either through a direct grant or a grant done on your behalf. If you are revoking privileges that were granted on behalf of a role, you must be a member of the role, and you must specify the role in the [GRANTED] BY clause.

If one or more privileges have not been granted, SQL returns a warning.

When you specify the CASCADE option, all objects that were created based upon the privileges being revoked are removed.

3.43.3. Examples of REVOKE

- To revoke GRANT OPTION for column level SELECT and table level DELETE privileges on a table from a user:

```
REVOKE GRANT OPTION FOR SELECT (part_no, part_name), DELETE ON TABLE invent.partloc
FROM jsmith;
```

- To revoke the privilege to grant SELECT and DELETE privileges on a table from a user and a role:

```
REVOKE SELECT (part_no, part_name), DELETE ON TABLE invent.partloc FROM jsmith,
clerks;
```

- To revoke a user's SELECT privileges on a table:

```
-- User administrator grants the SELECT privilege to JSMITH:
GRANT SELECT ON TABLE invent.partloc TO jsmith WITH GRANT OPTION;

-- JSMITH grants the SELECT privilege to AJONES:
GRANT SELECT ON TABLE invent.partloc TO ajones;

-- If the user administrator attempts to revoke the SELECT
-- privilege from JSMITH, this would fail because
-- of the privilege granted to AJONES based on the
-- privilege granted to JSMITH.
-- To successfully revoke the SELECT privilege from
-- JSMITH, the SELECT privilege granted to AJONES
-- must be revoked first. For this example:
-- 1. JSMITH revokes the SELECT privilege granted to AJONES:
REVOKE SELECT ON TABLE invent.partloc FROM ajones;

-- 2. User administrator revokes the SELECT privilege on the
-- table from JSMITH:
REVOKE SELECT ON TABLE invent.partloc FROM jsmith RESTRICT;

-- The REVOKE operation succeeds.
-- An easier way to make the REVOKE operation successful is
-- to use the CASCADE option:
REVOKE SELECT ON TABLE invent.partloc FROM jsmith CASCADE;

-- The REVOKE operation succeeds because the CASCADE option
-- causes all specified privileges, and all privileges that
-- were granted based upon the specified privileges, to be
-- removed.
```

- Administration in the shipping department decides that the CLERKS role should no longer be able to grant privileges on the invent.partloc table. Fred has recently moved to another department, so JSMITH revokes the SELECT privilege on the invent.partloc table from Fred, who was granted the privilege by CLERKS. Then, JSMITH revokes the grant option from CLERKS:

```
REVOKE SELECT on table invent.partloc FROM fred GRANTED BY clerks;
REVOKE GRANT OPTION FOR SELECT ON TABLE invent.partloc FROM clerks;
```

3.44. REVOKE COMPONENT PRIVILEGE Statement

The REVOKE COMPONENT PRIVILEGE statement removes one or more component privileges from a user or role. See [Privileges](#) and [Roles](#).

REVOKE COMPONENT PRIVILEGE is a Trafodion SQL extension.



This statement works only when authentication and authorization are enabled in Trafodion. For more information, http://trafodion.incubator.apache.org/docs/provisioning_guide/index.html#enable-security [Enable Secure Trafodion].

```
REVOKE [GRANT OPTION FOR]
  COMPONENT PRIVILEGE {privilege-name[ , privilege-name]...}
  ON component-name
  FROM grantee
  [[GRANTED] BY grantor]

grantee is:
  auth-name

grantor is:
  role-name
```

3.44.1. Syntax Description of REVOKE COMPONENT PRIVILEGE

- GRANT OPTION FOR

specifies that the grantee's authority to grant the specified component privileges to other users or roles (that is, WITH GRANT OPTION) be revoked. This is an optional clause. When this clause is specified, only the ability to grant the component privilege to another user is revoked.

- *privilege-name*

specifies one or more component privileges to revoke. The comma-separated list can include only privileges within the same component.

- ON *component-name*

specifies a valid component name on which to revoke component privileges. Currently, the only valid component name is SQL_OPERATIONS.

- FROM *grantee*

specifies an *auth-name* from which you revoke the component privileges.

- *auth-name*

specifies the name of an authorization ID from which you revoke privileges. See [Authorization IDs](#). The authorization ID must be a registered database username, existing role name, or PUBLIC. The name is a regular or delimited case-insensitive identifier. See [Case-Insensitive Delimited Identifiers](#).

- [GRANTED] BY *grantor*

allows you to revoke component privileges on behalf of a role. If not specified, the component privileges will be revoked on your behalf as the current user/grantor.

- *role-name*

specifies a role on whose behalf the GRANT COMPONENT PRIVILEGE operation was performed. To revoke the privileges on behalf of a role, you must be a member of the role, and the role must have the authority to revoke the privileges; that is, the role must have been granted the privileges WITH GRANT OPTION.

3.44.2. Considerations for REVOKE COMPONENT PRIVILEGE

- At revoke time, all privileges granted WITH GRANT OPTION are removed. That is, the revoke behavior is CASCADE.
- If none of the component privileges has been granted, SQL returns an error.
- If one or more component privileges have not been granted, SQL silently ignores those privileges and proceeds with the revoke operation.
- Component privileges must be revoked before a role can be dropped or a user unregistered. If any privileges have been granted to a role or user, an error is returned when that role is dropped or the user unregistered. For more information, see the [DROP ROLE Statement](#) and the [UNREGISTER USER Statement](#).

Authorization and Availability Requirements

You can revoke component privileges for which you are the grantor, either through a direct grant or a grant done on your behalf. If you are revoking privileges that were granted on behalf of a role, you must be a member of the role, and you must specify the role in the [GRANTED] BY clause.

3.44.3. Examples of REVOKE COMPONENT PRIVILEGE

- Revoke a component privilege from SQLUSER1:

```
REVOKE COMPONENT PRIVILEGE CREATE_TABLE ON SQL_OPERATIONS FROM sqluser1;
```

3.45. REVOKE ROLE Statement

The REVOKE ROLE statement removes one or more roles from a user. See [Roles](#).



This statement works only when authentication and authorization are enabled in Trafodion. For more information, http://trafodion.incubator.apache.org/docs/provisioning_guide/index.html#enable-security [Enable Secure Trafodion].

```
REVOKE ROLE {role-name [,role-name]...}
  FROM grantee
  [RESTRICT | CASCADE]

grantee is:
  database-username
```

3.45.1. Syntax Description of REVOKE ROLE

- *role-name* [, *role-name*] ...

specifies the valid roles to revoke.

- FROM *grantee*

specifies the registered database username from whom you revoke the roles.

- [RESTRICT | CASCADE]

If you specify RESTRICT, the REVOKE ROLE operation fails if any privileges were granted to the role or any objects were created based upon those privileges.

If you specify CASCADE, any dependent privileges are removed as part of the REVOKE ROLE operation.

The default value is RESTRICT.

3.45.2. Considerations for REVOKE ROLE

- To revoke roles from users, you must own the roles or have user administrative privileges for the roles. You have user administrative privileges for roles if have been granted the MANAGE_ROLES component privilege. Initially, DB ROOT is the only database user who has been granted the MANAGE_ROLES component privilege.
- If RESTRICT (or nothing) is specified and if you want to revoke a role from a user that has created objects based solely on role privileges, you must drop the objects before revoking the role. However, if you specify CASCADE, the dependent objects are automatically dropped, and the role is revoked.
- All of the specified roles must have been granted to the specified user. If any role has not been granted to the user, the operation returns an error, and no roles are revoked.
- When you revoke a role from a user, the reduction in privileges is automatically propagated to and detected by active sessions. There is no need for users to disconnect from and reconnect to a session to see the updated set of privileges.
- If the REVOKE ROLE names multiple roles and any errors occur in processing, no revokes are performed.

3.45.3. Examples of REVOKE ROLE

- To revoke multiple roles from a user:

```
REVOKE ROLE clerks, sales FROM jsmith;
```

- To revoke a role with dependent objects from a user:

```
-- CMILLER grants a role to AJONES:  
GRANT ROLE sales TO ajones;  
  
-- CMILLER grants a privilege to the role:  
GRANT SELECT ON TABLE invent.partloc TO sales;  
  
-- AJONES creates a view based upon the privilege granted  
-- to the role granted to him:  
CREATE VIEW invent.partlocview (partnum, loc_code) AS  
    SELECT partnum, loc_code FROM invent.partloc;  
  
-- If CMILLER attempts to revoke the role from AJONES,  
-- this would fail because of the view created based  
-- upon the privilege granted to the role granted to  
-- AJONES.  
-- CMILLER revokes the role from AJONES with the CASCADE option:  
REVOKE ROLE sales from AJONES CASCADE;  
  
-- The REVOKE ROLE operation succeeds, and all dependent object privileges are  
revoked.
```

3.46. ROLLBACK WORK Statement

The ROLLBACK WORK statement undoes all database modifications to objects made during the current transaction and ends the transaction. See [Transaction Management](#).

```
ROLLBACK [ WORK ]
```

3.46.1. Syntax Description of ROLLBACK WORK

WORK is an optional keyword that has no effect.

ROLLBACK WORK issued outside of an active transaction generates error 8609.

3.46.2. Considerations for ROLLBACK WORK

Begin and End a Transaction

BEGIN WORK starts a transaction. COMMIT WORK or ROLLBACK WORK ends a transaction.

3.46.3. Example of ROLLBACK WORK

- Suppose that you add an order for two parts numbered 4130 to the ORDERS and ODETAIL tables. When you update the PARTLOC table to decrement the quantity available, you discover no such part number exists in the given location.

Use ROLLBACK WORK to terminate the transaction without committing the database changes:

```
BEGIN WORK;

INSERT INTO sales.orders
VALUES (124, DATE '2007-04-10',
        DATE '2007-06-10', 75, 7654);

INSERT INTO sales.odetail VALUES (124, 4130, 25000, 2);

UPDATE invent.partloc
SET qty_on_hand = qty_on_hand - 2
WHERE partnum = 4130 AND loc_code = 'K43';

ROLLBACK WORK;
```

ROLLBACK WORK cancels the insert and update that occurred during the transaction.

3.47. SELECT Statement

The SELECT statement is a DML statement that retrieves values from tables, views, and derived tables determined by the evaluation of query expressions, or joined tables.

```

sql-query is:
    query-specification
    | query-expr-and-order

query-specification is:
[with-clause]
SELECT [ "[" ANY N "]" | "[" FIRST N "]" ] [ALL | DISTINCT] select-list
    FROM table-ref [,table-ref]...
    [WHERE search-condition]
    [SAMPLE sampling-method]
    [TRANSPOSE transpose-set [transpose-set]...
        [KEY BY key-colname]]...
    [SEQUENCE BY colname [ASC[ENDING] | DESC[ENDING]]
        [,colname [ASC[ENDING] | DESC[ENDING]]]...]
    [GROUP BY {colname | column} [,,{colname | column}]...]
    [HAVING search-condition]
    [access-clause]
    [mode-clause]

With-clause is:
WITH with_clause_elements

with_clause_elements is:
with_clause_element [,with_clause_element] ...

with_clause_element is:
cte-table-name AS (sql-query)

query-expr-and-order is:
    query-expr [order-by-clause] [access-clause] [mode-clause]

query-expr is:
    query-primary
    | query-expr UNION [ALL] query-primary
    | query-expr INTERSECT query-primary
    | query-expr EXCEPT query-primary

query-primary is:
    simple-table | (query-expr)

simple-table is:
    VALUES (row-value-const) [,(row-value-const)]...
    | TABLE table
    | query-specification

row-value-const is:

```

```
row-subquery  
| {expression | NULL} [, {expression | NULL}]...  
  
order-by-clause is:  
[ORDER BY {colname | colnum} [ASC[ENDING] | DESC[ENDING]]  
[, {colname | colnum} [ASC[ENDING] | DESC[ENDING]]]...]  
[access-clause]  
  
access clause is:  
[FOR] access-option ACCESS
```

```

access-option is:
  READ COMMITTED

[LIMIT num]

select-list is:
  * | select-sublist [,select-sublist]...

select-sublist is:
  corr.* | [corr.]single-col [[AS]name] | col-expr [[AS] name]

table-ref is:
  table [[AS] corr [(col-expr-list)]]
  | view [[AS] corr [(col-expr-list)]]
  | (query-expr) [AS] corr [(col-expr-list)]
  | (delete-statement [RETURN select-list])
    [AS] corr [(col-expr-list)]
  | (update-statement [RETURN select-list])
    [AS] corr [(col-expr-list)]
  | (insert-statement) [AS] corr [(col-expr-list)]
  | joined-table

joined-table is:
  table-ref [join-type] JOIN table-ref join-spec
  | table-ref NATURAL [join-type] JOIN table-ref
  | table-ref CROSS JOIN table-ref
  | (joined-table)

join-type is:
  INNER | LEFT [OUTER] | RIGHT [OUTER] | FULL [OUTER]

join-spec is:
  ON search-condition

sampling-method is:
  RANDOM percent-size
  | FIRST rows-size
    [SORT BY colname [ASC[ENDING] | DESC[ENDING]]
     [,colname [ASC[ENDING] | DESC[ENDING]]...]
  | PERIODIC rows-size EVERY number-rows ROWS
    [SORT BY colname [ASC[ENDING] | DESC[ENDING]]
     [,colname [ASC[ENDING] | DESC[ENDING]]...]

percent-size is:
  percent-result PERCENT [ROWS]
  | BALANCE WHEN condition
    THEN percent-result PERCENT [ROWS]
    [WHEN condition
      THEN percent-result PERCENT [ROWS]]...
    [ELSE percent-result PERCENT [ROWS]] END

```

```

rows-size is:
  number-rows ROWS
  | BALANCE WHEN condition
    THEN number-rows ROWS
    [WHEN condition
      THEN number-rows ROWS]...
    [ELSE number-rows ROWS] END

transpose-set is:
  transpose-item-list AS transpose-col-list

transpose-item-list is:
  expression-list | (expression-list) [, (expression-list)]...

```

3.47.1. Syntax Description of SELECT

- with-clause

With-clause, known as Common Table Expressions (CTEs) or subquery factoring clause, was introduced in the SQL-99 standard and has been implemented into Trafodion R2.1.

The with-clause assigns an alias to a complex expression. The alias is treated like a temporary table or an inline view that lasts only for the duration of the query and can be referenced multiple times in the same query.

By abstracting the complicated parts of the query into simpler, separate and logical blocks, and possibly materializing the results of these parts to avoid recomputing it multiple times, the with-clause has following advantages:

- Simplifies complicated queries, increasing readability and reducing repeated references.
- Builds reusable units and decreases maintenance cost.
- Shortens response time and enhances performance of the query.
- Improves compatibility with other systems which support with-clause as well.
- cte-table-name

specifies the unique name of the CTE to be created, which is a valid SQL identifier with a maximum of 128 characters. Duplicate names are not allowed in a single with-clause.

- "[" ANY N "]" | "[" FIRST N "]"

specifies that N rows are to be returned (assuming the table has at least N rows and that the qualification criteria specified in the WHERE clause, if any, would select at least N rows) and you do not care which N rows are chosen (out of the qualified rows) to actually be returned.

You must enclose ANY N or FIRST N in square brackets ([]). The quotation marks ("") around each square bracket in the syntax diagram indicate that the bracket is a required character that you must type as shown (for example, [ANY 10] or [FIRST 5]). Do not include quotation marks in ANY or FIRST clauses.

[FIRST N] is different from [ANY N] only if you use ORDER BY on any of the columns in the select list to sort the result table of the SELECT statement. N is an unsigned numeric literal with no scale. If N is greater than the number of rows in the table, all rows are returned. [ANY N] and [FIRST N] are disallowed in nested SELECT statements and on either side of a UNION operation.

- ALL | DISTINCT

specifies whether to retrieve all rows whose columns are specified by the *select-list* (ALL) or only rows that are not duplicates (DISTINCT). Nulls are considered equal for the purpose of removing duplicates. The default is ALL.

- *select-list*

specifies the columns or column expressions to select from the table references in the FROM clause. See the discussion of limitations in [Considerations for Select List](#).

- *

specifies all columns in a table, view, joined table, or derived table determined by the evaluation of a query expression, as specified in the FROM clause.

- *corr.**

specifies all columns of specific table references by using the correlation name *corr* of the table references, as specified in the FROM clause. See [Correlation Names](#).

- *corr.single-col* [[AS] *name*]

specifies one column of specific table references by using the correlation name of the table reference, as specified in the FROM clause. See [Correlation Names](#). By using the AS clause, you can associate the column with a *name*. *name* is an SQL identifier. See [Identifiers](#).

- *single-col* [[AS] *name*]

specifies a column. By using the AS clause, you can associate the column with a *name*. *name* is an SQL identifier. See [Identifiers](#).

- *col-expr* [[AS] *name*]

specifies a derived column determined by the evaluation of an SQL value expression in the list. By using the AS clause, you can associate a derived column, *col-expr*, with a *name*. *name* is an SQL identifier. See [Identifiers](#).

- FROM *table-ref* [,*table-ref*]...

specifies a list of tables, views, derived tables, or joined tables that determine the contents of an intermediate result table from which Trafodion SQL returns the columns you specify in *select-list*.

If you specify only one *table-ref*, the intermediate result table consists of rows derived from that table reference. If you specify more than one *table-ref*, the intermediate result table is the cross-product of result tables derived from the individual table references.

- `table [[AS] corr [(col-expr-list)]] | view [[AS] corr [(col-expr-list)]] | (query-expr) [AS] corr [(col-expr-list)] | (delete-statement [RETURN select-list]) [AS] corr [(col-expr-list)] | (update-statement [RETURN select-list]) [AS] corr [(col-expr-list)] | (insert-statement) [AS] corr [(col-expr-list)] | joined-table`

specifies a *table-ref* as a single table, view, derived table determined by the evaluation of a query expression, or a joined table.

You can specify this optional clause for a table or view. This clause is required for a derived table:

- `[AS] corr [(col-expr-list)]`

specifies a correlation name, *corr*, for the preceding table reference *table-ref* in the FROM clause. See [Correlation Names](#).

- `col-expr [[AS] name] [, col-expr [[AS] name]] ...`

specifies the items in *col-expr-list*, a list of derived columns. By using the AS clause, you can associate a derived column, *col-expr*, with a *name*. *name* is an SQL identifier. See [Identifiers](#).

For the specification of a query expression, see the syntax diagram for *query-expr* above.

- `(delete-statement [RETURN select-list]) [AS] corr [(col-expr-list)]`

enables an application to read and delete rows with a single operation. For the syntax of *delete-statement*, see the [DELETE Statement](#).

- `RETURN select-list`

specifies the columns or column expressions returned from the deleted row. the items in the *select-list* can be of these forms:

- `[old.]*`

specifies the row from the old table exposed by the embedded delete. the old table refers to column values before the delete operation. new is not allowed. an implicit old.* return list is assumed for a delete operation that does not specify a return list.

- *col-expr* [[AS] *name*]

specifies a derived column determined by the evaluation of an sql value expression in the list. any column referred to in a value expression is from the row in the old table exposed by the delete. the old table refers to column values before the delete operation.

By using the as clause, you can associate a derived column, *col-expr*, with a *name*. *name* is an SQL identifier. See [Identifier](#).

- [AS] *corr* [(*col-expr-list*)]

specifies a correlation name, *corr*, and an optional column list for the preceding items in the select list RETURN *select-list*. See [Correlation Names](#).

- (*update-statement* [RETURN *select-list*]) [AS] *corr* [(*col-expr-list*)]

enables an application to read and update rows with a single operation. For the syntax of *update-statement*, see the [UPDATE Statement](#).

- RETURN *select-list*

specifies the columns or column expressions returned from the updated row. The items in the *select-list* can be of these forms:

- [OLD . | NEW .] *

specifies the row from the old or new table exposed by the update. The old table refers to column values before the update operation; the new table refers to column values after the update operation. If a column has not been updated, the new value is equivalent to the old value.

An implicit NEW.* return list is assumed for an update operation that does not specify a return list.

- *col-expr* [[AS] *name*]

specifies a derived column determined by the evaluation of an SQL value expression in the list. Any column referred to in a value expression can be specified as being from the row in the old table exposed by the update or can be specified as being from the row in the new table exposed by the update.

For example:

```
RETURN old.empno,old.salary,new.salary, (new.salary - old.salary).
```

By using the AS clause, you can associate a derived column, *col-expr*, with a *name*. *name* is an SQL identifier. See [Identifiers](#).

- [AS] *corr* [(*col-expr-list*)]

specifies a correlation name, *corr*, and an optional column list for the preceding items in the select list RETURN *select-list*. See [Correlation Names](#). For example:

```
RETURN old.empno,old.salary,new.salary,
       (new.salary - old.salary)
AS emp (empno, oldsalary, newsalary, increase).
```

- (*insert-statement*) [AS] *corr* [(*col-expr-list*)]

For the syntax of *insert-statement*, see the [INSERT Statement](#).

- [AS] *corr* [(*col-expr-list*)]

specifies a correlation name, *corr*, and an optional column list. See [Correlation Names](#).

- *joined-table*

A *joined-table* can be specified as:

```
_table-ref_ [_join-type_] JOIN _table-ref join-spec_
| _table-ref_ NATURAL [_join-type_] JOIN _table-ref_
| _table-ref_ CROSS JOIN _table-ref_
| (_joined-table_)
```

- *join-type* is: INNER | LEFT [OUTER] | RIGHT [OUTER] | FULL [OUTER]

is a joined table. You specify the *join-type* by using the CROSS, INNER, OUTER, LEFT, RIGHT, and FULL keywords. If you omit the optional OUTER keyword and use LEFT, RIGHT, or FULL in a join, Trafodion SQL assumes the join is an outer join.

If you specify a CROSS join as the *join-type*, you cannot specify a NATURAL join or a

- *join-spec*.

If you specify an INNER, LEFT, RIGHT, or FULL join as the *join-type* and you do not specify a NATURAL join, you must use an ON clause as the *join-spec*, as follows: subqueries are not allowed in the join predicate of FULL OUTER JOIN.

- ON *search-condition*

specifies a *search-condition* for the join. Each column reference in *search-condition* must be a column that exists in either of the two result tables derived from the table references to the left and right of the JOIN keyword. A join of two rows in the result tables occurs if the condition is satisfied for those rows.

The type of join and the join specification if used determine which rows are joined from the two table references, as follows:

- *table-ref* CROSS JOIN *table-ref*

joins each row of the left *table-ref* with each row of the right *table-ref*.

- *table-ref* NATURAL JOIN *table-ref*

joins rows only where the values of all columns that have the same name in both tables match. This option is equivalent to NATURAL INNER.

- *table-ref* NATURAL LEFT JOIN *table-ref*

joins rows where the values of all columns that have the same name in both tables match, plus rows from the left *table-ref* that do not meet this condition.

- *table-ref* NATURAL RIGHT JOIN *table-ref*

joins rows where the values of all columns that have the same name in both tables match, plus rows from the right *table-ref* that do not meet this condition.

- *table-ref* NATURAL FULL JOIN *table-ref*

joins rows where the values of all columns that have the same name in both tables match, plus rows from either side that do not meet this condition, filling in NULLs for missing values.

- *table-ref* JOIN *table-ref* *join-spec*

joins only rows that satisfy the condition in the *join-spec* clause. This option is equivalent to INNER JOIN ... ON.

- *table-ref* LEFT JOIN *table-ref* *join-spec*

joins rows that satisfy the condition in the *join-spec* clause, plus rows from the left *table-ref* that do not satisfy the condition.

- *table-ref* RIGHT JOIN *table-ref* *join-spec*

joins rows that satisfy the condition in the *join-spec* clause, plus rows from the right *table-ref* that do not satisfy the condition.

- *table-ref* FULL OUTER JOIN *table-ref* *join-spec*

combines the results of both left and right outer joins. These joins show records from both tables and fill in NULLs for missing matches on either side

- *simple-table*

A *simple-table* can be specified as:

```
VALUES (_row-value-const_) [,(_row-value-const_)]...
| TABLE _table_
| _query-specification_
```

A *simple-table* can be a table value constructor. It starts with the VALUES keyword followed by a sequence of row value constructors, each of which is enclosed in parentheses. A *row-value-const* is a list of expressions (or NULL) or a row subquery (a subquery that returns a single row of column values). An operand of an expression cannot reference a column (except when the operand is a scalar subquery returning a single column value in its result table).

The use of NULL as a *row-value-const* element is a Trafodion SQL extension.

A *simple-table* can be specified by using the TABLE keyword followed by a table name, which is equivalent to the query specification SELECT * FROM *table*.

A *simple-table* can be a *query-specification*—that is, a SELECT statement consisting of SELECT ... FROM ... with optionally the WHERE, SAMPLE, TRANPOSE, SEQUENCE BY, GROUP BY, and HAVING clauses.

- WHERE *search-condition*

specifies a *search-condition* for selecting rows. See [Search Condition](#). The WHERE clause cannot contain an aggregate (set) function.

The *search-condition* is applied to each row of the result table derived from the table reference in the FROM clause or, in the case of multiple table references, the cross-product of result tables derived from the individual table references.

Each column you specify in *search-condition* is typically a column in this intermediate result table. In the case of nested subqueries used to provide comparison values, the column can also be an outer reference. See [Subquery](#).

To comply with ANSI standards, Trafodion SQL does not move aggregate predicates from the WHERE clause to a HAVING clause and does not move non-aggregate predicates from the HAVING clause to the WHERE clause.

- SAMPLE *sampling-method*

specifies the sampling method used to select a subset of the intermediate result table of a SELECT statement.

Each of the methods uses a sampling size. The three sampling methods—random, first, and periodic—are specified as:

- RANDOM *percent-size*

directs Trafodion SQL to choose rows randomly (each row having an unbiased probability of being chosen) without replacement from the result table. The sampling size is determined by using a percent of the result table.

- FIRST *rows-size* [SORT BY *colname* [, *colname*] ...]

directs Trafodion SQL to choose the first *rows-size* rows from the sorted result table. The sampling size is determined by using the specified number of rows.

- PERIODIC *rows-size* EVERY *number-rows* ROWS [SORT BY *colname* [, *colname*] ...]

directs Trafodion SQL to choose the first rows from each block (period) of contiguous sorted rows. The sampling size is determined by using the specified number of rows chosen from each block.

- SAMPLE is a Trafodion SQL extension. See [SAMPLE Clause](#).

- `TRANSPOSE transpose-set[transpose-set]... [KEY BY key-colname]`

specifies the *transpose-sets* and an optional key clause within a TRANSPOSE clause. You can use multiple TRANSPOSE clauses in a SELECT statement.

- `transpose-item-list AS transpose-col-list`

specifies a *transpose-set*. You can use multiple transpose sets within a TRANSPOSE clause. The TRANSPOSE clause generates, for each row of the source table derived from the table reference or references in the FROM clause, a row for each item in each *transpose-item-list* of all the transpose sets.

The result table of a TRANSPOSE clause has all the columns of the source table plus a value column or columns, as specified in each *transpose-col-list* of all the transpose sets, and an optional key column *key-colname*.

- `KEY BY key-colname`

optionally specifies an optional key column *key-colname*. It identifies which expression the value in the transpose column list corresponds to by its position in the *transpose-item-list*. *key-colname* is an SQL identifier. The data type is exact numeric, and the value is NOT NULL.

- TRANSPOSE is a Trafodion SQL extension. See [TRANSPOSE Clause](#).

- `SEQUENCE BY colname [ASC[ENDING] | DESC[ENDING]] [,colname [ASC[ENDING] | DESC[ENDING]]] ...`

specifies the order in which to sort the rows of the intermediate result table for calculating sequence functions. You must include a SEQUENCE BY clause if you include a sequence function in *select-list*. Otherwise, Trafodion SQL returns an error. Further, you cannot include a SEQUENCE BY clause if no sequence function is in *select-list*.

- `colname`

names a column in *select-list* or a column in a table reference in the FROM clause of the SELECT statement. *colname* is optionally qualified by a table, view, or correlation name; for example, CUSTOMER.CITY.

- `ASC | DESC`

specifies the sort order. The default is ASC. When Trafodion SQL orders an intermediate result table on a column that can contain null, nulls are considered equal to one another but greater than all other non-null values.

- GROUP BY [*col-expr*] {*colname* | *colnum*} [, {*colname* | *colnum*}]...]

specifies grouping columns that define a set of groups for the result table of the SELECT statement. The expression in the GROUP BY clause must be exactly the same as the expression in the select list. These columns must appear in the list of columns in the table references in the FROM clause of the SELECT statement.

If you include a GROUP BY clause, the columns you refer to in the *select-list* must be grouping columns or arguments of an aggregate (or set) function.

The grouping columns define a set of groups in which each group consists of rows with identical values in the specified columns. The column names can be qualified by a table or view name or a correlation name; for example, CUSTOMER.CITY.

For example, if you specify AGE, the result table contains one group of rows with AGE equal to 40 and one group of rows with AGE equal to 50. If you specify AGE and then JOB, the result table contains one group for each age and, within each age group, subgroups for each job code.

You can specify GROUP BY using ordinals to refer to the relative position within the SELECT list. For example, GROUP BY 3, 2, 1.

For grouping purposes, all nulls are considered equal to one another. The result table of a GROUP BY clause can have only one null group. See [Considerations for GROUP BY](#).

- HAVING *search-condition*

specifies a *search-condition* to apply to each group of the grouped table resulting from the preceding GROUP BY clause in the SELECT statement.

To comply with ANSI standards, Trafodion SQL does not move aggregate predicates from the WHERE clause to a HAVING clause and does not move non-aggregate predicates from the HAVING clause to the WHERE clause.

If no GROUP BY clause exists, the *search-condition* is applied to the entire table (which consists of one group) resulting from the WHERE clause (or the FROM clause if no WHERE clause exists).

In *search-condition*, you can specify any column as the argument of an aggregate (or set) function; for example, AVG(SALARY). An aggregate function is applied to each group in the grouped table.

A column that is not an argument of an aggregate function must be a grouping column. When you refer to a grouping column, you are referring to a single value because each row in the group contains the same value in the grouping column. See [Search Condition](#).

- [FOR] *access-option* ACCESS

specifies the *access-option* when accessing data specified by the SELECT statement or by a table reference in the FROM clause derived from the evaluation of a query expression that is a SELECT statement. See [Data Consistency and Access Options](#).

- READ COMMITTED

specifies that any data accessed must be from committed rows.

- UNION [ALL] *select-stmt*

specifies a set union operation between the result table of a SELECT statement and the result table of another SELECT statement.

The result of the union operation is a table that consists of rows belonging to either of the two contributing tables. If you specify UNION ALL, the table contains all the rows retrieved by each SELECT statement. Otherwise, duplicate rows are removed.

The select lists in the two SELECT statements of a union operation must have the same number of columns, and columns in corresponding positions within the lists must have compatible data types. The select lists must not be preceded by [ANY N] or [FIRST N].

The number of columns in the result table of the union operation is the same as the number of columns in each select list. The column names in the result table of the union are the same as the corresponding names in the select list of the left SELECT statement. A column resulting from the union of expressions or constants has the name (EXPR). See [Considerations for UNION](#).

- *select-stmt* INTERSECT *select-stmt*

specifies a set intersect operation between the result table of a SELECT statement and the result table of another SELECT statement. The result of the intersect operation is a table that consists of rows appear in both result sets.

The result of INTERSECT does not contain any duplicate rows.

The select lists in the two SELECT statements of an intersect operation must have the same number of columns, and columns in corresponding positions within the lists must have compatible data types. The select lists must not be preceded by [ANY N] or [FIRST N].

- *select-stmt* EXCEPT *select-stmt*

specifies a set except operation between the result table of a SELECT statement and the result table of another

SELECT statement. The result of the except operation is a table that consists of rows that are in the result of the left SELECT statement but not in the result of the right one.

The result of EXCEPT does not contain any duplicate rows.

The select lists in the two SELECT statements of an except operation must have the same number of columns, and columns in corresponding positions within the lists must have compatible data types. The select lists must not be preceded by [ANY N] or [FIRST N].

- ORDER BY {*colname* | *colnum*} [ASC[ENDING] | DESC[ENDING]] [, {*colname* | *colnum*} [ASC[ENDING] | DESC[ENDING]]]...

specifies the order in which to sort the rows of the final result table.

- *colname*

names a column in *select-list* or a column in a table reference in the FROM clause of the SELECT statement. *colname* is optionally qualified by a table, view, or correlation name; for example, CUSTOMER.CITY. If a column has been aliased to another name you must use the alias name.

- *colnum*

specifies a column by its position in *select-list*. Use *colnum* to refer to unnamed columns, such as derived columns.

- ASC | DESC

specifies the sort order. The default is ASC. For ordering a result table on a column that can contain null, nulls are considered equal to one another but greater than all other non-null values.

[See Considerations for ORDER BY.](#)

- LIMIT *num*

limits the number of rows returned by the query with no limit applied if *num* is null or less than zero. The LIMIT clause is executed after the ORDER BY clause to support TopN queries.

3.47.2. Considerations for SELECT

Authorization Requirements

SELECT requires authority to read all views and tables referred to in the statement, including the underlying tables of

views referred to in the statement.

Use of Views With SELECT

When a view is referenced in a SELECT statement, the specification that defines the view is combined with the statement. The combination can cause the SELECT statement to be invalid. If you receive an error message that indicates a problem but the SELECT statement seems to be valid, check the view definition.

For example, suppose that the view named AVESAL includes column A defined as AVG (X). The SELECT statement that contains MAX (A) in its select list is invalid because the select list actually contains MAX (AVG (X)), and an aggregate function cannot have an argument that includes another aggregate function.

Join Limits



We recommend that you limit the number of tables in a join to a maximum of 64, which includes base tables of views referenced in joins. Queries with joins that involve a larger number of tables are not guaranteed to compile.

Object Names in SELECT

You can use fully qualified names only in the FROM clause of a SELECT statement.

AS and ORDER BY Conflicts

When you use the AS verb to rename a column in a SELECT statement, and the ORDER BY clause uses the original column name, the query fails. If a column has been aliased to another name, you must use the alias name. The ANSI standard does not support this type of query.

Restrictions on Embedded Inserts

- An embedded INSERT cannot be used in a join.
- An embedded INSERT cannot appear in a subquery.
- An embedded INSERT statement cannot have a subquery in the WHERE clause.
- An INSERT statement cannot contain an embedded INSERT statement.
- A union between embedded INSERT expressions is not supported.
- Declaring a cursor on an embedded INSERT statement is not supported.

DISTINCT Aggregate Functions

An aggregate function can accept an argument specified as DISTINCT, which eliminates duplicate values before the aggregate function is applied. For a given grouping, multiple DISTINCT aggregates are allowed and can be used with non distinct aggregates. A restriction exists that DISTINCT STDDEV and VARIANCE cannot be used with multiple DISTINCT aggregates.

Limitations of DISTINCT Aggregates

- No limit exists to the number of distinct aggregates.
- Distinct STDDEV and distinct VARIANCE are not supported with multiple distinct aggregates. For example, this statement will result in an error.

```
SELECT sum(distinct a), stddev(distinct b) from T group by d;
```

Examples of Multiple Distinct Aggregates

- This statement contains distinct aggregates:

```
SELECT sum(distinct a), count(distinct b), avg(distinct c) from T group by d;
```

- This statement does not contain multiple distincts. Because each distinct aggregate is on the same column (a), this is treated as one distinct value.

```
SELECT sum(distinct a), count(distinct a), avg(distinct a) from T group by d;
```

- This statement shows that multiple distinct aggregates can be used with non distinct aggregates:

```
SELECT sum(distinct a), avg(distinct b), sum(c) from T group by d;
```

Considerations for with-clause

- Materialization of CTEs in temporary tables is not yet enabled by default.
- Trafodion only supports non-recursive common table expressions, which means with-clause cannot be self-referencing, but it can reference a previously defined CTE within the same with-clause.
- The with-clause in Trafodion can be specified only once, at the beginning of a SELECT statement. INSERT, UPDATE, DELETE and CREATE VIEW statements are not supported yet.

Considerations for Select List

- The * and corr.* forms of a *select-list* specification are convenient. However, such specifications make the order of columns in the SELECT result table dependent on the order of columns in the current definition of the referenced tables or views.
- A *col-expr* is a single column name or a derived column. A derived column is an SQL value expression; its operands can be numeric, string, datetime, or interval literals, columns, functions (including aggregate functions) defined on columns, scalar subqueries, CASE expressions, or CAST expressions. Any single columns named in *col-expr* must be from tables or views specified in the FROM clause. For a list of aggregate functions, see [Aggregate \(Set\) Functions](#).
- If *col-expr* is a single column name, that column of the SELECT result table is a named column. All other columns are unnamed columns in the result table (and have the (EXPR) heading) unless you use the AS clause to specify a name for a derived column.

Considerations for GROUP BY

- If you include a GROUP BY clause, the columns you refer to in the *select-list* must be either grouping columns or arguments of an aggregate (or set) function. For example, if AGE is not a grouping column, you can refer to AGE only as the argument of a function, such as AVG (AGE).
- The expression in the GROUP BY clause must be exactly the same as the expression in the select list. An error will be returned if it is not. It cannot contain aggregate functions or subqueries.
- If the value of *col-expr* is a numeric constant, it refers to the position of the select list item and is treated as the current GROUP BY using the ordinal feature.
- You can specify GROUP BY using ordinals to refer to the relative position within the SELECT list. For example, GROUP BY 3, 2, 1.
- If you do not include a GROUP BY clause but you specify an aggregate function in the *select-list*, all rows of the result table form the one and only group. The result of AVG, for example, is a single value for the entire table.

Considerations for ORDER BY

When you specify an ORDER BY clause and its ordering columns, consider:

- ORDER BY is allowed only in the outer level of a query or in the SELECT part of an INSERT/SELECT statement. It is not allowed inside nested SELECT expressions, such as subqueries.
- If you specify DISTINCT, the ordering column must be in *select-list*.
- If you specify a GROUP BY clause, the ordering column must also be a grouping column.
- If an ORDER BY clause applies to a union of SELECT statements, the ordering column must be explicitly referenced, and not within an aggregate function or an expression, in the *select-list* of the leftmost SELECT statement.
- SQL does not guarantee a specific or consistent order of rows unless you specify an ORDER BY clause. ORDER BY can reduce performance, however, so use it only if you require a specific order.

Considerations for UNION

Suppose that the contributing SELECT statements are named SELECT1 and SELECT2, the contributing tables resulting from the SELECT statements are named TABLE1 and TABLE2, and the table resulting from the UNION operation is named RESULT.

Characteristics of the UNION Columns

For columns in TABLE1 and TABLE2 that contribute to the RESULT table:

- If both columns contain character strings, the corresponding column in RESULT contains a character string whose length is equal to the greater of the two contributing columns.
- If both columns contain variable-length character strings, RESULT contains a variable-length character string whose length is equal to the greater of the two contributing columns.
- If both columns are of exact numeric data types, RESULT contains an exact numeric value whose precision and scale are equal to the greater of the two contributing columns.
- If both columns are of approximate numeric data types, RESULT contains an approximate numeric value whose precision is equal to the greater of the two contributing columns.
- If both columns are of datetime data type (DATE, TIME, or TIMESTAMP), the corresponding column in RESULT has the same data type.
- If both columns are INTERVAL data type and both columns are year-month or day-time, RESULT contains an INTERVAL value whose range of fields is the most significant start field to the least significant end field of the INTERVAL fields in the contributing columns. (The year-month fields are YEAR and MONTH. The day-time fields are DAY, HOUR, MINUTE, and SECOND.)

For example, suppose that the column in TABLE1 has the data type INTERVAL HOUR TO MINUTE, and the column in TABLE2 has the data type INTERVAL DAY TO HOUR. The data type of the column resulting from the union operation is INTERVAL DAY TO MINUTE.

- If both columns are described with NOT NULL, the corresponding column of RESULT cannot be null. Otherwise, the column can be null.

ORDER BY Clause and the UNION Operator

In a query containing a UNION operator, the ORDER BY clause defines an ordering on the result of the union. In this case, the SELECT statement cannot have an individual ORDER BY clause.

You can specify an ORDER BY clause only as the last clause following the final SELECT statement (SELECT2 in this example). The ORDER BY clause in RESULT specifies the ordinal position of the sort column either by using an integer or by using the column name from the select list of SELECT1.

- This SELECT statement shows correct use of the ORDER BY clause:

```
SELECT A FROM T1 UNION SELECT B FROM T2 ORDER BY A
```

- This SELECT statement is incorrect because the ORDER BY clause does not follow the final SELECT statement:

```
SELECT A FROM T1 ORDER BY A UNION SELECT B FROM T2
```

- This SELECT statement is also incorrect:

```
SELECT A FROM T1 UNION (SELECT B FROM T2 ORDER BY A)
```

Because the subquery (SELECT B FROM T2...) is processed first, the ORDER BY clause does not follow the final SELECT.

GROUP BY Clause, HAVING Clause, and the UNION Operator

In a query containing a UNION operator, the GROUP BY or HAVING clause is associated with the SELECT statement it is a part of (unlike the ORDER BY clause, which can be associated with the result of a union operation). The groups are visible in the result table of the particular SELECT statement. The GROUP BY and HAVING clauses cannot be used to form groups in the result of a union operation.

UNION ALL and Associativity

The UNION ALL operation is left associative, meaning that these two queries return the same result:

```
(SELECT * FROM TABLE1 UNION ALL  
SELECT * FROM TABLE2) UNION ALL SELECT * FROM TABLE3;  
  
SELECT * FROM TABLE1 UNION ALL  
  
(SELECT * FROM TABLE2 UNION ALL SELECT * FROM TABLE3);
```

If both the UNION ALL and UNION operators are present in the query, the order of evaluation is always from left to right. A parenthesized union of SELECT statements is evaluated first, from left to right, followed by the remaining union of SELECT statements.

3.47.3. Examples of SELECT

- The following example defines two CTEs, w1 and w2. w2 references w1 which is defined before w2.

```
>>select * from t1  
  
C1 C2  
-----  
  
1 1  
2 2  
3 3  
4 4  
5 5  
  
--- SQL operation complete.  
  
>>with w1 as (select * from t1),  
>>w2 as (select * from w1)  
>>select * from w2;  
  
C1 C2  
-----  
  
1 1  
2 2  
3 3  
4 4  
5 5  
  
--- SQL operation complete.
```

- The following example defines two CTEs, w1 and w2, and then perform a JOIN between them.

```
>>select * from t1

C1 C2
-----
1 1
2 2
3 3
4 4
5 5

--- SQL operation complete.

>>select * from t2

C1 C2
-----
3 3
4 4
5 5
6 6
7 7

--- SQL operation complete.

>>with w1 as (select c1, c2 from t1),
>>w2 as (select c1, c2 from t2)
>>select * from w1, w2 where w1.c1 = w2.c1;

C1 C2 C1 C2
-----
3 3 3 3
4 4 4 4
5 5 5 5

--- SQL operation complete.
```

- Retrieve information from the EMPLOYEE table for employees with a job code greater than 500 and who are in departments with numbers less than or equal to 3000, displaying the results in ascending order by job code:

```
SELECT jobcode, deptnum, first_name, last_name, salary
FROM persnl.employee
WHERE jobcode > 500
    AND deptnum <= 3000
ORDER BY jobcode;
```

DEPTNUM	FIRST_NAME	LAST_NAME	SALARY
1500	JONATHAN	MITCHELL	32000.00
1500	JIMMY	SCHNEIDER	26000.00
2500	MIRIAM	KING	18000.00
1000	SUE	CRAMER	19000.00
...			

- Display selected rows grouped by job code in ascending order:

```
SELECT jobcode, AVG(salary)
FROM persnl.employee
WHERE jobcode > 500
    AND deptnum <= 3000
GROUP BY jobcode
ORDER BY jobcode;
```

JOBCODE	EXPR
600	29000.00
900	25100.00

--- 2 row(s) selected.

This select list contains only grouping columns and aggregate functions. Each row of the output summarizes the selected data within one group.

- Select data from more than one table by specifying the table names in the FROM clause and specifying the condition for selecting rows of the result in the WHERE clause:

```
SELECT jobdesc, first_name, last_name, salary
FROM persnl.employee E, persnl.job J
WHERE E.jobcode = J.jobcode
AND E.jobcode IN (900, 300, 420);
```

JOBDESC	FIRST_NAME	LAST_NAME	SALARY
SALESREP	TIM	WALKER	32000.00
SALESREP	HERBERT	KARAJAN	29000.00
...			
ENGINEER	MARK	FOLEY	33000.00
ENGINEER	MARIA	JOSEF	18000.10
...			
SECRETARY	BILL	WINN	32000.00
SECRETARY	DINAH	CLARK	37000.00
...			

--- 27 row(s) selected.

This type of condition is sometimes called a join predicate. The query first joins the EMPLOYEE and JOB tables by combining each row of the EMPLOYEE table with each row of the JOB table; the intermediate result is the Cartesian product of the two tables.

This join predicate specifies that any row (in the intermediate result) with equal job codes is included in the result table. The WHERE condition further specifies that the job code must be 900, 300, or 420. All other rows are eliminated.

The four logical steps that determine the intermediate and final results of the previous query are:

1. Join the tables.

EMPLOYEE Table		JOB Table	
EMPNUM ...	JOBCODE ...	SALARY	JOBCODE

2. Drop rows with unequal job codes.

EMPLOYEE Table			JOB Table	
EMPNUM ...	JOBCODE ...	SALARY	JOBCODE	JOBDESC
1	100	175500	100	MANAGER
...
75	300	32000	300	SALESREP
...
178	900	28000	900	SECRETARY
...
207	420	33000	420	ENGINEER
...
568	300	39500	300	SALESREP

3. Drop rows with job codes not equal to 900, 300, or 420.

EMPLOYEE Table			JOB Table	
EMPNUM ...	JOBCODE ...	SALARY	JOBCODE	JOBDESC
75	300	32000	300	SALESREP
...
178	900	28000	900	SECRETARY
...
207	420	33000	420	ENGINEER
...
568	300	39500	300	SALESREP

4. Process the select list, leaving only four columns.

JOBDESC	FIRST_NAME	LAST_NAME	SALARY
SALESREP	TIM	WALKER	32000
...
SECRETARY	JOHN	CHOU	28000
...
ENGINEER	MARK	FOLEY	33000
...
SALESREP	JESSICA	CRINER	39500

The final result is shown in the output:

JOBDESC	FIRST_NAME	LAST_NAME	SALARY
SALESREP	TIM	WALKER	32000.00
...			
SECRETARY	JOHN	CHOU	28000.00
...			

- Select from three tables, group the rows by job code and (within job code) by department number, and order the groups by the maximum salary of each group:

```
SELECT E.jobcode, E.deptnum, MIN (salary), MAX (salary)
FROM persnl.employee E, persnl.dept D, persnl.job J
WHERE E.deptnum = D.deptnum
    AND E.jobcode = J.jobcode
    AND E.jobcode IN (900, 300, 420)
GROUP BY E.jobcode, E.deptnum
ORDER BY 4;
```

JOBCODE	DEPTNUM	(EXPR)	(EXPR)
900	1500	17000.00	17000.00
900	2500	18000.00	18000.00
...			
300	3000	19000.00	32000.00
900	2000	32000.00	32000.00
...			
300	3200	22000.00	33000.10
420	4000	18000.10	36000.00
...			

--- 16 row(s) selected.

Only job codes 300, 420, and 900 are selected. The minimum and maximum salary for the same job in each department are computed, and the rows are ordered by maximum salary.

- Select from two tables that have been joined by using an INNER JOIN on matching part numbers:

```
SELECT OD.*, P.*  
FROM sales.odetail OD  
INNER JOIN sales.parts P ON OD.partnum = P.partnum;
```

Order/Num Qty/Avail	Part/Num	Unit/Price	Qty/Ord	Part/Num	Part Description	PRICE
400410 3525	212	2450.00	12	212	PCSILVER, 20 MB	2500.00
500450 3525	212	2500.00	8	212	PCSILVER, 20 MB	2500.00
100210 4426	244	3500.00	3	244	PCGOLD, 30 MB	3000.00
800660 4426	244	3000.00	6	244	PCGOLD, 30 MB	3000.00
...
...						

--- 72 row(s) selected.

- Select from three tables and display them in employee number order. Two tables are joined by using a LEFT JOIN on matching department numbers, then an additional table is joined on matching job codes:

```
SELECT emplnum, first_name, last_name, deptname, location, jobdesc
FROM employee e
LEFT JOIN dept d ON e.deptnum = d.deptnum
LEFT JOIN job j ON e.jobcode = j.jobcode
ORDER BY emplnum;
```

- Suppose that the JOB_CORPORATE table has been created from the JOB table by using the CREATE LIKE statement. Form the union of these two tables:

```
SELECT * FROM job UNION SELECT * FROM job_corporate;
```

JOBCODE	JOBDESC
100	MANAGER
200	PRODUCTION SUPV
250	ASSEMBLER
300	SALESREP
400	SYSTEM ANALYST
420	ENGINEER
450	PROGRAMMER
500	ACCOUNTANT
600	ADMINISTRATOR
900	SECRETARY
100	CORP MANAGER
300	CORP SALESREP
400	CORP SYSTEM ANALYS
500	CORP ACCOUNTANT
600	CORP ADMINISTRATOR
900	CORP SECRETARY

--- 16 row(s) selected.

- A FULL OUTER JOIN combines the results of both left and right outer joins. These joins show records from both tables and fill in NULLs for missing matches on either side:

```
SELECT *
FROM employee
FULL OUTER JOIN department
ON employee.DepartmentID = department.DepartmentID;
```

LastName	DepartmentID	DepartmentName	DepartmentID
Smith	34	Clerical	34
Jones	33	Engineering	33
Robinson	34	Clerical	34
Jasper	36	NULL	NULL
Steinberg	33	Engineering	33
Rafferty	31	Sales	31
NULL	NULL	Marketing	35

- Present two ways to select the same data submitted by customers from California. The first way:

```
SELECT OD.ordernum, SUM (qty_ordered * price)
FROM sales.parts P, sales.odetail OD
WHERE OD.partnum = P.partnum AND OD.ordernum IN
( SELECT O.ordernum
  FROM sales.orders O, sales.customer C
  WHERE O.custnum = C.custnum AND state = 'CALIFORNIA'
)
GROUP BY OD.ordernum;

ORDERNUM      (EXPR)
-----
200490          1030.00
300350          71025.00
300380          28560.00

--- 3 row(s) selected.
```

The second way:

```

SELECT OD.ordernum, SUM (qty_ordered * price)
FROM sales.parts P, sales.odetail OD
WHERE OD.partnum = P.partnum AND OD.ordernum IN
( SELECT O.ordernum
  FROM sales.orders O WHERE custnum IN
  ( SELECT custnum
    FROM sales.customer
    WHERE state = 'CALIFORNIA'
  )
)
GROUP BY OD.ordernum;

ORDERNUM      (EXPR)
-----
200490          1030.00
300350          71025.00
300380          28560.00

--- 3 row(s) selected.

```

The price for the total quantity ordered is computed for each order number.

- Show employees, their salaries, and the percentage of the total payroll that their salaries represent. Note the subquery as part of the expression in the select list:

```

SELECT
  empnum
, first_name
, last_name
, salary
, CAST(salary * 100 / ( SELECT SUM(salary) FROM persnl.employee) AS NUMERIC(4,2))
FROM persnl.employee ORDER BY salary, empnum;

Employee/Number First Name      Last Name        salary      (EXPR)
-----
209 SUSAN           CHAPMAN       17000.00     .61
235 MIRIAM          KING         18000.00     .65
224 MARIA           JOSEF        18000.10     .65
...
23 JERRY            HOWARD       137000.10    4.94
32 THOMAS           RUDLOFF      138000.40    4.98
1 ROGER             GREEN        175500.00    6.33
...
--- 62 row(s) selected.

```

- Examples of using expressions in the GROUP BY clause:

```
SELECT a+1 FROM t GROUP BY a+1;  
  
SELECT cast(a AS int) FROM t GROUP BY cast(a AS int);  
  
SELECT a+1 FROM t GROUP BY 1;
```

- Examples of unsupported expressions in the GROUP BY clause:

```
SELECT sum(a) FROM t GROUP BY sum(a);  
  
SELECT (SELECT a FROM t1) FROM t GROUP BY (SELECT a FROM t1);  
  
SELECT a+1 FROM t GROUP BY 1+a;
```

3.48. SET SCHEMA Statement

The SET SCHEMA statement sets the default logical schema for unqualified object names for the current SQL session.

```
SET SCHEMA default-schema-name
```

3.48.1. Syntax Description of SET SCHEMA

- *default-schema-name*

specifies the name of a schema. See [Schemas](#).

default-schema-name is an SQL identifier. For example, you can use MYSCHHEMA or myschema or a delimited identifier "My_Schema". See [Identifiers](#).

3.48.2. Considerations for SET SCHEMA

The default schema you specify with SET SCHEMA remains in effect until the end of the session or until you execute another SET SCHEMA statement. If you do not set a schema name for the session using SET SCHEMA, the default schema is SEABASE, which exists in the TRAFODION catalog.

For information on how to create a schema, see [Creating and Dropping Schemas](#).

3.48.3. Examples of SET SCHEMA

- Set the default schema name:

```
SET SCHEMA myschema;
```

3.49. SET TRANSACTION Statement

The SET TRANSACTION statement sets the autocommit attribute for transactions. It stays in effect until the end of the session or until the next SET TRANSACTION statement, whichever comes first. Therefore, the SET TRANSACTION statement can set the autocommit attribute of all subsequent transactions in the session.

```
SET TRANSACTION autocommit-option  
  
autocommit-option is:  
    AUTOCOMMIT [ ON ] | AUTOCOMMIT OFF
```

3.49.1. Syntax Description of SET TRANSACTION

- *autocommit-option*

specifies whether Trafodion SQL commits or rolls back automatically at the end of statement execution. This option applies to any statement for which the system initiates a transaction.

If this option is set to ON, Trafodion SQL automatically commits any changes or rolls back any changes made to the database at the end of statement execution. AUTOCOMMIT is on by default at the start of a session.

If this option is set to OFF, the current transaction remains active until the end of the session unless you explicitly commit or rollback the transaction. AUTOCOMMIT is a Trafodion SQL extension; you cannot use it with any other option.

Using the AUTOCOMMIT option in a SET TRANSACTION statement does not reset other transaction attributes that may have been specified in a previous SET TRANSACTION statement. Similarly, a SET TRANSACTION statement that does not specify the AUTOCOMMIT attribute does not reset this attribute.

3.49.2. Considerations for SET TRANSACTION

Implicit Transactions

Most DML statements are transaction initiating—the system automatically initiates a transaction when the statement begins executing.

The exceptions (statements that are not transaction initiating) are:

- COMMIT, FETCH, ROLLBACK, and SET TRANSACTION
- EXECUTE, which is transaction initiating only if the associated statement is transaction-initiating

Explicit Transactions

You can issue an explicit BEGIN WORK even if the autocommit option is on. The autocommit option is temporarily disabled until you explicitly issue COMMIT or ROLLBACK.

3.49.3. Examples of SET TRANSACTION

- The following SET TRANSACTION statement turns off autocommit so that the current transaction remains active until the end of the session unless you explicitly commit or rollback the transaction. Trafodion SQL does not automatically commit or roll back any changes made to the database at the end of statement execution. Instead, Trafodion SQL commits all the changes when you issue the COMMIT WORK statement.

```
SET TRANSACTION AUTOCOMMIT OFF;
--- SQL operation complete.

BEGIN WORK;
--- SQL operation complete.

DELETE FROM persnl.employee WHERE empnum = 23;
--- 1 row(s) deleted.

INSERT INTO persnl.employee
  (empnum, first_name, last_name, deptnum, salary)
VALUES (50, 'JERRY', 'HOWARD', 1000, 137000.00);
--- 1 row(s) inserted.

UPDATE persnl.dept SET manager = 50
WHERE deptnum = 1000;
--- 1 row(s) updated.

COMMIT WORK;
--- SQL operation complete.
```

3.50. SHOWCONTROL Statement

The SHOWCONTROL statement displays the default attributes in effect.

SHOWCONTROL is a Trafodion SQL extension.

```
SHOWCONTROL {ALL | [QUERY] DEFAULT [attribute-name[ , MATCH {FULL | PARTIAL }]]}
```

3.50.1. Syntax Description of SHOWCONTROL

- ALL

displays all the hard-coded default attributes that have been set for the Trafodion instance.

- [QUERY] DEFAULT

displays the CONTROL QUERY DEFAULT statements in effect for the session. For more information, see the [Control Query Default Statement](#).

- *attribute-name*[, MATCH {FULL | PARTIAL }]

displays only the defaults that match, either fully or partially, the *attribute* used in CONTROL QUERY DEFAULT statements. The match is not case-sensitive. For descriptions of these attributes, see the [Trafodion Control Query Default \(CQD\) Reference Guide](#).

MATCH FULL specifies that *attribute-name* must be the same as the attribute name used in a control query default statement. match partial specifies that *attribute-name* must be included in the attribute name used in a control query default statement. the default is match partial.

If *attribute-name* is a reserved word, such as MIN, MAX, or TIME, you must capitalize *attribute-name* and delimit it within double quotes (""). The only exceptions to this rule are the reserved words CATALOG and SCHEMA, which you can either capitalize and delimit within double quotes or specify without quotation marks.

3.50.2. Examples of SHOWCONTROL

- Issue multiple CONTROL QUERY DEFAULT statements followed by a SHOWCONTROL DEFAULT command:

```
CONTROL QUERY DEFAULT CACHE_HISTOGRAMS_REFRESH_INTERVAL '7200';
--- SQL operation complete.

CONTROL QUERY DEFAULT HIST_NO_STATS_REFRESH_INTERVAL '7200';
--- SQL operation complete.

SHOWCONTROL DEFAULT;

CONTROL QUERY DEFAULT
  CACHE_HISTOGRAMS_REFRESH_INTERVAL 7200
  HIST_NO_STATS_REFRESH_INTERVAL 7200

--- SQL operation complete.
```

3.51. SHOWDDL Statement

The SHOWDDL statement describes the DDL syntax used to create an object as it exists in the metadata, or it returns a description of a user, role, or component in the form of a GRANT statement.

SHOWDDL is a Trafodion SQL extension.

```
SHOWDDL showddl-spec

showddl-spec
  [ TABLE | LIBRARY | PROCEDURE ] [ schema-name . ] object-name[ , PRIVILEGES ]
  | COMPONENT component-name
  | USER database-username
  | ROLE role-name[ , GRANTEES ]
```

3.51.1. Syntax Description of SHOWDDL

- *object-name*

specifies the ANSI name of an existing table, view, library, or procedure. See [Database Object Names](#). If *object-name* is not fully qualified, SHOWDDL uses the default schema for the session.

- PRIVILEGES

describes the PRIVILEGES associated with the object. If specified, privileges are displayed for an object in the form of GRANT statements.

- *component-name*

specifies an existing component. Currently, the only valid component name is SQL_OPERATIONS.

- *database-username*

specifies a registered database username.

- *role-name*

specifies an existing role.

- GRANTEES

displays all users who have been granted the role in the form of GRANT ROLE statements. This is an optional clause.

3.51.2. Considerations for SHOWDDL

- SHOWDDL can differ from the original DDL used to create an object.
- SHOWDDL can be used within TrafCI.
- SHOWDDL [TABLE \ LIBRARY \ PROCEDURE] displays the following information:
 - A constraint may be disabled.
 - A table may be off line.
 - An active DDL lock may exist on an object.
- SHOWDDL USER displays user information as a REGISTER USER statement.
- SHOWDDL ROLE displays the role information as a CREATE ROLE statement.

Required Privileges

To issue a SHOWDDL statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the database object.
- You have the SHOW component privilege for the SQL_OPERATIONS component. The SHOW component privilege is granted to PUBLIC by default.
- You have the SELECT privilege on the target object.

Differences Between SHOWDDL Output and Original DDL

- All column constraints (NOT NULL, PRIMARY KEY, and CHECK) are transformed into table constraints. All NOT NULL constraints are consolidated into a single check constraint.
- Check constraints are moved out of the CREATE TABLE statement and encapsulated in a separate ALTER TABLE ADD CONSTRAINT statement.
- SHOWDDL generates ALTER TABLE ADD COLUMN statements for each column that was added to the table.
- All ANSI names in the output are qualified with the schema name.
- SHOWDDL displays constraint names even though they might not have been specified during the creation of the constraint.
- SHOWDDL always generates a Java signature for the SPJ.

PRIVILEGES Option

The PRIVILEGES option includes the GRANT statements as they apply to the option. Each privilege is specified in separate GRANT statements even if they were granted in a single statement.

3.51.3. Examples of SHOWDDL

- This SHOWDDL statement displays the statement that created the specified table in the database and the privileges granted on that table:

```
SQL>showddl tab41;

CREATE TABLE TRAFODION.SCH41.TAB41 (
A INT DEFAULT NULL
, B INT DEFAULT NULL
)
;

-- GRANT DELETE, INSERT, SELECT, UPDATE, REFERENCES ON TRAFODION."SCH41"."TAB41" TO
PAULLOW41 WITH GRANT OPTION;

--- SQL operation complete.
```

- This SHOWDDL statement displays the statement that registered the specified user in the database:

```
SQL>showddl user sqluser_admin;

REGISTER USER "SQLUSER_ADMIN";

--- SQL operation complete.
```

- This SHOWDDL statement displays the statement that created the specified role in the database and the users who have been granted this role:

```
SQL>showddl role db rootrole;

CREATE ROLE "DB ROOTROLE" ;

SHOWDDL Statement 161

-- GRANT ROLE "DB ROOTROLE" TO "DB ROOT" WITH ADMIN OPTION;

--- SQL operation complete.
```

3.52. SHOWDDL SCHEMA Statement

The SHOWDDL SCHEMA statement displays the DDL syntax used to create a schema as it exists in the metadata and shows the authorization ID that owns the schema.

SHOWDDL SCHEMA is a Trafodion SQL extension.

```
SHOWDDL SCHEMA [catalog-name.]schema-name
```

3.52.1. Syntax Description for SHOWDDL SCHEMA

- *schema-name*

specifies the ANSI name of an existing catalog and schema. If *schema-name* is not fully qualified, SHOWDDL uses the default catalog for the session, TRAFODION. For more information, see [Database Object Names](#).

3.52.2. Considerations for SHOWDDL SCHEMA

If not specified, the catalog is the current default catalog, TRAFODION.

Required Privileges

To issue a SHOWDDL SCHEMA statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the schema.
- You have the SHOW component privilege for the SQL_OPERATIONS component. The SHOW component privilege is granted to PUBLIC by default.

3.52.3. Examples of SHOWDDL SCHEMA

- This SHOWDDL SCHEMA statement displays the DDL syntax used to create the schema, MYSHEMA, as it exists in the metadata and shows the authorization ID that owns the schema:

```
SHOWDDL SCHEMA MYSHEMA;

CREATE PRIVATE SCHEMA "TRAFODION"."MYSHEMA" AUTHORIZATION "DB ROOT";

--- SQL operation complete.
```

3.53. SHOWSTATS Statement

The SHOWSTATS statement displays the histogram statistics for one or more groups of columns within a table. These statistics are used to devise optimized access plans.

SHOWSTATS is a Trafodion SQL extension.

```
SHOWSTATS FOR TABLE table-name ON group-list [DETAIL]
```

group-list is:

```
column-list[, column-list]...
| EVERY COLUMN[, column-list]...
| EVERY KEY[, column-list]...
| EXISTING COLUMN[S][, column-list]...
```

column-list for a single-column group is:

```
column-name
| (column-name)
| column-name TO column-name
| (column-name) TO (column-name)
| column-name TO (column-name)
| (column-name) TO column-name
```

column-list for a multicololumn group is:

```
(column-name, column-name[, column-name]...)
```

3.53.1. Syntax Description of SHOWSTATS

- *table-name*

is the ANSI name of the table for which statistics are to be displayed.

- ON *group-list*

specifies one or more groups of columns, *group-list*, for which to display histogram statistics.

- *group-list* is: *column-list* [, *column-list*]... | EVERY COLUMN [, *column-list*]... | EVERY KEY [, *column-list*]... | EXISTING COLUMN[S] [, *column-list*]...

specifies the ways in which *group-list* can be defined. The column list represents both a single-column group and a multi-column group.

- **EVERY COLUMN**

indicates that histogram statistics are to be displayed for each individual column of *table* and any multi columns that make up the primary key and indexes. For columns that do not have histograms, this option returns `No histogram data for column(s) ---`.

- **EVERY KEY**

indicates that histogram statistics are to be displayed for columns that make up the primary key and indexes.

- **EXISTING COLUMN[S]**

indicates that histogram statistics are to be displayed only for columns of *table* that actually have histograms. This option yields a more concise report because columns with no histogram data are omitted. This option includes any existing multicolumn histograms.

- **DETAIL**

displays statistics for corresponding histogram intervals and other details.

If you do not select the **DETAIL** keyword, the default display lists the basic histogram information, including the histogram ID, number of intervals, total rows, total UEC, and the column names. The detailed display additionally includes the low value and high value as well as interval data.

- *column-list* for a single-column group is: *column-name* | (*column-name*) | *column-name* TO *column-name* | (*column-name*) TO (*column-name*) | *column-name* TO (*column-name*) | (*column-name*) TO *column-name*

specifies the ways in which the *column-name* can be defined for single-column groups. A range of columns specified using the TO keyword causes all columns in that range to be included, defined by their order of declaration in the table.

- *column-list* for a multicolumn group is: (*column-name*, *column-name*[,*column-name*]...)

specifies the ways in which the *column-name* can be defined for multicolumn groups. For example, (abc, def) indicates the multicolumn histogram consisting of columns abc and def, not two single-column histograms.

For more information about the column list syntax and specifying columns, see the [UPDATE STATISTICS Statement](#).

3.53.2. Considerations for SHOWSTATS

Required Privileges

To issue a SHOWSTATS statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the database object.
- You have the SHOW component privilege for the SQL_OPERATIONS component. The SHOW component privilege is granted to PUBLIC by default.
- You have the SELECT privilege on the target object.
- You have the MANAGE_STATISTICS component privilege for the SQL_OPERATIONS component.

3.53.3. Examples of SHOWSTATS

- This example displays histogram statistics for table A using the EVERY KEY keyword. In addition, the DETAIL keyword is selected:

```
SHOWSTATS FOR TABLE A ON EVERY KEY DETAIL;
```

- This example displays statistics for table CAT.SCH.A and selects all columns from abc through def:

```
SHOWSTATS FOR TABLE CAT.SCH.A ON ABC TO DEF;
```

- This example displays statistics for table A. The list of column names contained within parenthesis refers to a multicolumn group:

```
SHOWSTATS FOR TABLE A ON (ABC,DEF);
```

- This example displays statistics for table A using the EXISTING COLUMNS keyword. In addition, the DETAIL keyword is selected:

```
SHOWSTATS FOR TABLE A ON EXISTING COLUMNS DETAIL;
```

Default output example:

```
>>SHOWSTATS FOR TABLE A ON EXISTING COLUMNS;

Histogram data for Table CAT.SCH.A Table ID: 341261536378386
Hist ID #   Ints   Rowcount     UEC Colname(s)
===== ===== ===== ===== =====
623327638      1       11      10 ABC, DEF, GHI
623327633     10       11      10 ABC
623327628      9       11       9 DEF
623327623     10       11      10 GHI

--- SQL operation complete.

>>SHOWSTATS FOR TABLE A ON ABC;

Histogram data for Table CAT.SCH.A Table ID: 341261536378386
Hist ID #   Ints   Rowcount     UEC Colname(s)
===== ===== ===== ===== =====
623327633     10       11      10 ABC

--- SQL operation complete.

>>SHOWSTATS FOR TABLE A ON DEF DETAIL;

Detailed Histogram data for Table CAT.SCH.A Table ID: 341261536378386

Hist ID: 623327628
Column(s): DEF
Total Rows: 11
Total UEC: 9
Low Value: (1)
High Value: (199)
Intervals: 9

Number Rowcount     UEC Boundary
===== ===== ===== =====
0           0       0 (1)
1           1       1 (1)
2           3       1 (2)
3           1       1 (4)
4           1       1 (11)
5           1       1 (12)
6           1       1 (14)
7           1       1 (99)
8           1       1 (123)
9           1       1 (199)

--- SQL operation complete.
```

3.54. TABLE Statement

The TABLE statement is equivalent to the query specification SELECT * FROM *table*.

```
TABLE table
```

3.54.1. Syntax Description of Table Statement

- *table*

names the user table or view.

3.54.2. Considerations for TABLE

Relationship to SELECT Statement

The result of the TABLE statement is one form of a simple-table, which refers to the definition of a table reference within a SELECT statement. See the [SELECT Statement](#).

3.54.3. Examples of TABLE Statement

- This TABLE statement returns the same result as SELECT * FROM job:

```
TABLE job;

Job/Code Job Description
-----
100 MANAGER
200 PRODUCTION SUPV
250 ASSEMBLER
300 SALESREP
400 SYSTEM ANALYST
420 ENGINEER
450 PROGRAMMER
500 ACCOUNTANT
600 ADMINISTRATOR
900 SECRETARY

--- 10 row(s) selected.
```

3.55. UNREGISTER USER Statement

The UNREGISTER USER statement removes a database username from the SQL database. The user can no longer log on to the database.

UNREGISTER USER is a Trafodion SQL extension.

```
UNREGISTER USER database-username [RESTRICT | CASCADE]
```

3.55.1. Syntax Description of UNREGISTER USER

- *database-username*

is the name of a currently registered database user. *database-username* is a regular or delimited case-insensitive identifier. See [Case-Insensitive Delimited Identifiers](#).

- [RESTRICT | CASCADE]

If you specify RESTRICT, the UNREGISTER USER operation fails if there are any objects or schemas in the database owned by the user or any privileges or roles granted to the user.

If you specify CASCADE, all objects and schemas owned by the user are dropped, and all privileges and roles granted to the user are revoked as part of the UNREGISTER USER operation.

The default value is RESTRICT.

3.55.2. Considerations for UNREGISTER USER

- To unregister a user, you must have user administrative privileges. You have user administrative privileges if you have been granted the MANAGE_USERS component privilege. Initially,

DB ROOT is the only database user who has been granted the MANAGE_USERS component privilege.

- You cannot unregister any username beginning with DB . Role names beginning with DB are reserved by Trafodion.
- UNREGISTER USER fails if you specify RESTRICT (or nothing) and if the user owns any objects or schemas or if the user has been granted any privileges or roles.

3.55.3. Examples of UNREGISTER USER

- To unregister a user:

```
UNREGISTER USER "jsmith@company.com";
```

3.56. UPDATE Statement

The UPDATE statement is a DML statement that updates data in a row or rows in a table or updatable view. Updating rows in a view updates the rows in the table on which the view is based.

Searched UPDATE is:

UPDATE *table*

{ set-clause-type1 | set-clause-type2 }

set-clause-type1 is:

SET set-clause[, set-clause]..

set-clause is:

column-name = {*expression* | NULL}

set-clause-type2 is:

SET (*column1*, ..., *columnN*) = {(*value1*, ..., *valueN*) | (*query-expr*)}
[WHERE *search-condition*]
[[FOR] *access-option* ACCESS]

access-option is:

READ COMMITTED

3.56.1. Syntax Description of UPDATE

- *table*

names the user table or view to update. *table* must be a base table or an updatable view. To refer to a table or view, use the ANSI logical name. See [Database Object Names](#).

- *set-clause-type1*

This type of SET clause associates a value with a specific column in the table being updated. For each *set-clause*, the value of the specified target *column-name* is replaced by the value of the update source *expression* (or NULL). The data type of each target column must be compatible with the data type of its source value.

- *column-name*

names a column in *table* to update. You cannot qualify or repeat a column name. You cannot update the value of a column that is part of the primary key.

- *expression*

is an SQL value expression that specifies a value for the column. The *expression* cannot contain an aggregate function defined on a column. The data type of *expression* must be compatible with the data type of *column-name*.

If *expression* refers to columns being updated, Trafodion SQL uses the original values to evaluate the expression and determine the new value. See [Expressions](#).

- `NULL`

can also specify the value of the update source.

- *set-clause-type2*

This type of SET clause allows multiple columns to be specified on the left side of the assignment operator. These columns are updated using multiple values specified on the right side of the assignment operator. The right side of the assignment operator could be simple values or a subquery.

- *column₁*, ..., *column_N*

names columns in *table* to update. You cannot qualify or repeat a column name. You cannot update the value of a column that is part of the primary key.

- *value₁*, ..., *value_N*

are values specified on the right side of the assignment operator for the columns specified on the left side of the assignment operator. The data type of each value must be compatible with the data type of the corresponding column on the left side of the assignment operator.

- *query-expr*

is a SELECT subquery. Only one subquery can be specified on the right side of a SET clause. The subquery cannot refer to the table being updated. For the syntax and description of *query-expr*, see the [SELECT Statement](#).

- `WHERE search-condition`

specifies a *search-condition* that selects rows to update. Within the *search-condition*, columns being compared are also being updated in the table or view. See [Search Condition](#).

If you do not specify a *search-condition*, all rows in the table or view are updated.

Do not use an UPDATE statement with a WHERE clause that contains a SELECT for the same table. Reading from and inserting into, updating in, or deleting from the same table generates an error. Use a positioned (WHERE CURRENT OF) UPDATE instead. See [MERGE Statement](#).

- [FOR] *access-option* ACCESS

specifies the *access-option* required for data used in the evaluation of a search condition. See [Data Consistency and Access Options](#).

- READ COMMITTED

specifies that any data used in the evaluation of the search condition must be from committed rows.

3.56.2. Considerations for UPDATE

Performance

An UPDATE of primary key columns could perform poorly when compared to an UPDATE of non-key columns. This is because the UPDATE operation involves moving records in disk by deleting all the records in the before-image and then inserting the records in the after-image back into the table.

Authorization Requirements

UPDATE requires authority to read and write to the table or view being updated and authority to read any table or view specified in subqueries used in the search condition. A column of a view can be updated if its underlying column in the base table can be updated.

Transaction Initiation and Termination

The UPDATE statement automatically initiates a transaction if no active transaction exists. Otherwise, you can explicitly initiate a transaction with the BEGIN WORK statement. When a transaction is started, the SQL statements execute within that transaction until a COMMIT or ROLLBACK is encountered or an error occurs.

Isolation Levels of Transactions and Access Options of Statements

The isolation level of a Trafodion SQL transaction defines the degree to which the operations on data within that transaction are affected by operations of concurrent transactions. When you specify access options for the DML statements within a transaction, you override the isolation level of the containing transaction. Each statement then executes with its individual access option.

Conflicting Updates in Concurrent Applications

If you are using the READ COMMITTED isolation level within a transaction, your application can read different committed values for the same data at different times. Further, two concurrent applications can update (possibly in error) the same column in the same row.

Requirements for Data in Row

Each row to be updated must satisfy the constraints of the table or underlying base table of the view. No column updates can occur unless all of these constraints are satisfied. (A table constraint is satisfied if the check condition is not false—that is, it is either true or has an unknown value.)

In addition, a candidate row from a view created with the WITH CHECK OPTION must satisfy the view selection criteria. The selection criteria are specified in the WHERE clause of the AS *query-expr* clause in the CREATE VIEW statement.

Reporting of Updates

When an UPDATE completes successfully, Trafodion SQL reports the number of times rows were updated during the operation.

Under certain conditions, updating a table with indexes can cause Trafodion SQL to update the same row more than once, causing the number of reported updates to be higher than the actual number of changed rows. However, both the data in the table and the number of reported updates are correct. This behavior occurs when all of these conditions are true:

- The optimizer chooses an alternate index as the access path.
- The index columns specified in WHERE *search-condition* are not changed by the update.
- Another column within the same index is updated to a higher value (if that column is stored in ascending order), or a lower value (if that column is stored in descending order).

When these conditions occur, the order of the index entries ensures that Trafodion SQL will encounter the same row (satisfying the same *search-condition*) at a later time during the processing of the table. The row is then updated again by using the same value or values.

For example, suppose that the index of MYTABLE consists of columns A and B, and the UPDATE statement is specified:

```
UPDATE MYTABLE SET B = 20 WHERE A > 10;
```

If the contents of columns A and B are 1 and 12 respectively before the UPDATE, after the UPDATE Trafodion SQL will encounter the same row indexed by the values 1 and 20.

Updating Character Values

For a fixed-length character column, an update value shorter than the column length is padded with single-byte ASCII blanks (HEX20) to fill the column. If the update value is longer than the column length, string truncation of non blank trailing characters returns an error, and the column is not updated.

For a variable-length character column, an update value is not padded; its length is the length of the value specified. As is the case for fixed length, if the update value is longer than the column length, string truncation of non blank trailing characters returns an error, and the column is not updated.

SET Clause Restrictions and Error Cases

The SET clause has the following restrictions:

- The number of columns on the left side of each assignment operator should match the number of values or SELECT list elements on the right side. The following examples are not allowed:

```
UPDATE t SET (a,b)=(10,20,30)
UPDATE t set (b,c)=(SELECT r,t,s FROM x)
```

- If multi-column update syntax is specified and the right side contains a subquery, only one element, the subquery, is not allowed.

```
UPDATE t SET (a,b)=(10, (SELECT a FROM t1))
```

- More than one subquery is not allowed if multiple-column syntax is used.

```
UPDATE t SET (a,b)=(SELECT x,y FROM z), (c,d)=(SELECT x,y FROM a))
```

- If a subquery is used, it must return at most one row.

3.56.3. Examples of UPDATE

- Update a single row of the ORDERS table that contains information about order number 200300 and change the delivery date:

```
UPDATE sales.orders
SET deliv_date = DATE '2008-05-02'
WHERE ordernum = 200300;
```

- Update several rows of the CUSTOMER table:

```
UPDATE sales.customer SET credit = 'A1'
WHERE custnum IN (21, 3333, 324);
```

- Update all rows of the CUSTOMER table to the default credit 'C1':

```
UPDATE sales.customer SET credit = 'C1';
```

- Update the salary of each employee working for all departments located in Chicago:

```
UPDATE persnl.employee
SET salary = salary * 1.1
WHERE deptnum IN
  (SELECT deptnum FROM persnl.dept
   WHERE location = 'CHICAGO');
```

The subquery is evaluated for each row of the DEPT table and returns department numbers for departments located in Chicago.

- This is an example of a self-referencing UPDATE statement, where the table being updated is scanned in a subquery:

```
UPDATE table3 SET b = b + 2000 WHERE a, b =
  (SELECT a, b FROM table3 WHERE b > 200);
```

3.57. UPSERT Statement

The UPSERT statement either updates a table if the row exists or inserts into a table if the row does not exist.

UPSERT is a Trafodion SQL extension.

```
UPSERT [USING LOAD] INTO table [(target-col-list)] {query-expr | values-clause}

target-col-list is:
  column-name[, column-name]...

values-clause is:
  VALUES ( expression[, expression]... )
```

3.57.1. Syntax Description of UPSERT

- USING LOAD

allows the UPSERT to occur without a transaction. Use this clause when inserting data into an empty table. If you do not specify this clause, the UPSERT occurs within a transaction.

- *table*

names the user table in which to insert or update rows. *table* must be a base table. (*target-col-list*)

names the columns in the table in which to insert or update values. The data type of each target

column must be compatible with the data type of its corresponding source value. Within the list, each target column must have the same position as its associated source value, whose position is determined by the columns in the table derived from the evaluation of the query expression (*query-expr*).

If you do not specify all of the columns in the target *table* in the *target-col-list*, column default values are inserted into or updated in the columns that do not appear in the list. See [Column Default Settings](#).

If you do not specify *target-col-list*, row values from the source table are inserted into or updated in all columns in *table*. The order of the column values in the source table must be the same order as that of the columns specified in the CREATE TABLE for *table*. (This order is the same as that of the columns listed in the result table of SHOWDDL *table*.)

- *column-name*

names a column in the target *table* in which to either insert or update data. You cannot qualify or repeat a column name.

- *query-expr*

is a SELECT subquery that returns data to be inserted into or updated in the target *table*. The subquery cannot refer to the table being operated on. For the syntax and description of *query-expr*, see the [SELECT Statement](#).

- `VALUES (expression[, expression]...)`

specifies an SQL value expression or a set of expressions that specify values to be inserted into or updated in the target *table*. The data type of *expression* must be compatible with the data type of the corresponding column in the target *table*. See [Expressions](#).

3.57.2. Examples of UPSERT

- This UPSERT statement either inserts or updates the part number and price in the PARTS table using the part number and unit price from the ODETAIL table where the part number is 244:

```
UPSERT INTO sales.parts (partnum, price)
SELECT partnum, unit_price FROM sales.odetail WHERE partnum = 244;
```

- This UPSERT statement either inserts or updates rows in the EMPLOYEE table using the results of querying the EMPLOYEE_EUROPE table:

```
UPSERT INTO persnl.employee SELECT * FROM persnl.employee_europe;
```

- This UPSERT statement either inserts or updates a row in the DEPT table using the specified values:

```
UPSERT INTO persnl.dept
VALUES (3500,'CHINA SALES',111,3000,'HONG KONG');
```

- This UPSERT statement either inserts or updates a row in the DEPT table using the specified values:

```
UPSERT INTO persnl.dept (deptnum, deptname, manager)
VALUES (3600,'JAPAN SALES', 996);
```

3.58. VALUES Statement

The VALUES statements starts with the VALUES keyword followed by a sequence of row value constructors, each of which is enclosed in parenthesis. It displays the results of the evaluation of the expressions and the results of row subqueries within the row value constructors.

```
VALUES (row-value-const) [, (row-value-const)]...
row-value-const is:
  row-subquery
  | {expression | NULL} [, {expression | NULL}]...
```

3.58.1. Syntax Description of VALUES

- *row-value-const*

specifies a list of expressions (or NULL) or a row subquery (a subquery that returns a single row of column values). An operand of an expression cannot reference a column (except when the operand is a scalar subquery returning a single column value in its result table).

The results of the evaluation of the expressions and the results of the row subqueries in the row value constructors must have compatible data types.

3.58.2. Considerations for VALUES

Relationship to SELECT Statement

The result of the VALUES statement is one form of a *simple-table*, which is part of the definition of a table reference within a SELECT statement. See the [SELECT Statement](#).

Relationship to INSERT Statement

For a VALUES clause that is the direct source of an INSERT statement, Trafodion SQL also allows the keyword DEFAULT in a VALUES clause, just like NULL is allowed. For more information, see the [INSERT Statement](#).

3.58.3. Examples of VALUES

- This VALUES statement displays two rows with simple constants:

```
VALUES (1,2,3), (4,5,6);

(EXPR) (EXPR) (EXPR)
-----
1      2      3
4      5      6

--- 2 row(s) selected.
```

- This VALUES statement displays the results of the expressions and the row subquery in the lists:

```
VALUES (1+2, 3+4), (5, (select count (*) from t));

(EXPR) (EXPR)
-----
3          7
5          2

--- 2 row(s) selected.
```

Chapter 4. SQL Utilities

A utility is a tool that runs within Trafodion SQL and performs tasks. This section describes the Trafodion SQL utilities:

LOAD Statement	Uses the Trafodion Bulk Loader to load data from a source table, either a Trafodion table or a Hive table, into a target Trafodion table.
POPULATE INDEX Utility	Loads indexes.
PURGEDATA Utility	Purges data from tables and indexes.
UNLOAD Statement	Unloads data from Trafodion tables into an HDFS location that you specify.
UPDATE STATISTICS Statement	Updates the histogram statistics for one or more groups of columns within a table. These statistics are used to devise optimized access plans.



Trafodion SQL utilities are entered interactively or from script files using a client-based tool, such as the Trafodion Command Interface (TrafCI). To install and configure a client application that enables you to connect to and issue SQL utilities, see the [Trafodion Client Installation Guide](#).

4.1. LOAD Statement

The LOAD statement uses the Trafodion Bulk Loader to load data from a source table, either a Trafodion table or a Hive table, into a target Trafodion table. The Trafodion Bulk Loader prepares and loads HFiles directly in the region servers and bypasses the write path and the cost associated with it. The write path begins at a client, moves to a region server, and ends when data eventually is written to an HBase data file called an HFile.

The Trafodion bulk load process takes place in the following phases:

- **Disable Indexes** (if incremental index build not used)
- **Prepare** (takes most time, heart of the bulk load operation)
 - Read source files (Trafodion Table, Hive table, or Hive external table)
 - Data encoded in Trafodion encoding
 - Data repartitioned and sorted to match regions of target table
 - Data written to HFiles
 - Data repartitioned and written to index HFiles (if incremental index build IS used)
- **Complete** (with or without Snapshot recovery)
 - Take a snapshot of the table
 - Merge HFiles into HBase table (very fast – move, not a copy)
 - Delete snapshot or restore from snapshot if merge fails
- **Populate Indexes** (if incremental index build is NOT used)
- **Cleanup**
 - HFiles temporary space cleanup

LOAD is a Trafodion SQL extension.

```
LOAD [WITH option[ [, ] option]...] INTO target-table SELECT ... FROM source-table

option is:
  TRUNCATE TABLE
  | NO RECOVERY
  | NO POPULATE INDEXES
  | NO DUPLICATE CHECK
  | NO OUTPUT
  | INDEX TABLE ONLY
  | UPSERT USING LOAD
```

4.1.1. Syntax Description of LOAD

- *target-table*

is the name of the target Trafodion table where the data will be loaded. See [Database Object Names](#).

- *source-table*

is the name of either a Trafodion table or a Hive table that has the source data. Hive tables can be accessed in Trafodion using the HIVE.HIVE schema (for example, hive.hive.orders). The Hive table needs to already exist in Hive before Trafodion can access it. If you want to load data that is already in an HDFS folder, then you need to create an external Hive table with the right fields and pointing to the HDFS folder containing the data. You can also specify a WHERE clause on the source data as a filter.

- [WITH *option*[[,] *option*]...]

is a set of options that you can specify for the load operation. You can specify one or more of these options:

- TRUNCATE TABLE

causes the Bulk Loader to truncate the target table before starting the load operation. By default, the Bulk Loader does not truncate the target table before loading data.

- NO RECOVERY

specifies that the Bulk Loader not use HBase snapshots for recovery. By default, the Bulk Loader handles recovery using the HBase snapshots mechanism.

- NO POPULATE INDEXES

specifies that the Bulk Loader not handle index maintenance or populate the indexes. By default, the Bulk Loader handles index maintenance, disabling indexes before starting the load operation and populating them after the load operation is complete.

- NO DUPLICATE CHECK

causes the Bulk Loader to ignore duplicates in the source data. By default, the Bulk Loader checks if there are duplicates in the source data and generates an error when it detects duplicates.

- NO OUTPUT

prevents the LOAD statement from displaying status messages. By default, the LOAD statement prints status messages listing the steps that the Bulk Loader is executing.

- INDEX TABLE ONLY

specifies that the target table, which is an index, be populated with data from the parent table.

- UPSERT USING LOAD

specifies that the data be inserted into the target table using row set inserts without a transaction.

4.1.2. Considerations for LOAD

Required Privileges

To issue a LOAD statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the target table.
- You have these privileges:
 - SELECT and INSERT privileges on the target table
 - DELETE privilege on the target table if TRUNCATE TABLE is specified
- You have the MANAGE_LOAD component privilege for the SQL_OPERATIONS component.

Configuration Before Running LOAD

Before running the LOAD statement, make sure that you have configured the staging folder, source table, and HBase according to these guidelines.

Staging Folder for HFiles

The Bulk Loader uses an HDFS folder as a staging area for the HFiles before calling HBase APIs to merge them into the Trafodion table.

By default, Trafodion uses /bulkload as the staging folder. This folder must be owned by the same user as the one under which Trafodion runs. Trafodion also must have full permissions on this folder. The HBase user (that is, the user under which HBase runs) must have read/write access to this folder.

Example:

```
drwxr-xr-x - trafodion trafodion 0 2014-07-07 09:49 /bulkload.
```

Improving Throughput

The following CQD (Control Query Default) settings help improve the Bulk Loader throughput:

- `TRAF_LOAD_MAX_HFILE_SIZE`

Specifies the HFile size limit beyond which the current file is closed and a new file is created for the same partition. Adjust this setting to minimize HBase splitting/merging.

Default: 10GB

- `TRAF_LOAD_PREP_TMP_LOCATION`

Specifies the HDFS directory where HFiles are created during load.

Default: /bulkload

Also, consider using `NO DUPLICATE CHECK` to improve throughput if your source data is clean.

Hive Source Table

To load data stored in HDFS, you need to create a Hive table with the right fields and types pointing to the HDFS folder containing the data before you start the load.

HBase Snapshots

If you do not specify the NO RECOVERY OPTION in the LOAD statement, the Bulk Loader uses HBase snapshots as a mechanism for recovery. Snapshots are a lightweight operation where some metadata is copied. (Data is not copied.)

A snapshot is taken before the load starts and is removed after the load completes successfully. If something goes wrong and it is possible to recover, the snapshot is used to restore the table to its initial state before the load started. To use this recovery mechanism, HBase needs to be configured to allow snapshots.

Incremental Loads

The Bulk Loader allows for incremental loads by default. Snapshots are taken before second phase starts and deleted once the bulk load completes.

If something goes wrong with the load, then the snapshot is restored to go to the previous state.

Non-Incremental Loads

These following bulk load options can be used to do non-incremental load:

- NO RECOVERY: Do not take a snapshot of the table.
- TRUNCATE TABLE: Truncates the table before starting the load.

Space Usage

The target table values for SYSKEY, SALT, identity, divisioning columns are created automatically during transformation step. The size of the HBase files is determined based on encoding, compression, HDFS replication factor, and row format. Target table can be pre-split into regions using salting, a Java Program, by seeding the table with data.

Performance

The overall throughput is influenced by row format, row length, number of columns, skew in data, etc. LOAD has upsert semantics (duplicate constraint not checked with existing data). LOAD has lower CPU and disk activity than similar trickle load (INSERT, UPSERT, or UPSERT USING LOAD). Also, LOAD has lower compaction activity after completion than Trickle Load.

Hive Scans

Direct access for Hive table data supports:

- Only text input format and sequence files.
- Only structured data types.

Tables must be created/dropped/ALTERED through Hive itself.

Trafodion:

- Reads Hive metadata to determine information about table.
- UPDATE STATISTICS can be performed on Hive tables - improves performance!
- Can write to Hive tables in both Text and Sequence formats (used by UNLOAD).

4.1.3. Examples of LOAD

- For customer demographics data residing in /hive/tpcds/customer_demographics, create an external Hive table using the following Hive SQL:

```
create external table customer_demographics
(
    cd_demo_sk int
    , cd_gender string
    , cd_marital_status string
    , cd_education_status string
    , cd_purchase_estimate int
    , cd_credit_rating string
    , cd_dep_count int
    , cd_dep_employed_count int
    , cd_dep_college_count int
)
row format delimited fields terminated by '|' location
'/hive/tpcds/customer_demographics';
```

- The Trafodion table where you want to load the data is defined using this DDL:

```
create table customer_demographics_salt
(
    cd_demo_sk int not null
    , cd_gender char(1)
    , cd_marital_status char(1)
    , cd_education_status char(20)
    , cd_purchase_estimate int
    , cd_credit_rating char(10)
    , cd_dep_count int
    , cd_dep_employed_count int
    , cd_dep_college_count int
    , primary key (cd_demo_sk)
)
salt using 4 partitions on (cd_demo_sk);
```

- This example shows how the LOAD statement loads the customer_demographics_salt table from the Hive table, hive.hive.customer_demographics:

```
>>load into customer_demographics_salt
+>select * from hive.hive.customer_demographics where cd_demo_sk <= 5000;
Task: LOAD Status: Started Object: TRAFODION.HBASE.CUSTOMER_DEMOGRAPHICS_SALT
Task: DISABLE INDEX Status: Started Object:
TRAFODION.HBASE.CUSTOMER_DEMOGRAPHICS_SALT
Task: DISABLE INDEX Status: Ended Object: TRAFODION.HBASE.CUSTOMER_DEMOGRAPHICS_SALT
Task: PREPARATION Status: Started Object: TRAFODION.HBASE.CUSTOMER_DEMOGRAPHICS_SALT
    Rows Processed: 5000
Task: PREPARATION Status: Ended ET: 00:00:03.199
Task: COMPLETION Status: Started Object: TRAFODION.HBASE.CUSTOMER_DEMOGRAPHICS_SALT
Task: COMPLETION Status: Ended ET: 00:00:00.331
Task: POPULATE INDEX Status: Started Object:
TRAFODION.HBASE.CUSTOMER_DEMOGRAPHICS_SALT
Task: POPULATE INDEX Status: Ended ET: 00:00:05.262
```

4.2. POPULATE INDEX Utility

The POPULATE INDEX utility performs a fast INSERT of data into an index from the parent table. You can execute this utility in a client-based tool like TrafCI.

```
POPULATE INDEX index ON table [index-option]  
index-option is:  
    ONLINE | OFFLINE
```

4.2.1. Syntax Description of POPULATE INDEX

- *index*

is an SQL identifier that specifies the simple name for the index. You cannot qualify *index* with its schema name. Indexes have their own name space within a schema, so an index name might be the same as a table or constraint name. However, no two indexes in a schema can have the same name.

- *table*

is the name of the table for which to populate the index. See [Database Object Names](#).

- ONLINE

specifies that the populate operation should be done on-line. That is, ONLINE allows read and write DML access on the base table while the populate operation occurs. Additionally, ONLINE reads the audit trail to replay updates to the base table during the populate phase. If a lot of audit is generated and you perform many CREATE INDEX operations, we recommend that you avoid ONLINE operations because they can add more contention to the audit trail. The default is ONLINE.

- OFFLINE

specifies that the populate should be done off-line. OFFLINE allows only read DML access to the base table. The base table is unavailable for write operations at this time. OFFLINE must be specified explicitly. SELECT is allowed.

4.2.2. Considerations for POPULATE INDEX

When POPULATE INDEX is executed, the following steps occur:

- The POPULATE INDEX operation runs in many transactions.
- The actual data load operation is run outside of a transaction.

If a failure occurs, the rollback is faster because it does not have to process a lot of audit. Also, if a failure occurs, the index remains empty, unaudited, and not attached to the base table (off-line).

- When an off-line POPULATE INDEX is being executed, the base table is accessible for read DML operations. When an on-line POPULATE INDEX is being executed, the base table is accessible for read and write DML operations during that time period, except during the commit phase at the very end.
- If the POPULATE INDEX operation fails unexpectedly, you may need to drop the index again and re-create and repopulate.
- On-line POPULATE INDEX reads the audit trail to replay updates by allowing read/write access. If you plan to create many indexes in parallel or if you have a high level of activity on the audit trail, you should consider using the OFFLINE option.

Errors can occur if the source base table or target index cannot be accessed, or if the load fails due to some resource problem or problem in the file system.

Required Privileges

To perform a POPULATE INDEX operation, one of the following must be true:

- You are DB ROOT.
- You are the owner of the table.
- You have the SELECT and INSERT (or ALL) privileges on the associated table.

4.2.3. Examples of POPULATE INDEX

- This example loads the specified index from the specified table:

```
POPULATE INDEX myindex ON myschema.mytable;
```

- This example loads the specified index from the specified table, which uses the default schema:

```
POPULATE INDEX index2 ON table2;
```

4.3. PURGEDATA Utility

The PURGEDATA utility performs a fast DELETE of data from a table and its related indexes. You can execute this utility in a client-based tool like TrafCI.

PURGEDATA *object*

4.3.1. Syntax Description of PURGEDATA

object

is the name of the table from which to purge the data. See [Database Object Names](#).

4.3.2. Considerations for PURGEDATA

- The *object* can be a table name.
- Errors are returned if *table* cannot be accessed or if a resource or file-system problem causes the delete to fail.
- PURGEDATA is not supported for volatile tables.

Required Privileges

To perform a PURGEDATA operation, one of the following must be true:

- You are DB ROOT.
- You are the owner of the table.
- You have the SELECT and DELETE (or ALL) privileges on the associated table.

Availability

PURGEDATA marks the table OFFLINE and sets the corrupt bit while processing. If PURGEDATA fails before it completes, the table and its dependent indexes will be unavailable, and you must run PURGEDATA again to complete the operation and remove the data. Error 8551 with an accompanying file system error 59 or error 1071 is returned in this case.

4.3.3. Examples of PURGEDATA

- This example purges the data in the specified table. If the table has indexes, their data is also purged.

```
PURGEDATA myschema.mytable;
```

4.4. UNLOAD Statement

The UNLOAD statement unloads data from Trafodion tables into an HDFS location that you specify. Extracted data can be either compressed or uncompressed based on what you choose.

UNLOAD is a Trafodion SQL extension.

```
UNLOAD [WITH option[ option]...] INTO 'target-location' SELECT ... FROM source-table
...
option is:
| DELIMITER { 'delimiter-string' | delimiter-ascii-value }
| RECORD_SEPARATOR { 'separator-literal' | separator-ascii-value }
| NULL_STRING 'string-literal'
| PURGEDATA FROM TARGET
| COMPRESSION GZIP
| MERGE FILE merged_file-path [OVERWRITE]
| NO OUTPUT
| { NEW | EXISTING } SNAPSHOT HAVING SUFFIX 'string'
```

4.4.1. Syntax Description of UNLOAD

- *'target-location'*

is the full pathname of the target HDFS folder where the extracted data will be written. Enclose the name of folder in single quotes. Specify the folder name as a full pathname and not as a relative path. You must have write permissions on the target HDFS folder. If you run UNLOAD in parallel, multiple files will be produced under the *target-location*. The number of files created will equal the number of ESPs.

- `SELECT ... FROM source-table ...`

is either a simple query or a complex one that contains GROUP BY, JOIN, or UNION clauses. *source-table* is the name of a Trafodion table that has the source data. See [Database Object Names](#).

- `[WITH option[option]...]`

is a set of options that you can specify for the unload operation. If you specify an option more than once, Trafodion returns an error with SQLCODE -4489. You can specify one or more of these options:

- `DELIMITER { 'delimiter-string' | delimiter-ascii-value }`

specifies the delimiter as either a delimiter string or an ASCII value. If you do not specify this option, Trafodion uses the character "|" as the delimiter.

- *delimiter-string* can be any ASCII or Unicode string. You can also specify the delimiter as an ASCII value. Valid values range from 1 to 255. Specify the value in decimal notation; hexadecimal or octal notation are currently not supported. If you are using an ASCII value, the delimiter can be only one character wide. Do not use quotes when specifying an ASCII value for the delimiter.
- RECORD_SEPARATOR { 'separator-literal' | separator-ascii-value }

specifies the character that will be used to separate consecutive records or rows in the output file. You can specify either a literal or an ASCII value for the separator. The default value is a newline character.

- *separator-literal* can be any ASCII or Unicode character. You can also specify the separator as an ASCII value. Valid values range from 1 to 255. Specify the value in decimal notation; hexadecimal or octal notation are currently not supported. If you are using an ASCII value, the separator can be only one character wide. Do not use quotes when specifying an ASCII value for the separator.
- NULL_STRING '*string-literal*'

specifies the string that will be used to indicate a NULL value. The default value is the empty string "".

- PURGEDATA FROM TARGET

causes files in the target HDFS folder to be deleted before the unload operation.

- COMPRESSION GZIP

uses gzip compression in the extract node, writing the data to disk in this compressed format. GZIP is currently the only supported type of compression. If you do not specify this option, the extracted data will be uncompressed.

- MERGE FILE *merged-file-path* [OVERWRITE]

merges the unloaded files into one single file in the specified *merged-file-path*. If you specify compression, the unloaded data will be in compressed format, and the merged file will also be in compressed format. If you specify the optional OVERWRITE keyword, the file is overwritten if it already exists; otherwise, Trafodion raises an error if the file already exists.

- NO OUTPUT

prevents the UNLOAD statement from displaying status messages. By default, the UNLOAD statement prints status messages listing the steps that the Bulk Unloader is executing.

- { NEW | EXISTING } SNAPSHOT HAVING SUFFIX 'string'

initiates an HBase snapshot scan during the unload operation. During a snapshot scan, the Bulk Unloader will get a list of the Trafodion tables from the query explain plan and will create and verify snapshots for the tables. Specify a suffix string, 'string', which will be appended to each table name.

4.4.2. Considerations for UNLOAD

- You must have write permissions on the target HDFS folder.
- If a WITH option is specified more than once, Trafodion returns an error with SQLCODE -4489.

Required Privileges

To issue an UNLOAD statement, one of the following must be true:

- You are DB ROOT.
- You are the owner of the target table.
- You have the SELECT privilege on the target table.
- You have the MANAGE_LOAD component privilege for the SQL_OPERATIONS component.

4.4.3. Examples of UNLOAD

- This example shows how the UNLOAD statement extracts data from a Trafodion table, TRAFODION.HBASE.CUSTOMER_DEMOGRAPHICS, into an HDFS folder, /bulkload/customer_demographics:

```
>>UNLOAD
+>WITH PURGEDATA FROM TARGET
+>MERGE FILE 'merged_customer_demo.gz' OVERWRITE
+>COMPRESSION GZIP
+>INTO '/bulkload/customer_demographics'
+>select * from trafodion.hbase.customer_demographics
+><<+ cardinality 10e10 , + cardinality 10e10 >>;
Task: UNLOAD Status: Started
Task: EMPTY TARGET Status: Started
Task: EMPTY TARGET Status: Ended ET: 00:00:00.014
Task: EXTRACT Status: Started
    Rows Processed: 200000
Task: EXTRACT Status: Ended ET: 00:00:04.743 Task: MERGE FILES Status: Started
Task: MERGE FILES Status: Ended ET: 00:00:00.063

--- 200000 row(s) unloaded.
```

4.5. UPDATE STATISTICS Statement

The UPDATE STATISTICS statement updates the histogram statistics for one or more groups of columns within a table. These statistics are used to devise optimized access plans.

UPDATE STATISTICS is a Trafodion SQL extension.

```
UPDATE STATISTICS FOR TABLE table [CLEAR | on-clause | sample-table-clause ]

on-clause is:
  ON column-group-list CLEAR
  | ON column-group-list [histogram-option]...
  | ON column-group-list INCREMENTAL WHERE predicate

column-group-list is:
  column-list [,column-list]...
  | EVERY COLUMN [,column-list]...
  | EVERY KEY [,column-list]...
  | EXISTING COLUMN[S] [,column-list]...
  | NECESSARY COLUMN[S] [,column-list]...

column-list for a single-column group is:
  column-name
  | (column-name)
  | column-name TO column-name
  | (column-name) TO (column-name)
  | column-name TO (column-name)
  | (column-name) TO column-name

column-list for a multicol column group is:
  (column-name, column-name [,column-name]...)

histogram-option is:
  GENERATE n INTERVALS
  | SAMPLE [sample-option]

sample-option is:
  [r ROWS]
  | RANDOM percent PERCENT [PERSISTENT]
  | PERIODIC size ROWS EVERY period ROWS

sample-table-clause is:
  CREATE SAMPLE RANDOM percent PERCENT
  | REMOVE SAMPLE
```

4.5.1. Syntax Description of UPDATE STATISTICS

- *table*

names the table for which statistics are to be updated. To refer to a table, use the ANSI logical name. See [Database Object Names](#).

- **CLEAR**

deletes some or all histograms for the table *table*. Use this option when new applications no longer use certain histogram statistics.

If you do not specify *column-group-list*, all histograms for *table* are deleted. If you specify *column-group-list*, only columns in the group list are deleted.

- **ON *column-group-list***

specifies one or more groups of columns for which to generate histogram statistics with the option of clearing the histogram statistics. You must use the ON clause to generate statistics stored in histogram tables.

- ***column-list***

specifies how *column-group-list* can be defined. The column list represents both a single-column group and a multi-column group.

- Single-column group:

- *column-name* | (*column-name*) | *column-name* TO *column-name* | (*column-name*) TO (*column-name*)

specifies how you can specify individual columns or a group of individual columns.

To generate statistics for individual columns, list each column. You can list each single column name within or without parentheses.

- Multicolumn group:

- (*column-name*, *column-name* [, *column-name*]...)

specifies a multi-column group.

To generate multi-column statistics, group a set of columns within parentheses, as shown. You cannot specify the name of a column more than once in the same group of columns.

One histogram is generated for each unique column group. Duplicate groups, meaning any permutation of the same group of columns, are ignored and processing continues. When you run UPDATE STATISTICS again for the same user table, the new data for that table replaces the data previously generated and stored in the table's histogram tables. Histograms of column groups not specified in the ON clause remain unchanged in histogram tables.

For more information about specifying columns, see [Generating and Clearing Statistics for Columns](#).

- **EVERY COLUMN**

The EVERY COLUMN keyword indicates that histogram statistics are to be generated for each individual column of *table* and any multi-columns that make up the primary key and indexes. For example, *table* has columns A, B, C, D defined, where A, B, C compose the primary key. In this case, the ON EVERY COLUMN option generates a single column histogram for columns A, B, C, D, and two multi-column histograms of (A, B, C) and (A, B).

The EVERY COLUMN option does what EVERY KEY does, with additional statistics on the individual columns.

- **EVERY KEY**

The EVERY KEY keyword indicates that histogram statistics are to be generated for columns that make up the primary key and indexes. For example, *table* has columns A, B, C, D defined. If the primary key comprises columns A, B, statistics are generated for (A, B), A and B. If the primary key comprises columns A, B, C, statistics are generated for (A,B,C), (A,B), A, B, C. If the primary key comprises columns A, B, C, D, statistics are generated for (A, B, C, D), (A, B, C), (A, B), and A, B, C, D.

- **EXISTING COLUMN[S]**

The EXISTING COLUMN keyword indicates that all existing histograms of the table are to be updated. Statistics must be previously captured to establish existing columns.

- **NECESSARY COLUMN[S]**

The NECESSARY COLUMN[S] keyword generates statistics for histograms that the optimizer has requested but do not exist. Update statistics automation must be enabled for NECESSARY COLUMN[S] to generate statistics. To enable automation, see [Automating Update Statistics](#).

- *histogram-option*

- GENERATE *n* INTERVALS

The GENERATE *n* INTERVALS option for UPDATE STATISTICS accepts values between 1 and 10,000. Keep in mind that increasing the number of intervals per histograms may have a negative impact on compile time.

Increasing the number of intervals can be used for columns with small set of possible values and large variance of the frequency of these values. For example, consider a column 'CITY' in table SALES, which stores the city code where the item was sold, where number of cities in the sales data is 1538. Setting the number of intervals to a number greater or equal to the number of cities (that is, setting the number of intervals to 1600) guarantees that the generated histogram captures the number of rows for each city. If the specified value *n* exceeds the number of unique values in the column, the system generates only as many intervals as the number of unique values.

- SAMPLE [*sample-option*]

is a clause that specifies that sampling is to be used to gather a subset of the data from the table. UPDATE STATISTICS stores the sample results and generates histograms.

If you specify the SAMPLE clause without additional options, the result depends on the number of rows in the table. If the table contains no more than 10,000 rows, the entire table will be read (no sampling). If the number of rows is greater than 10,000 but less than 1 million, 10,000 rows are randomly sampled from the table. If there are more than 1 million rows in the table, a random row sample is used to read 1 percent of the rows in the table, with a maximum of 1 million rows sampled.



As a guideline, the default sample of 1 percent of the rows in the table, with a maximum of 1 million rows, provides good statistics for the optimizer to generate good plans.

If you do not specify the SAMPLE clause, if the table has fewer rows than specified, or if the sample size is greater than the system limit, Trafodion SQL reads all rows from *table*. See [SAMPLE Clause](#).

- *sample-option*

- *r_* rows

A row sample is used to read *r* rows from the table. The value *r* must be an integer that is greater than zero

- RANDOM *percent* PERCENT

directs Trafodion SQL to choose rows randomly from the table. The value *percent* must be a value between zero and 100 ($0 < \text{percent} \leq 100$). In addition, only the first four digits to the right of the decimal point are significant. For example, value 0.00001 is considered to be 0.0000, Value 1.23456 is considered to be

1.2345.

- PERSISTENT

directs Trafodion SQL to create a persistent sample table and store the random sample in it. This table can then be used later for updating statistics incrementally.

- PERIODIC *size* ROWS EVERY *period* ROW

directs Trafodion SQL to choose the first *size* number of rows from each *period* of rows. The value *size* must be an integer that is greater than zero and less than or equal to the value *period*. ($0 < \text{size} \leq \text{period}$). The size of the *period* is defined by the number of rows specified for *period*. The value *period* must be an integer that is greater than zero ($\text{period} > 0$).

- INCREMENTAL WHERE *predicate*

directs Trafodion SQL to update statistics incrementally. That is, instead of taking a fresh sample of the entire table, Trafodion SQL will use a previously created persistent sample table. Trafodion SQL will update the persistent sample by replacing any rows satisfying the *predicate* with a fresh sample of rows from the original table satisfying the *predicate*. The sampling rate used is the *percent* specified when the persistent sample table was created. Statistics are then generated from this updated sample. See also [Incremental Update Statistics](#).

- CREATE SAMPLE RANDOM *percent* PERCENT

Creates a persistent sample table associated with this table. The sample is created using a random sample of *percent* percent of the rows. The table can then be used for later incremental statistics update.

- REMOVE SAMPLE

Drops the persistent sample table associated with this table.

4.5.2. Considerations for UPDATE STATISTICS

Using Statistics

Use UPDATE STATISTICS to collect and save statistics on columns. The SQL compiler uses histogram statistics to determine the selectivity of predicates, indexes, and tables. Because selectivity directly influences the cost of access plans, regular collection of statistics increases the likelihood that Trafodion SQL chooses efficient access plans.

While UPDATE STATISTICS is running on a table, the table is active and available for query access.

When a user table is changed, either by changing its data significantly or its definition, re-execute the UPDATE STATISTICS statement for the table.

Histogram Statistics

Histogram statistics are used by the compiler to produce the best plan for a given SQL query. When histograms are not available, default assumptions are made by the compiler and the resultant plan might not perform well. Histograms that reflect the latest data in a table are optimal.

The compiler does not need histogram statistics for every column of a table. For example, if a column is only in the select list, its histogram statistics will be irrelevant. A histogram statistic is useful when a column appears in:

- A predicate
- A GROUP BY column
- An ORDER BY clause
- A HAVING clause
- Or similar clause

In addition to single-column histogram statistics, the compiler needs multi-column histogram statistics, such as when group by column-5, column-3, column-19 appears in a query. Then, histogram statistics for the combination (column-5, column-3, column-19) are needed.

Required Privileges

To perform an UPDATE STATISTICS operation, one of the following must be true:

- You are DB ROOT.
- You are the owner of the target table.
- You have the MANAGE_STATISTICS component privilege for the SQL_OPERATIONS component.

Locking

UPDATE STATISTICS momentarily locks the definition of the user table during the operation but not the user table itself. The UPDATE STATISTICS statement uses READ UNCOMMITTED isolation level for the user table.

Transactions

Do not start a transaction before executing UPDATE STATISTICS. UPDATE STATISTICS runs multiple transactions of its own, as needed. Starting your own transaction in which UPDATE STATISTICS runs could cause the transaction auto abort time to be exceeded during processing.

Generating and Clearing Statistics for Columns

To generate statistics for particular columns, name each column, or name the first and last columns of a sequence of columns in the table. For example, suppose that a table has consecutive columns CITY, STATE, ZIP. This list gives a few examples of possible options you can specify:

Single-Column Group	Single-Column Group Within Parentheses	Multicolumn Group
ON CITY, STATE, ZIP	ON (CITY),(STATE),(ZIP)	ON (CITY, STATE) or ON (CITY,STATE,ZIP)
ON CITY TO ZIP	ON (CITY) TO (ZIP)	
ON ZIP TO CITY	ON (ZIP) TO (CITY)	
ON CITY, STATE TO ZIP	ON (CITY), (STATE) TO (ZIP)	
ON CITY TO STATE, ZIP	ON (CITY) TO (STATE), (ZIP)	

The TO specification is useful when a table has many columns, and you want histograms on a subset of columns. Do not confuse (CITY) TO (ZIP) with (CITY, STATE, ZIP), which refers to a multi-column histogram.

You can clear statistics in any combination of columns you specify, not necessarily with the *column-group-list* you used to create statistics. However, those statistics will remain until you clear them.

Column Lists and Access Plans

Generate statistics for columns most often used in data access plans for a table—that is, the primary key, indexes defined on the table, and any other columns frequently referenced in predicates in WHERE or GROUP BY clauses of queries issued on the table. Use the EVERY COLUMN option to generate histograms for every individual column or multi columns that make up the primary key and indexes.

The EVERY KEY option generates histograms that make up the primary key and indexes.

If you often perform a GROUP BY over specific columns in a table, use multi-column lists in the UPDATE STATISTICS statement (consisting of the columns in the GROUP BY clause) to generate histogram statistics that enable the optimizer to choose a better plan. Similarly, when a query joins two tables by two or more columns, multi-column lists (consisting of the columns being joined) help the optimizer choose a better plan.

Automating Update Statistics

To enable update statistics automation, set the Control Query Default (CQD) attribute, USTAT_AUTOMATION_INTERVAL, in a session where you will run update statistics operations. For example:

```
control query default USTAT_AUTOMATION_INTERVAL '1440' ;
```

The value of USTAT_AUTOMATION_INTERVAL is intended to be an automation interval (in minutes), but, in Trafodion Release 1.0, this value does not act as a timing interval. Instead, any value greater than zero enables update statistics automation.

After enabling update statistics automation, prepare each of the queries that you want to optimize. For example:

```
prepare s from select...;
```

The PREPARE statement causes the Trafodion SQL compiler to compile and optimize a query without executing it. When preparing queries with update statistic automation enabled, any histograms needed by the optimizer that are not present will cause those columns to be marked as needing histograms.

Next, run this UPDATE STATISTICS statement against each table, using ON NECESSARY COLUMN[S] to generate the needed histograms:

```
update statistics for table _table-name_ on necessary columns sample;
```

Incremental Update Statistics

UPDATE STATISTICS processing time can be lengthy for very large tables. One strategy for reducing the time is to create histograms only for columns that actually need them (for example, using the ON NECESSARY COLUMNS column group). Another strategy is to update statistics incrementally. These strategies can be used together if desired.

To use the incremental update statistics feature, you must first create statistics for the table and create a persistent sample table. One way to do this is to perform a normal update statistics command, adding the PERSISTENT keyword to the *sample-option*. Another way to do this if you already have reasonably up-to-date statistics for the table, is to create a persistent sample table separately using the CREATE SAMPLE option.

You can then perform update statistics incrementally by using the INCREMENTAL WHERE *predicate* syntax in the on-clause. The *predicate* should be chosen to describe the set of rows that have changed since the last statistics update was performed. For example, if your table contains a column with a timestamp giving the date and time of last update, this is a particularly useful column to use in the *predicate*.

If you decide later that you wish to change the *percent* sampling rate used for the persistent sample table, you can do so by dropping the persistent sample table (using REMOVE SAMPLE) and creating a new one (by using the CREATE SAMPLE option). Using a higher *percent* results in more accurate histograms, but at the price of a longer-running operation.

4.5.3. Examples of UPDATE STATISTICS

- This example generates four histograms for the columns jobcode, empnum, deptnum, and (empnum, deptnum) for the table EMPLOYEE. Depending on the table's size and data distribution, each histogram should contain ten intervals.

```
UPDATE STATISTICS FOR TABLE employee
ON (jobcode), (empnum, deptnum) GENERATE 10 INTERVALS;
--- SQL operation complete.
```

- This example generates histogram statistics using the ON EVERY COLUMN option for the table DEPT. This statement performs a full scan, and Trafodion SQL determines the default number of intervals.

```
UPDATE STATISTICS FOR TABLE dept ON EVERY COLUMN;
--- SQL operation complete.
```

- Suppose that a construction company has an ADDRESS table of potential sites and a DEMOLITION_SITES table that contains some of the columns of the ADDRESS table. The primary key is ZIP. Join these two tables on two of the columns in common:

```
SELECT COUNT(AD.number), AD.street,
       AD.city, AD.zip, AD.state
  FROM address AD, demolition_sites DS
 WHERE AD.zip = DS.zip AND AD.type = DS.type
 GROUP BY AD.street, AD.city, AD.zip, AD.state;
```

To generate statistics specific to this query, enter these statements:

```
UPDATE STATISTICS FOR TABLE address
ON (street), (city), (state), (zip, type);
UPDATE STATISTICS FOR TABLE demolition_sites ON (zip, type);
```

- This example removes all histograms for table DEMOLITION_SITES:

```
UPDATE STATISTICS FOR TABLE demolition_sites CLEAR;
```

- This example selectively removes the histogram for column STREET in table ADDRESS:

```
UPDATE STATISTICS FOR TABLE address ON street CLEAR;
```

- This example generates statistics but also creates a persistent sample table for use when updating statistics incrementally:

```
UPDATE STATISTICS FOR TABLE address
ON (street), (city), (state), (zip, type)
SAMPLE RANDOM 5 PERCENT PERSISTENT;
```

- This example updates statistics incrementally. It assumes that a persistent sample table has already been created. The predicate in the WHERE clause describes the set of rows that have changed since statistics were last updated. Here we assume that rows with a state of California are the only rows that have changed:

```
UPDATE STATISTICS FOR TABLE address
ON EXISTING COLUMNS
INCREMENTAL WHERE state = 'CA';
```

Chapter 5. SQL Language Elements

Trafodion SQL language elements, which include data types, expressions, functions, identifiers, literals, and predicates, occur within the syntax of SQL statements. The statement and command topics support the syntactical and semantic descriptions of the language elements in this section.

5.1. Authorization IDs

An authorization ID is used for an authorization operation. Authorization is the process of validating that a database user has permission to perform a specified SQL operation. Externally, the authorization ID is a regular or delimited case-insensitive identifier that can have a maximum of 128 characters. See [Case-Insensitive Delimited Identifiers](#). Internally, the authorization ID is associated with a 32-bit number that the database generates and uses for efficient access and storage.

All authorization IDs share the same name space. An authorization ID can be a database user name or a role name. Therefore, a database user and a role cannot share the same name.

An authorization ID can be the PUBLIC authorization ID, which represents all present and future authorization IDs. An authorization ID cannot be SYSTEM, which is the implicit grantor of privileges to the creator of objects.

5.2. Character Sets

You can specify ISO88591 or UTF8 for a character column definition. The use of UTF8 permits you to store characters from many different languages.

5.3. Columns

A column is a vertical component of a table and is the relational representation of a field in a record. A column contains one data value for each row of the table.

A column value is the smallest unit of data that can be selected from or updated in a table. Each column has a name that is an SQL identifier and is unique within the table or view that contains the column.

5.3.1. Column References

A qualified column name, or column reference, is a column name qualified by the name of the table or view to which the column belongs, or by a correlation name.

If a query refers to columns that have the same name but belong to different tables, you must use a qualified column name to refer to the columns within the query. You must also refer to a column by a qualified column name if you join a table with itself within a query to compare one row of the table with other rows in the same table.

The syntax of a column reference or qualified column name is:

```
{table-name | view-name | correlation-name}.column-name
```

If you define a correlation name for a table in the FROM clause of a statement, you must use that correlation name if you need to qualify the column name within the statement.

If you do not define an explicit correlation name in the FROM clause, you can qualify the column name with the name of the table or view that contains the column. See [Correlation Names](#).

5.3.2. Derived Column Names

A derived column is an SQL value expression that appears as an item in the select list of a SELECT statement. An explicit name for a derived column is an SQL identifier associated with the derived column. The syntax of a derived column name is:

```
column-expression [[AS] column-name]
```

The column expression can simply be a column reference. The expression is optionally followed by the AS keyword and the name of the derived column.

If you do not assign a name to derived columns, the headings for unnamed columns in query result tables appear as (EXPR). Use the AS clause to assign names that are meaningful to you, which is important if you have more than one derived column in your select list.

Examples of Derived Column Names

These two examples show how to use names for derived columns.

- The first example shows (EXPR) as the column heading of the SELECT result table:

```
SELECT AVG (salary) FROM persnl.employee; (EXPR)

-----
49441.52

--- 1 row(s) selected.
```

- The second example shows AVERAGE SALARY as the column heading:

```
SELECT AVG (salary) AS "AVERAGE SALARY"
FROM persnl.employee; "AVERAGE SALARY"

-----
49441.52

--- 1 row(s) selected.
```

5.3.3. Column Default Settings

You can define specific default settings for columns when the table is created. The CREATE TABLE statement defines the default settings for columns within tables. The default setting for a column is the value inserted in a row when an INSERT statement omits a value for a particular column.

5.4. Constraints

An SQL constraint is an object that protects the integrity of data in a table by specifying a condition that all the values in a particular column or set of columns of the table must satisfy.

Trafodion SQL enforces these constraints on SQL tables:

CHECK	Column or table constraint specifying a condition must be satisfied for each row in the table.
FOREIGN KEY	Column or table constraint that specifies a referential constraint for the table, declaring that a column or set of columns (called a foreign key) in a table can contain only values that match those in a column or set of columns in the table specified in the REFERENCES clause.
NOT NULL	Column constraint specifying the column cannot contain nulls.
PRIMARY KEY	Column or table constraint specifying the column or set of columns as the primary key for the table.
UNIQUE	Column or table constraint that specifies that the column or set of columns cannot contain more than one occurrence of the same value or set of values.

5.4.1. Creating or Adding Constraints on SQL Tables

To create constraints on an SQL table when you create the table, use the NOT NULL, UNIQUE, CHECK, FOREIGN KEY, or PRIMARY KEY clause of the CREATE TABLE statement.

For more information on Trafodion SQL commands, see [CREATE TABLE Statement](#) and [ALTER TABLE Statement](#).

5.4.2. Constraint Names

When you create a constraint, you can specify a name for it or allow a name to be generated by Trafodion SQL. You can optionally specify both column and table constraint names. Constraint names are ANSI logical names. See [Database Object Names](#). Constraint names are in the same name space as tables and views, so a constraint name cannot have the same name as a table or view.

The name you specify can be fully qualified or not. If you specify the schema parts of the name, they must match those parts of the affected table and must be unique among table, view, and constraint names in that schema. If you omit the schema portion of the name you specify, Trafodion SQL expands the name by using the schema for the table.

If you do not specify a constraint name, Trafodion SQL constructs an SQL identifier as the name for the constraint and qualifies it with the schema of the table. The identifier consists of the table name concatenated with a system-generated unique identifier.

5.5. Correlation Names

A correlation name is a name you can associate with a table reference that is a table, view, or subquery in a SELECT statement to:

- Distinguish a table or view from another table or view referred to in a statement
- Distinguish different uses of the same table
- Make the query shorter

A correlation name can be explicit or implicit.

5.5.1. Explicit Correlation Names

An explicit correlation name for a table reference is an SQL identifier associated with the table reference in the FROM clause of a SELECT statement. See [Identifiers](#). The correlation name must be unique within the FROM clause. For more information about the FROM clause, table references, and correlation names, see [SELECT Statement](#).

The syntax of a correlation name for the different forms of a table reference within a FROM clause is the same:

```
{table | view | (query-expression)} [AS]correlation-name
```

A table or view is optionally followed by the AS keyword and the correlation name. A derived table, resulting from the evaluation of a query expression, must be followed by the AS keyword and the correlation name. An explicit correlation name is known only to the statement in which you define it. You can use the same identifier as a correlation name in another statement.

5.5.2. Implicit Correlation Names

A table or view reference that has no explicit correlation name has an implicit correlation name. The implicit correlation name is the table or view name qualified with the schema names.

You cannot use an implicit correlation name for a reference that has an explicit correlation name within the statement.

5.5.3. Examples of Correlation Names

This query refers to two tables, ORDERS and CUSTOMER, that contain columns named CUSTNUM. In the WHERE clause, one column reference is qualified by an implicit correlation name (ORDERS) and the other by an explicit correlation name ©:

```
SELECT ordernum, custname FROM orders, customer c  
WHERE orders.custnum = c.custnum AND orders.custnum = 543;
```

5.6. Database Objects

A database object is an SQL entity that exists in a name space. SQL statements can access Trafodion SQL database objects. The subsections listed below describe these Trafodion SQL database objects.

- [Constraints](#)
- [Indexes](#)
- [Tables](#)
- [Views](#)

5.6.1. Ownership

In Trafodion SQL, the creator of an object owns the object defined in the schema and has all privileges on the object. In addition, you can use the GRANT and REVOKE statements to grant access privileges for a table or view to specified users.

For more information, see the [GRANT Statement](#) and [REVOKE Statement](#). For information on privileges on tables and views, see [CREATE TABLE Statement](#) and [CREATE VIEW Statement](#).

5.7. Database Object Names

DML statements can refer to Trafodion SQL database objects. To refer to a database object in a statement, use an appropriate database object name. For information on the types of database objects see [Database Objects](#).

5.7.1. Logical Names for SQL Objects

You may refer to an SQL table, view, constraint, library, function, or procedure by using a one-part, two-part, or three-part logical name, also called an ANSI name:

```
catalog-name.schema-name.object-name
```

In this three-part name, *catalog-name* is the name of the catalog, which is TRAFODION for Trafodion SQL objects that map to HBase tables. *schema-name* is the name of the schema, and *object-name* is the simple name of the table, view, constraint, library, function, or procedure. Each of the parts is an SQL identifier. See [Identifiers](#).

Trafodion SQL automatically qualifies an object name with a schema name unless you explicitly specify schema names with the object name. If you do not set a schema name for the session using a SET SCHEMA statement, the default schema is SEABASE, which exists in the TRAFODION catalog. See [SET SCHEMA Statement](#). A one-part name *object-name* is qualified implicitly with the default schema.

You can qualify a column name in a Trafodion SQL statement by using a three-part, two-part, or one-part object name, or a correlation name.

5.7.2. SQL Object Namespaces

Trafodion SQL objects are organized in a hierarchical manner. Database objects exist in schemas, which are themselves contained in a catalog called TRAFODION. A catalog is a collection of schemas. Schema names must be unique within the catalog.

Multiple objects with the same name can exist provided that each belongs to a different name space. Trafodion SQL supports these namespaces:

- Index
- Functions and procedures
- Library
- Schema label
- Table value object (table, view, constraint)

Objects in one schema can refer to objects in a different schema. Objects of a given name space are required to have unique names within a given schema.

5.8. Data Types

Trafodion SQL data types are character, datetime, interval, or numeric (exact or approximate):

Character String Data Types	Fixed-length and variable-length character data types.
Datetime Data Types	DATE, TIME, and TIMESTAMP data types.
Interval Data Types	Year-month intervals (years and months) and day-time intervals (days, hours, minutes, seconds, and fractions of a second).
Numeric Data Types	Exact and approximate numeric data types.

Each column in a table is associated with a data type. You can use the CAST expression to convert data to the data type that you specify. For more information, see [CAST Expression](#).

The following table summarizes the Trafodion SQL data types:

Type	SQL Designation	Description	Size or Range ¹
Fixed-length character	CHAR[ACTER]	Fixed-length character data	1 to 32707 characters ²
	NCHAR	Fixed-length character data in predefined national character set	1 to 32707 bytes ^{3 7}
	NATIONAL CHAR[ACTER]	Fixed-length character data in predefined national character set	1 to 32707 bytes ^{3 7}
	VARCHAR	Variable-length ASCII character string	1 to 32703 characters ⁴
Variable-length character	CHAR[ACTER] VARYING	Variable-length ASCII character string	1 to 32703 characters ⁴
	NCHAR VARYING	Variable-length ASCII character string	1 to 32703 bytes ^{4 8}
	NATIONAL CHAR[ACTER] VARYING	Variable-length ASCII character string	1 to 32703 characters ^{4 8}
	NUMERIC (1, <i>scale</i>) to NUMERIC (128, <i>scale</i>)	Binary number with optional scale; 1 to 128 digits; stored: signed or unsigned for 1 to 9 digits 1 to 4 digits in 2 bytes 5 to 9 digits in 4 bytes 10 to 128 digits in 8-64 bytes, depending on precision	1 to 128 digits in 8-64 bytes, depending on precision
Numeric	SMALLINT	Binary integer; signed or unsigned	0 to 65535 unsigned, -32768 to +32767 signed; stored in 2 bytes
	INTEGER	Binary integer; signed or unsigned	0 to 4294967295 unsigned, -2147483648 to +2147483647 signed; stored in 4 bytes
	LARGEINT	Binary integer; signed only	-263 to +(263)-1; stored in 8 bytes
Numeric (extended numeric precision)	NUMERIC (precision 19 to 128)	Binary integer; signed or unsigned	Stored as multiple chunks of 16-bit integers, with a minimum storage length of 8 bytes.

Type	SQL Designation	Description	Size or Range ¹
Floating point number	FLOAT[(<i>precision</i>)]	Floating point number; precision designates from 1 through 52 bits of precision	+/- 2.2250738585072014e-308 through +/- 1.7976931348623157e+308; stored in 8 bytes
	REAL	Floating point number (32 bits)	+/- 1.17549435e-38 through +/- 3.40282347e+38; stored in 4 bytes
	DOUBLE PRECISION	Floating-point numbers (64 bits) with 1 through 52 bits of precision (52 bits of binary precision and 1 bits of exponent)	+/- 2.2250738585072014e-308 through +/- 1.7976931348623157e+308; stored in 8 bytes
Decimal number	DECIMAL (1, <i>scale</i>) to DECIMAL (18, <i>scale</i>)	Decimal number with optional scale; stored as ASCII characters; signed or unsigned for 1 to 9 digits; signed required for 10 or more digits	1 to 18 digits. Byte length equals the number of digits. Sign is stored as the first bit of the leftmost byte.
	Date-Time	Point in time, using the Gregorian calendar and a 24 hour clock system. The five supported designations are listed below.	<p>YEAR 0001-9999 MONTH 1-12 DAY 1-31</p> <p>DAY constrained by MONTH and YEAR</p> <p>HOUR 0-23 MINUTE 0-59 SECOND 0-59 FRACTION(n) 0-999999</p>
			in which n is the number of significant digits, from 1 to 6 (default is 6; minimum is 1; maximum is 6). Actual database storage is incremental, as follows: YEAR in 2 bytes MONTH in 1 byte DAY in 1 byte HOUR in 1 byte MINUTE in 1 byte SECOND in 1 byte FRACTION in 4 bytes
	DATE	Date	Format as YYYY-MM-DD; actual database storage size is 4 bytes
	TIME	Time of day, 24 hour clock, no time precision. Format as HH:MM:SS; actual database storage size is 3 bytes	
TIME (with time precision)	Time of day, 24 hour clock, with time precision	Format as HH:MM:SS.FFFFFFF; actual database storage size is 7 bytes	
TIMESTAMP	Point in time, no time precision	Format as YYYY-MM-DD HH:MM:SS; actual database storage size is 7 bytes	

Type	SQL Designation	Description	Size or Range ¹
TIMESTAMP (with time precision) Point in time, with time precision	Format as YYYY-MM-DD HH:MM:SS.FFFFFFF; actual database storage size is 1 byte	Interval	INTERVAL

- *scale* is the number of digits to the right of the decimal.
- *precision* specifies the allowed number of decimal digits.

1. The size of a column that allows null values is 2 bytes larger than the size for the defined data type.
2. The maximum row size is 32708 bytes, but the actual row size is less than that because of bytes used by null indicators, varchar column length indicators, and actual data encoding.
3. Storage size is the same as that required by CHAR data type but store only half as many characters depending on character set selection.
4. Storage size is reduced by 4 bytes for storage of the varying character length.
5. The maximum number of digits in an INTERVAL value is 18, including the digits in all INTERVAL fields of the value. Any INTERVAL field that is a starting field can have up to 18 digits minus the number of other digits in the INTERVAL value.
6. The maximum is 32707 if the national character set was specified at installation time to be ISO88591. The maximum is 16353 if the national character set was specified at installation time as UTF8.
7. The maximum is 32703 if the national character set was specified at installation time to be ISO88591. The maximum is 16351 if the national character set was specified at installation time as UTF8.

5.8.1. Comparable and Compatible Data Types

Two data types are comparable if a value of one data type can be compared to a value of the other data type.

Two data types are compatible if a value of one data type can be assigned to a column of the other data type, and if columns of the two data types can be combined using arithmetic operations. Compatible data types are also comparable.

Assignment and comparison are the basic operations of Trafodion SQL. Assignment operations are performed during the execution of INSERT and UPDATE statements. Comparison operations are performed during the execution of statements that include predicates, aggregate (or set) functions, and GROUP BY, HAVING, and ORDER BY clauses.

The basic rule for both assignment and comparison is that the operands have compatible data types. Data types with different character sets cannot be compared without converting one character set to the other. However, the SQL compiler will usually generate the necessary code to do this conversion automatically.

Character Data Types

Values of fixed and variable length character data types of the same character set are all character strings and are all mutually comparable and mutually assignable.

When two strings are compared, the comparison is made with a temporary copy of the shorter string that has been padded on the right with blanks to have the same length as the longer string.

Datetime Data Types

Values of type datetime are mutually comparable and mutually assignable only if the types have the same datetime fields. A DATE, TIME, or TIMESTAMP value can be compared with another value only if the other value has the same data type.

All comparisons are chronological. For example, this predicate is true:

```
TIMESTAMP '2008-09-28 00:00:00' > TIMESTAMP '2008-06-26 00:00:00'
```

Interval Data Types

Values of type INTERVAL are mutually comparable and mutually assignable only if the types are either both year-month intervals or both day-time intervals.

For example, this predicate is true:

```
INTERVAL '02-01' YEAR TO MONTH > INTERVAL '00-01' YEAR TO MONTH
```

The field components of the INTERVAL do not have to be the same. For example, this predicate is also true:

```
INTERVAL '02-01' YEAR TO MONTH > INTERVAL '01' YEAR
```

Numeric Data Types

Values of the approximate data types FLOAT, REAL, and DOUBLE PRECISION, and values of the exact data types NUMERIC, DECIMAL, INTEGER, SMALLINT, and LARGEINT, are all numbers and are all mutually comparable and mutually assignable.

When an approximate data type value is assigned to a column with exact data type, rounding might occur, and the fractional part might be truncated. When an exact data type value is assigned to a column with approximate data type, the result might not be identical to the original number.

When two numbers are compared, the comparison is made with a temporary copy of one of the numbers, according to defined rules of conversion. For example, if one number is INTEGER and the other is DECIMAL, the comparison is made with a temporary copy of the integer converted to a decimal.

Extended Numeric Precision

Trafodion SQL provides support for extended numeric precision data type. Extended numeric precision is an extension to the NUMERIC(x,y) data type where no theoretical limit exists on precision. It is a software data type, which means that the underlying hardware does not support it and all computations are performed by software. Computations using this data type may not match the performance of other hardware supported data types.

Considerations for Extended NUMERIC Precision Data Type

Consider these points and limitations for extended NUMERIC precision data type:

- May cost more than other data type options.
 - Is a software data type.
 - Cannot be compared to data types that are supported by hardware.
 - If your application requires extended NUMERIC precision arithmetic expressions, specify the required precision in the table DDL or as explicit extended precision type casts of your select list items. The default system behavior is to treat user-specified extended precision expressions as extended precision values. Conversely, non-user-specified (that is, temporary, intermediate) extended precision expressions may lose precision. In the following example, the precision appears to lose one digit because the system treats the sum of two NUMERIC(18,4) type columns as NUMERIC(18,4). NUMERIC(18) is the longest non-extended precision numeric type. NUMERIC(19) is the shortest extended precision numeric type. The system actually computes the sum of 2 NUMERIC(18,4) columns as an extended precision NUMERIC(19,4) sum. But because no user-specified extended precision columns exist, the system casts the sum back to the user-specified type of NUMERIC(18,4).

```
CREATE TABLE T(a NUMERIC(18,4), B NUMERIC(18,4));
INSERT INTO T VALUES (1.1234, 2.1234);

>> SELECT A+B FROM T;

(EXPR)
-----
3.246
```

If this behavior is not acceptable, you can use one of these options:

Note the result for the previous example when changing to NUMERIC(19,4):

```
SELECT CAST(A+B AS NUMERIC(19,4)) FROM T;
(EXPR)
-----
3.2468
```

When displaying output results in the command interface of a client-based tool, casting a select list item to an extended precision numeric type is acceptable. However, when retrieving an extended precision select list item into an application program's host variable, you must first convert the extended precision numeric type into a string data type. For example:

```
SELECT CAST(CAST(A+B AS NUMERIC(19,4)) AS CHAR(24)) FROM T;
(EXPR)
-----
3.2468
```



An application program can convert an externalized extended precision value in string form into a numeric value it can handle. But, an application program cannot correctly interpret an extended precision value in internal form.

Rules for Extended NUMERIC Precision Data Type

These rules apply:

- No limit on maximum precision.
- Supported in all DDL and DML statements where regular NUMERIC data type is supported.
- Allowed as part of key columns for hash partitioned tables only.
- NUMERIC type with precision 10 through 18.
 - UNSIGNED is supported as extended NUMERIC precision data type
 - SIGNED is supported as 64-bit integer
- CAST function allows conversion between regular NUMERIC and extended NUMERIC precision data type.
- Parameters in SQL queries support extended NUMERIC precision data type.

Example of Extended NUMERIC Precision Data Type

```
>>CREATE TABLE t( n NUMERIC(128,30));  
--- SQL operation complete.  
  
>>SHOWDDL TABLE t;  
CREATE TABLE SCH.T  
(  
    N NUMERIC(128, 30) DEFAULT NULL  
)  
;  
--- SQL operation complete.  
  
>>
```

5.8.2. Character String Data Types

Trafodion SQL includes both fixed-length character data and variable-length character data. You cannot compare character data to numeric, datetime, or interval data.

- *character-type* is:

```
CHAR[ACTER] [(_length_ [CHARACTERS])] [_char-set_] [UPSHIFT] [[NOT]CASESPECIFIC]
| CHAR[ACTER] VARYING(_length_) [CHARACTERS][_char-set_] [UPSHIFT]
| [[NOT]CASESPECIFIC]
| VARCHAR(_length_) [CHARACTERS] [_char-set_] [UPSHIFT] [[NOT]CASESPECIFIC]
| NCHAR [(_length_)] [CHARACTERS] [UPSHIFT] [[NOT]CASESPECIFIC]
| NCHAR VARYING (_length_) [CHARACTERS] [UPSHIFT] [[NOT]CASESPECIFIC]
| NATIONAL CHAR[ACTER] [(_length_)] [CHARACTERS] [UPSHIFT] [[NOT]CASESPECIFIC]
| NATIONAL CHAR[ACTER] VARYING (_length_) [CHARACTERS] [UPSHIFT] [[NOT]CASESPECIFIC]
```

- *char-set* is

```
CHARACTER SET char-set-name
```

CHAR, NCHAR, and NATIONAL CHAR are fixed-length character types. CHAR VARYING, VARCHAR, NCHAR VARYING and NATIONAL CHAR VARYING are varying-length character types.

- *length*

is a positive integer that specifies the number of characters allowed in the column. You must specify a value for *length*.

- *char-set-name*

is the character set name, which can be ISO88591 or UTF8.

- CHAR[ACTER] [(_length_ [CHARACTERS])] [*char-set*] [UPSHIFT] [[NOT]CASESPECIFIC]

specifies a column with fixed-length character data.

- CHAR[ACTER] VARYING (_length_) [CHARACTERS] [*char-set*] [UPSHIFT] [[NOT]CASESPECIFIC]

specifies a column with varying-length character data. VARYING specifies that the number of characters stored in the column can be fewer than the *length*.

Values in a column declared as VARYING can be logically and physically shorter than the maximum length, but the maximum internal size of a VARYING column is actually four bytes larger than the size required for an equivalent column that is not VARYING.

- `VARCHAR (length) [char-set] [UPSHIFT] [[NOT]CASESPECIFIC]`

specifies a column with varying-length character data. VARCHAR is equivalent to data type CHAR[ACTER] VARYING.

- `NCHAR [(length)] [UPSHIFT] [[NOT]CASESPECIFIC], NATIONAL CHAR[ACTER] [(length)] [UPSHIFT] [[NOT]CASESPECIFIC]`

specifies a column with data in the predefined national character set.

- `NCHAR VARYING [(length)] [UPSHIFT] [[NOT]CASESPECIFIC], NATIONAL CHAR[ACTER] VARYING (length) [UPSHIFT] [[NOT]CASESPECIFIC]`

specifies a column with varying-length data in the predefined national character set.

Considerations for Character String Data Types

Difference Between CHAR and VARCHAR

You can specify a fixed-length character column as `CHAR(n)`, where *n* is the number of characters you want to store. However, if you store five characters into a column specified as `CHAR(10)`, ten characters are stored where the rightmost five characters are blank.

If you do not want to have blanks added to your character string, you can specify a variable-length character column as `VARCHAR(n)`, where *n* is the maximum number of characters you want to store. If you store five characters in a column specified as `VARCHAR(10)`, only the five characters are stored logically—without blank padding.

NCHAR Columns in SQL Tables

In Trafodion SQL, the NCHAR type specification is equivalent to:

- NATIONAL CHARACTER
- NATIONAL CHAR
- CHAR ... CHARACTER SET ..., where the character set is the character set for NCHAR

Similarly, you can use NCHAR VARYING, NATIONAL CHARACTER VARYING, NATIONAL CHAR VARYING, and VARCHAR ... CHARACTER SET ..., where the character set is the character set for NCHAR. The character set for NCHAR is determined when Trafodion SQL is installed.

5.8.3. Datetime Data Types

A value of datetime data type represents a point in time according to the Gregorian calendar and a 24-hour clock in local civil time (LCT). A datetime item can represent a date, a time, or a date and time.

When a numeric value is added to or subtracted from a date type, the numeric value is automatically casted to an INTERVAL DAY value. When a numeric value is added to or subtracted from a time type or a timestamp type, the numeric value is automatically casted to an INTERVAL SECOND value. For information on CAST, see [CAST Expression](#).

Trafodion SQL accepts dates, such as October 5 to 14, 1582, that were omitted from the Gregorian calendar. This functionality is a Trafodion SQL extension.

The range of times that a datetime value can represent is:

```
January 1, 1 A.D., 00:00:00.000000 (low value) December 31, 9999, 23:59:59.999999 (high value)
```

Trafodion SQL has three datetime data types:

- *datetime-type* is:

```
DATE
| TIME [(_time-precision_)]
| TIMESTAMP [(_timestamp-precision_)]
```

- DATE

specifies a datetime column that contains a date in the external form yyyy-mm-dd and stored in four bytes.

- TIME [(*time-precision*)]

specifies a datetime column that, without the optional time-precision, contains a time in the external form hh:mm:ss and is stored in three bytes. *time-precision* is an unsigned integer that specifies the number of digits in the fractional seconds and is stored in four bytes. The default for *time-precision* is 0, and the maximum is 6.

- TIMESTAMP [(*timestamp-precision*)]

specifies a datetime column that, without the optional *timestamp-precision*, contains a timestamp in the external form yyyy-mm-dd hh:mm:ss and is stored in seven bytes. *timestamp-precision* is an unsigned integer that specifies the number of digits in the fractional seconds and is stored in four bytes. The default for *timestamp-precision* is 6, and the maximum is 6.

Considerations for Datetime Data Types

Datetime Ranges

The range of values for the individual fields in a DATE, TIME, or TIMESTAMP column is specified as:

yyyy	Year, from 0001 to 9999
mm	Month, from 01 to 12
dd	Day, from 01 to 31
hh	Hour, from 00 to 23
mm	Minute, from 00 to 59
ss	Second, from 00 to 59
msssss	Microsecond, from 000000 to 999999

When you specify *datetime_value* (FORMAT ‘string’) in the DML statement and the specified format is ‘mm/dd/yyyy’, ‘MM/DD/YYYY’, or ‘yyyy/mm/dd’ or ‘yyyy-mm-dd’, the datetime type is automatically cast.

5.8.4. Interval Data Types

Values of interval data type represent durations of time in year-month units (years and months) or in day-time units (days, hours, minutes, seconds, and fractions of a second).

- *interval-type* is:

```
INTERVAL[-] { start-field TO end-field | single-field }
```

- *start-field* is:

```
{YEAR | MONTH | DAY | HOUR | MINUTE} [(_leading-precision_)]
```

- `end-field` is:

```
YEAR | MONTH | DAY | HOUR | MINUTE | SECOND [(_fractional-precision_)]
```

- *single-field* is:

```
_start-field_ | SECOND [(_leading-precision_, _fractional-precision_)]
```

- INTERVAL[-] { *start-field* TO *end-field* | *single-field* }

specifies a column that represents a duration of time as a year-month or day-time range or a single-field. The optional sign indicates if this is a positive or negative integer. If you omit the sign, it defaults to positive.

If the interval is specified as a range, the *start-field* and *end-field* must be in one of these categories:

- {YEAR | MONTH | DAY | HOUR | MINUTE} [(*leading-precision*)]

specifies the *start-field*. A *start-field* can have a *leading-precision* up to 18 digits (the maximum depends on the number of fields in the interval). The *leading-precision* is the number of digits allowed in the *start-field*. The default for *leading-precision* is 2.

- YEAR | MONTH | DAY | HOUR | MINUTE | SECOND [(*fractional-precision*)]

specifies the *end-field*. If the *end-field* is SECOND, it can have a *fractional-precision* up to 6 digits. The *fractional-precision* is the number of digits of precision after the decimal point. The default for *fractional-precision* is 6.

- start-field | SECOND [(*leading-precision*, *fractional-precision*)]

specifies the *single-field*. If the *single-field* is SECOND, the *leading-precision* is the number of digits of precision before the decimal point, and the *fractional-precision* is the number of digits of precision after the decimal point. The default for *leading-precision* is 2, and the default for *fractional-precision* is 6. The maximum for *leading-precision* is 18, and the maximum for *fractional-precision* is 6.

Considerations for Interval Data Types

Adding or Subtracting Imprecise Interval Values

Adding or subtracting an interval that is any multiple of a MONTH, a YEAR, or a combination of these may result in a runtime error. For example, adding 1 MONTH to January 31, 2009 will result in an error because February 31 does not exist and it is not clear whether the user would want rounding back to February 28, 2009, rounding up to March 1, 2009 or perhaps treating the interval 1 MONTH as if it were 30 days resulting in an answer of March 2, 2009. Similarly, subtracting 1 YEAR from February 29, 2008 will result in an error. See the descriptions for the [ADD_MONTHS Function](#), [DATE_ADD Function](#), [DATE_SUB Function](#), and [DATEADD Function](#) for ways to add or subtract such intervals without getting errors at runtime.

Interval Leading Precision

The maximum for the *leading-precision* depends on the number of fields in the interval and on the *fractional-precision*. The maximum is computed as:

```
[[18 - _fractional-precision_ - 2 * (_n_ - 1)]]
_max-leading-precision_ = 18 - _fractional-precision_ - 2 * (_N_ - 1)
```

where *N* is the number of fields in the interval.

For example, the maximum number of digits for the *leading-precision* in a column with data type INTERVAL YEAR TO MONTH is computed as: $18 - 0 - 2 * (2 - 1) = 16$

Interval Ranges

Within the definition of an interval range (other than a single field), the *start-field* and *end-field* can be any of the specified fields with these restrictions:

- An interval range is either year-month or day-time—that is, if the *start-field* is YEAR, the *end-field* is MONTH; if the *start-field* is DAY, HOUR, or MINUTE, the *end-field* is also a time field.
- The *start-field* must precede the *end-field* within the hierarchy: YEAR, MONTH, DAY, HOUR, MINUTE, and SECOND.

Signed Intervals

To include a quoted string in a signed interval data type, the sign must be outside the quoted string. It can be before the entire literal or immediately before the duration enclosed in quotes.

For example, for the interval “minus (5 years 5 months) these formats are valid:

```
INTERVAL - '05-05' YEAR TO MONTH  
- INTERVAL '05-05' YEAR TO MONTH
```

Overflow Conditions

When you insert a fractional value into an INTERVAL data type field, if the fractional value is 0 (zero) it does not cause an overflow. Inserting value INTERVAL '1.000000' SECOND(6) into a field SECOND(0) does not cause a loss of value. Provided that the value fits in the target column without a loss of precision, Trafodion SQL does not return an overflow error.

However, if the fractional value is > 0, an overflow occurs. Inserting value INTERVAL '1.000001' SECOND(6) causes a loss of value.

5.8.5. Numeric Data Types

Numeric data types are either exact or approximate. A numeric data type is compatible with any other numeric data type, but not with character, datetime, or interval data types.

- *exact-numeric-type* is:

```
NUMERIC [(_precision_ [, _scale_])] [SIGNED|UNSIGNED]
| SMALLINT [SIGNED|UNSIGNED]
| INT[TEGER] [SIGNED|UNSIGNED]
| LARGEINT
| DECIMAL [(_precision_ [, _scale_])] [SIGNED|UNSIGNED]
```

- *approximate-numeric-type* is:

```
FLOAT [(_precision_)]
| REAL
| DOUBLE PRECISION
```

Exact numeric data types are types that can represent a value exactly: NUMERIC, SMALLINT, INTEGER, LARGEINT, and DECIMAL.

Approximate numeric data types are types that do not necessarily represent a value exactly: FLOAT, REAL, and DOUBLE PRECISION.

A column in a Trafodion SQL table declared with a floating-point data type is stored in IEEE floating-point format and all computations on it are done assuming that. Trafodion SQL tables can contain only IEEE floating-point data.

- `NUMERIC [(precision [, scale])] [SIGNED|UNSIGNED]`

specifies an exact numeric column—a two-byte binary number, SIGNED or UNSIGNED. *precision* specifies the total number of digits and cannot exceed 128. If *precision* is between 10 and 18, you must use a signed value to obtain the supported hardware data type. If precision is over 18, you will receive the supported software data type. You will also receive the supported software data type if the precision type is between 10 and 18, and you specify UNSIGNED. *scale* specifies the number of digits to the right of the decimal point.

The default is NUMERIC (9,0) SIGNED.

- `SMALLINT [SIGNED|UNSIGNED]`

specifies an exact numeric column—a two-byte binary integer, SIGNED or UNSIGNED. The column stores integers in the range unsigned 0 to 65535 or signed -32768 to +32767. The default is SIGNED.

- **INT[EGER] [SIGNED | UNSIGNED]**

specifies an exact numeric column—a 4-byte binary integer, SIGNED or UNSIGNED. The column stores integers in the range unsigned 0 to 4294967295 or signed -2147483648 to +2147483647.

The default is SIGNED.

- **LARGEINT**

specifies an exact numeric column—an 8-byte signed binary integer. The column stores integers in the range -2^{63} to $+2^{63} - 1$ (approximately 9.223 times 10 to the eighteenth power).

- **DEC[IMAL] [(precision [,scale])] [SIGNED|UNSIGNED]**

specifies an exact numeric column—a decimal number, SIGNED or UNSIGNED, stored as ASCII characters. *precision* specifies the total number of digits and cannot exceed 18. If *precision* is 10 or more, the value must be SIGNED. The sign is stored as the first bit of the leftmost byte. *scale* specifies the number of digits to the right of the decimal point.

The default is DECIMAL (9,0) SIGNED.

- **FLOAT [(precision)]**

specifies an approximate numeric column. The column stores floating-point numbers and designates from 1 through 54 bits of *precision*. The range is from +/- 2.2250738585072014e-308 through +/- 1.7976931348623157e+308 stored in 8 bytes.

An IEEE FLOAT *precision* data type is stored as an IEEE DOUBLE, that is, in 8 bytes, with the specified precision.

The default *precision* is 54.

- **REAL**

specifies a 4-byte approximate numeric column. The column stores 32-bit floating-point numbers with 23 bits of binary precision and 8 bits of exponent.

The minimum and maximum range is from +/- 1.17549435e-38 through +/- 3.40282347e+38.

- DOUBLE PRECISION

specifies an 8-byte approximate numeric column.

The column stores 64-bit floating-point numbers and designates from 1 through 52 bits of *precision*.

An IEEE DOUBLE PRECISION data type is stored in 8 bytes with 52 bits of binary precision and 1 bits of exponent.

The minimum and maximum range is from +/- 2.2250738585072014e-308 through +/-1.7976931348623157e+308.

5.9. Expressions

An SQL value expression, called an expression, evaluates to a value. Trafodion SQL supports these types of expressions:

Character Value Expressions	Operands can be combined with the concatenation operator (). Example: 'HOUSTON' ' TEXAS'
Datetime Value Expressions	Operands can be combined in specific ways with arithmetic operators. Example: CURRENT_DATE + INTERVAL '1' DAY
Interval Value Expressions	Operands can be combined in specific ways with addition and subtraction operators. Example: INTERVAL '2' YEAR - INTERVAL '3' MONTH
Numeric Value Expressions	Operands can be combined in specific ways with arithmetic operators. Example: SALARY * 1.10

The data type of an expression is the data type of the value of the expression.

A value expression can be a character string literal, a numeric literal, a dynamic parameter, or a column name that specifies the value of the column in a row of a table. A value expression can also include functions and scalar subqueries.

5.9.1. Character Value Expressions

The operands of a character value expression—called character primaries—can be combined with the concatenation operator (||). The data type of a character primary is character string.

- *character-expression* is:

```
character-primary
| character-expression || character-primary
```

- *character-primary* is:

```
character-string-literal
| column-reference
| character-type-host-variable
| dynamic parameter
| character-value-function
| aggregate-function
| sequence-function
| scalar-subquery
| CASE-expression
| CAST-expression
| (character-expression)
```

Character (or string) value expressions are built from operands that can be:

- Character string literals
- Character string functions
- Column references with character values
- Dynamic parameters
- Aggregate functions, sequence functions, scalar subqueries, CASE expressions, or CAST expressions that return character values

Examples of Character Value Expressions

These are examples of character value expressions:

Expression	Description
'ABILENE'	Character string literal.
'ABILENE' ' TEXAS'	The concatenation of two string literals.
'ABILENE' ' TEXAS' x'55 53 41'	The concatenation of three string literals to form the literal: 'ABILENE TEXAS USA'
'Customer' custname	The concatenation of a string literal with the value in column CUSTNAME.
CAST (order_date AS CHAR(10))	CAST function applied to a DATE value.

5.9.2. Datetime Value Expressions

The operands of a datetime value expression can be combined in specific ways with arithmetic operators.

In this syntax diagram, the data type of a datetime primary is DATE, TIME, or TIMESTAMP. The data type of an interval term is INTERVAL.

- *datetime-expression* is:

```

datetime-primary
| interval-expression + datetime-primary
| datetime-expression + interval-term
| datetime-expression - interval-term

```

- *datetime-primary* is:

```

datetime-literal
| column-reference
| datetime-type-host-variable
| dynamic parameter
| datetime-value-function
| aggregate-function
| sequence-function
| scalar-subquery
| CASE-expression
| CAST-expression
| (datetime-expression)

```

- *interval-term* is:

```

interval-factor
| numeric-term * interval-factor

```

- *interval-factor* is:

```
[ + | - ] interval-primary
```

- *interval-primary* is:

```

interval-literal
| column-reference
| interval-type-host-variable
| dynamic parameter
| aggregate-function
| sequence-function
| scalar-subquery
| CASE-expression
| CAST-expression
| (interval-expression)

```

Datetime value expressions are built from operands that can be:

- Interval value expressions
- Datetime or interval literals
- Dynamic parameters
- Column references with datetime or interval values
- Dynamic parameters
- Datetime or interval value functions
- Any aggregate functions, sequence functions, scalar subqueries, CASE expressions, or CAST expressions that return datetime or interval values

Considerations for Datetime Value Expressions

Data Type of Result

In general, the data type of the result is the data type of the *datetime-primary* part of the datetime expression. For example, datetime value expressions include:

Datetime Expression	Description	Result Data Type
CURRENT_DATE + INTERVAL '1' DAY	The sum of the current date and an interval value of one day.	DATE
CURRENT_DATE + est_complete	The sum of the current date and the interval value in column EST_COMPLETE.	DATE
(SELECT ship_timestamp FROM project WHERE projcode=1000) + INTERVAL '07:04' DAY TO HOUR	The sum of the ship timestamp for the specified project and an interval value of seven days, four hours.	TIMESTAMP

The datetime primary in the first expression is CURRENT_DATE, a function that returns a value with DATE data type. Therefore, the data type of the result is DATE.

In the last expression, the datetime primary is this scalar subquery:

```
( SELECT ship_timestamp FROM project WHERE projcode=1000 )
```

The preceding subquery returns a value with TIMESTAMP data type. Therefore, the data type of the result is TIMESTAMP.

Restrictions on Operations With Datetime or Interval Operands

You can use datetime and interval operands with arithmetic operators in a datetime value expression only in these combinations:

Operand 1	Operator	Operand 2	Result Type
Datetime	+ or -	Interval	Datetime
Interval	+	Datetime	Datetime

When a numeric value is added to or subtracted from a DATE type, the numeric value is automatically casted to an INTERVAL DAY value. When a numeric value is added to or subtracted from a time type or a timestamp type, the numeric value is automatically casted to an INTERVAL SECOND value. For information on CAST, see [CAST Expression](#). For more information on INTERVALS, see [Interval Value Expressions](#)

When using these operations, note:

- Adding or subtracting an interval of months to a DATE value results in a value of the same day plus or minus the specified number of months. Because different months have different lengths, this is an approximate result.
- Datetime and interval arithmetic can yield unexpected results, depending on how the fields are used. For example, execution of this expression (evaluated left to right) returns an error:

```
DATE '2007-01-30' + INTERVAL '1' MONTH + INTERVAL '7' DAY
```

In contrast, this expression (which adds the same values as the previous expression, but in a different order) correctly generates the value 2007-03-06:

```
DATE '2007-01-30' + INTERVAL '7' DAY + INTERVAL '1' MONTH
```

You can avoid these unexpected results by using the [ADD_MONTHS Function](#).

Examples of Datetime Value Expressions

The PROJECT table consists of five columns that use the data types NUMERIC, VARCHAR, DATE, TIMESTAMP, and INTERVAL DAY. Suppose that you have inserted values into the PROJECT table. For example:

```
INSERT INTO persnl.project
VALUES (1000, 'SALT LAKE CITY', DATE '2007-04-10',
TIMESTAMP '2007-04-21:08:15:00.00', INTERVAL '15' DAY);
```

The next examples use these values in the PROJECT table:

PROJCODE	START_DATE	SHIP_TIMESTAMP	EST_COMPLETE
1000	2007-04-10	2007-04-21 08:15:00.00	15
945	2007-10-20	2007-12-21 08:15:00.00	30
920	2007-02-21	2007-03-12 09:45:00.00	20
134	2007-1 -20	2008-01-01 00:00:00.00	30

- Add an interval value qualified by YEAR to a datetime value:

```
SELECT start_date + INTERVAL '1' YEAR FROM persnl.project
WHERE projcode = 1000;

(EXPR)
-----
2008-04-10

--- 1 row(s) selected.
```

- Subtract an interval value qualified by MONTH from a datetime value:

```
SELECT ship_timestamp - INTERVAL '1' MONTH FROM persnl.project
WHERE projcode = 134;

(EXPR)
-----
2007-12-01 00:00:00.000000

--- 1 row(s) selected.
```

The result is 2007-12-01 00:00:00.00. The YEAR value is decremented by 1 because subtracting a month from January 1 causes the date to be in the previous year.

- Add a column whose value is an interval qualified by DAY to a datetime value:

```
SELECT start_date + est_complete FROM persnl.project  
WHERE projcode = 920;  
  
(EXPR)  
-----  
2007-03-12  
  
--- 1 row(s) selected.
```

The result of adding 20 days to 2008-02-21 is 2008-03-12. Trafodion SQL correctly handles 2008 as a leap year.

- Subtract an interval value qualified by HOUR TO MINUTE from a datetime value:

```
SELECT ship_timestamp - INTERVAL '15:30' HOUR TO MINUTE  
FROM persnl.project WHERE projcode = 1000;  
  
(EXPR)  
-----  
2008-04-20 16:45:00.000000
```

The result of subtracting 15 hours and 30 minutes from 2007-04-21 08:15:00.00 is 2007-04-20 16:45:00.00.

5.9.3. Interval Value Expressions

The operands of an interval value expression can be combined in specific ways with addition and subtraction operators. In this syntax diagram, the data type of a datetime expression is DATE, TIME, or TIMESTAMP; the data type of an interval term or expression is INTERVAL.

- *interval-expression* is:

```

interval-term
| interval-expression + interval-term
| interval-expression - interval-term
| (datetime-expression - datetime-primary)
  [interval-qualifier]
```

- *interval-term* is:

```

interval-factor
| interval-term * numeric-factor
| interval-term / numeric-factor
| numeric-term * interval-factor
```

- *interval-factor* is:

```
[+|-] interval-primary
```

- *interval-primary* is:

```

interval-literal
| column-reference
| interval-type-host-variable
| dynamic-parameter
| aggregate-function
| sequence-function
| scalar-subquery
| CASE-expression
| CAST-expression
| (interval-expression)
```

- *numeric-factor* is:

```

[+|-] numeric-primary
| [+|-] numeric-primary ** numeric-factor
```

Interval value expressions are built from operands that can be:

- Integers
- Datetime value expressions
- Interval literals
- Column references with datetime or interval values
- Dynamic parameters
- Datetime or interval value functions
- Aggregate functions, sequence functions, scalar subqueries, CASE expressions, or CAST expressions that return interval values

For *interval-term*, *datetime-expression*, and *datetime-primary*, see [Datetime Value Expressions](#).

If the interval expression is the difference of two datetime expressions, by default, the result is expressed in the least significant unit of measure for that interval. For date differences, the interval is expressed in days. For timestamp differences, the interval is expressed in fractional seconds.

If the interval expression is the difference or sum of interval operands, the interval qualifiers of the operands are either year-month or day-time. If you are updating or inserting a value that is the result of adding or subtracting two interval qualifiers, the interval qualifier of the result depends on the interval qualifier of the target column.

Considerations for Interval Value Expressions

Start and End Fields

Within the definition of an interval range, the *start-field* and *end-field* can be any of the specified fields with these restrictions:

- An interval is either year-month or day-time. If the *start-field* is YEAR, the *end-field* is MONTH; if the *start-field* is DAY, HOUR, or MINUTE, the *end-field* is also a time field.
- The *start-field* must precede the *end-field* within the hierarchy YEAR, MONTH, DAY, HOUR, MINUTE, and SECOND.

Within the definition of an interval expression, the *start-field* and *end-field* of all operands in the expression must be either year-month or day-time.

Interval Qualifier

The rules for determining the interval qualifier of the result expression vary. For example, interval value expressions include:

Datetime Expression	Description	Result Data Type
CURRENT_DATE - start_date	By default, the interval difference between the current date and the value in column START_DATE is expressed in days. You are not required to specify the interval qualifier.	INTERVAL DAY (12)
INTERVAL '3' DAY - INTERVAL '2' DAY	The difference of two interval literals. The result is 1 day.	INTERVAL DAY (3)
INTERVAL '3' DAY + INTERVAL '2' DAY	The sum of two interval literals. The result is 5 days.	INTERVAL DAY (3)
INTERVAL '2' YEAR - INTERVAL '3' MONTH	The difference of two interval literals. The result is 1 year, 9 months.	INTERVAL YEAR (3) TO MONTH

Restrictions on Operations

You can use datetime and interval operands with arithmetic operators in an interval value expression only in these combinations:

Operand 1	Operator	Operand 2	Result Type
Datetime	-	Datetime	Interval
Interval	+ or -	Interval	Interval
Interval	* or /	Numeric	Interval
Numeric	*	Interval	Interval

This table lists valid combinations of datetime and interval arithmetic operators, and the data type of the result:

Operands	Result type
Date + Interval or Interval + Date	Date
Date + Numeric or Numeric + Date	Date
Date - Numeric	Date
Date – Interval	Date
Date – Date	Interval
Time + Interval or Interval + Time	Time
Time + Numeric or Numeric + Time	Time
Time - Number	Time
Time – Interval	Time
Timestamp + Interval or Interval + Timestamp	Timestamp
Timestamp + Numeric or Numeric + Timestamp	Timestamp
Timestamp - Numeric	Timestamp
Timestamp – Interval	Timestamp
year-month Interval + year-month Interval	year-month Interval
day-time Interval + day-time Interval	day-time Interval
year-month Interval – year-month Interval	year-month Interval
day-time Interval – day-time Interval	day-time Interval
Time – Time	Interval
Timestamp – Timestamp	Interval
Interval * Number or Number * Interval	Interval
Interval / Number	Interval
Interval – Interval or Interval + Interval	Interval

When using these operations, note:

- If you subtract a datetime value from another datetime value, both values must have the same data type. To get this result, use the CAST expression. For example:

```
CAST (ship_timestamp AS DATE) - start_date
```

- If you subtract a datetime value from another datetime value, and you specify the interval qualifier, you must allow for the maximum number of digits in the result for the precision. For example:

```
(CURRENT_TIMESTAMP - ship_timestamp) DAY(4) TO SECOND(6)
```

- If you are updating a value that is the result of adding or subtracting two interval values, an SQL error occurs if the source value does not fit into the target column's range of interval fields. For example, this expression cannot replace an INTERVAL DAY column:

```
INTERVAL '1' MONTH + INTERVAL '7' DAY
```

- If you multiply or divide an interval value by a numeric value expression, Trafodion SQL converts the interval value to its least significant subfield and then multiplies or divides it by the numeric value expression. The result has the same fields as the interval that was multiplied or divided. For example, this expression returns the value 5-02:

```
INTERVAL '2-7' YEAR TO MONTH * 2
```

Examples of Interval Value Expressions

The PROJECT table consists of five columns using the data types NUMERIC, VARCHAR, DATE, TIMESTAMP, and INTERVAL DAY. Suppose that you have inserted values into the PROJECT table. For example:

```
INSERT INTO persnl.project
VALUES (1000,'SALT LAKE CITY',DATE '2007-04-10',
        TIMESTAMP '2007-04-21:08:15:00.00',INTERVAL '15' DAY);
```

The next example uses these values in the PROJECT table:

PROJCODE	START_DATE	SHIP_TIMESTAMP	EST_COMPLETE
1000	2007-04-10	2007-04-21:08:15:00.0000	15
2000	2007-06-10	2007-07-21:08:30:00.0000	30
2500	2007-10-10	2007-12-21:09:00:00.0000	60
3000	2007-08-21	2007-10-21:08:10:00.0000	60
4000	2007-09-21	2007-10-21:10:15:00.0000	30
5000	2007-09-28	2007-10-28:09:25:01.11	30

- Suppose that the CURRENT_TIMESTAMP is 2000-01-06 1:14:41.748703. Find the number of days, hours, minutes, seconds, and fractional seconds in the difference of the current timestamp and the SHIP_TIMESTAMP in the PROJECT table:

```
SELECT projcode,
       (CURRENT_TIMESTAMP - ship_timestamp) DAY(4) TO SECOND(6)
  FROM samdbc.cat.personl.project;

Project/Code (EXPR)
-----
 1000 1355 02:58:57.087086
 2000 1264 02:43:57.087086
 2500 1111 02:13:57.087086
 3000 1172 03:03:57.087086
 4000 1172 00:58:57.087086
 5000 1165 01:48:55.975986

--- 6 row(s) selected.
```

5.9.4. Numeric Value Expressions

The operands of a numeric value expression can be combined in specific ways with arithmetic operators. In this syntax diagram, the data type of a term, factor, or numeric primary is numeric.

```

numeric-expression` is:
  numeric-term
| numeric-expression + numeric-term
| numeric-expression - numeric-term

numeric-term is:
  numeric-factor
| numeric-term * numeric-factor
| numeric-term / numeric-factor

numeric-factor is:
  [+|-] numeric-primary
| [+|-] numeric-primary ** numeric-factor

numeric-primary is:
  unsigned-numeric-literal
| column-reference
| numeric-type-host-variable
| dynamic parameter
| numeric-value-function
| aggregate-function
| sequence-function
| scalar-subquery
| CASE-expression
| CAST-expression
| (numeric-expression)
  
```

As shown in the preceding syntax diagram, numeric value expressions are built from operands that can be:

- Numeric literals
- Column references with numeric values
- Dynamic parameters
- Numeric value functions
- Aggregate functions, sequence functions, scalar subqueries, CASE expressions, or CAST expressions that return numeric values

Considerations for Numeric Value Expressions

Order of Evaluation

1. Expressions within parentheses

2. Unary operators

3. Exponentiation

4. Multiplication and division

5. Addition and subtraction

Operators at the same level are evaluated from left to right for all operators except exponentiation. Exponentiation operators at the same level are evaluated from right to left. For example, $x + y + z$ is evaluated as $(x + y) + z$, whereas $x ** y ** z$ is evaluated as $x ** (y ** z)$.

Additional Rules for Arithmetic Operations

Numeric expressions are evaluated according to these additional rules:

- An expression with a numeric operator evaluates to null if any of the operands is null.
- Dividing by 0 causes an error.
- Exponentiation is allowed only with numeric data types. If the first operand is 0 (zero), the second operand must be greater than 0, and the result is 0. If the second operand is 0, the first operand cannot be 0, and the result is 1. If the first operand is negative, the second operand must be a value with an exact numeric data type and a scale of zero.
- Exponentiation is subject to rounding error. In general, results of exponentiation should be considered approximate.

Precision, Magnitude, and Scale of Arithmetic Results

The precision, magnitude, and scale are computed during the evaluation of an arithmetic expression. Precision is the maximum number of digits in the expression. Magnitude is the number of digits to the left of the decimal point. Scale is the number of digits to the right of the decimal point.

For example, a column declared as NUMERIC (18, 5) has a precision of 18, a magnitude of 13, and a scale of 5. As another example, the literal 12345.6789 has a precision of 9, a magnitude of 5, and a scale of 4.

The maximum precision for exact numeric data types is 128 digits. The maximum precision for the REAL data type is approximately 7 decimal digits, and the maximum precision for the DOUBLE PRECISION data type is approximately 16 digits.

When Trafodion SQL encounters an arithmetic operator in an expression, it applies these rules (with the restriction that if the precision becomes greater than 18, the resulting precision is set to 18 and the resulting scale is the maximum of 0 and $(18 - (\text{resulted precision} - \text{resulted scale}))$).

- If the operator is + or -, the resulting scale is the maximum of the scales of the operands. The resulting precision is the maximum of the magnitudes of the operands, plus the scale of the result, plus 1.
- If the operator is *, the resulting scale is the sum of the scales of the operands. The resulting precision is the sum of the magnitudes of the operands and the scale of the result.
- If the operator is /, the resulting scale is the sum of the scale of the numerator and the magnitude of the denominator. The resulting magnitude is the sum of the magnitude of the numerator and the scale of the denominator.

For example, if the numerator is NUMERIC (7, 3) and the denominator is NUMERIC (7, 5), the resulting scale is 3 plus 2 (or 5), and the resulting magnitude is 4 plus 5 (or 9). The expression result is NUMERIC (14, 5).

Conversion of Numeric Types for Arithmetic Operations

Trafodion SQL automatically converts between floating-point numeric types (REAL and DOUBLE PRECISION) and other numeric types. All numeric values in the expression are first converted to binary, with the maximum precision needed anywhere in the evaluation.

Examples of Numeric Value Expressions

These are examples of numeric value expressions:

-57	Numeric literal.
salary * 1.10	The product of the values in the SALARY column and a numeric literal.
unit_price * qty_ordered	The product of the values in the UNIT_PRICE and QTY_ORDERED columns.
12 * (7 - 4)	An expression whose operands are numeric literals.
COUNT (DISTINCT city)	Function applied to the values in a column.

5.10. Identifiers

SQL identifiers are names used to identify tables, views, columns, and other SQL entities. The two types of identifiers are regular and delimited. A delimited identifier is enclosed in double quotes ("). Case-insensitive delimited identifiers are used only for user names and role names. Either regular, delimited, or case-sensitive delimited identifiers can contain up to 128 characters.

5.10.1. Regular Identifiers

Regular identifiers begin with a letter (A through Z and a through z), but can also contain digits (0 through 9) or underscore characters (_). Regular identifiers are not case-sensitive. You cannot use a reserved word as a regular identifier.

5.10.2. Delimited Identifiers

Delimited identifiers are character strings that appear within double quote characters ("") and consist of alphanumeric characters, including the underscore character (_) or a dash (-). Unlike regular identifiers, delimited identifiers are case-sensitive. Trafodion SQL does not support spaces or special characters in delimited identifiers given the constraints of the underlying HBase file system. You can use reserved words as delimited identifiers.

5.10.3. Case-Insensitive Delimited Identifiers

Case-insensitive delimited identifiers, which are used for user names and roles, are character strings that appear within double quote characters ("") and consist of alphanumeric characters (A through Z and a through z), digits (0 through 9), underscores (_), dashes (-), periods (.), at symbols (@), and forward slashes (/), except for the leading at sign (@) or leading forward slash (/) character.

Unlike other delimited identifiers, case-insensitive-delimited identifiers are case-insensitive. Identifiers are up-shifted before being inserted into the SQL metadata. Thus, whether you specify a user's name as

"Penelope.Quan@company.com", "PENELOPE.QUAN@company.com", or "penelope.quan@company.com", the value stored in the metadata will be the same: PENELOPE.QUAN@COMPANY.COM.

You can use reserved words as case-insensitive delimited identifiers.

5.10.4. Examples of Identifiers

- These are regular identifiers:

```
mytable SALES2006  
Employee_Benefits_Selections  
CUSTOMER_BILLING_INFORMATION
```

Because regular identifiers are case insensitive, SQL treats all these identifiers as alternative representations of mytable:

```
mytable      MYTABLE      MyTable      mYtAbLe
```

- These are delimited identifiers:

```
"mytable"  
"table"  
"CUSTOMER-BILLING-INFORMATION"
```

Because delimited identifiers are case-sensitive, SQL treats the identifier "mytable" as different from the identifiers "MYTABLE" or "MyTable".

You can use reserved words as delimited identifiers. For example, table is not allowed as a regular identifier, but "table" is allowed as a delimited identifier.

5.11. Identity Column

A identity column is an auto-increment column, which is defined to a column of a table with identity attribute and used to automatically generate increasing or decreasing sequential numeric value for a column with each row insertion into the table.

Identity column, unlike a sequence which works independently of table column, is bound to a table column and can be accessed only by the table column. For more information, see [CREATE SEQUENCE Statement](#).

```
GENERATED [ALWAYS | BY DEFAULT] AS IDENTITY  
[START WITH integer]  
[INCREMENT BY integer]  
[MAXVALUE integer | NOMAXVALUE]  
[MINVALUE integer]  
[CYCLE | NO CYCLE]  
[CACHE integer | NO CACHE]  
[DATA TYPE]
```

5.11.1. Syntax Description of Identity Column

- **ALWAYS**

Indicates that when a row is inserted to a table, a value will always be generated for the column.

- **BY DEFAULT**

Indicates that when a row is inserted to a table, if the value of the column is not specified, then a default value will be assigned for the column. The value can be unique if you place a unique index on the column.

The options above serve the same purposes as they serve when you create a sequence. For more information, see [CREATE SEQUENCE Statement](#).

5.11.2. Examples of Identity Column

- Example of **ALWAYS**

```

CREATE TABLE identity_employee (
    id LARGEINT GENERATED ALWAYS AS IDENTITY,
    description VARCHAR(40)
);

SQL>INSERT INTO identity_employee (description) VALUES ('Just DESCRIPTION');

--- 1 row(s) inserted.

SQL>INSERT INTO identity_employee (id, description) VALUES(NULL, 'ID=NULL and
DESCRIPTION');

*** ERROR[4122] NULL cannot be assigned to NOT NULL column
TRAFODION.SEBASE.IDENTITY_EMPLOYEE.ID.

SQL>INSERT INTO identity_employee (id, description) VALUES(999, 'ID=999 and
DESCRIPTION');

*** ERROR[3428] IDENTITY column ID defined as GENERATED ALWAYS cannot accept values
specified by the user.

```

- Example of BY DEFAULT

```

CREATE TABLE identity_employee (
    id LARGEINT GENERATED BY DEFAULT AS IDENTITY,
    description VARCHAR(40)
);

SQL>INSERT INTO identity_employee (description) VALUES ('Just DESCRIPTION');

--- 1 row(s) inserted.

SQL>INSERT INTO identity_employee (id, description) VALUES(NULL, 'ID=NULL and
DESCRIPTION');

*** ERROR[4122] NULL cannot be assigned to NOT NULL column
TRAFODION.SEBASE.IDENTITY_EMPLOYEE.ID.

SQL>INSERT INTO identity_employee (id, description) VALUES(999, 'ID=999 and
DESCRIPTION');

--- 1 row(s) inserted.

```

5.12. Indexes

An index is an ordered set of pointers to rows of a table. Each index is based on the values in one or more columns.

Indexes are transparent to DML syntax.

A one-to-one correspondence always exists between index rows and base table rows.

5.12.1. SQL Indexes

Each row in a Trafodion SQL index contains:

- The columns specified in the CREATE INDEX statement
- The clustering key of the underlying table (the user-defined clustering key)

An index name is an SQL identifier. Indexes have their own name space within a schema, so an index name might be the same as a table or constraint name. However, no two indexes in a schema can have the same name.

See [CREATE INDEX Statement](#).

5.13. Keys

5.13.1. Clustering Keys

Every table has a clustering key, which is the set of columns that determine the order of the rows on disk. Trafodion SQL organizes records of a table or index by using a b-tree based on this clustering key. Therefore, the values of the clustering key act as logical row-ids.

5.13.2. SYSKEY

When the STORE BY clause is specified with the *key-column-list* clause, an additional column is appended to the *key-column-list* called the SYSKEY.

A SYSKEY (or system-defined clustering key) is a clustering key column which is defined by Trafodion SQL rather than by the user. Its type is LARGEINT SIGNED. When you insert a record in a table, Trafodion SQL automatically generates a value for the SYSKEY column. You cannot supply the value.

You cannot specify a SYSKEY at insert time and you cannot update it after it has been generated. To see the value of the generated SYSKEY, include the SYSKEY column in the select list:

```
SELECT * , SYSKEY FROM t4;
```

5.13.3. Index Keys

A one-to-one correspondence always exists between index rows and base table rows. Each row in a Trafodion SQL index contains:

- The columns specified in the CREATE INDEX statement
- The clustering (primary) key of the underlying table (the user-defined clustering key)

For a non-unique index, the clustering key of the index is composed of both items. The clustering key cannot exceed 2048 bytes. Because the clustering key includes all the columns in the table, each row is also limited to 2048 bytes.

For varying-length character columns, the length referred to in these byte limits is the defined column length, not the stored length. (The stored length is the expanded length, which includes two extra bytes for storing the data length of the item.)

See [CREATE INDEX Statement](#).

5.13.4. Primary Keys

A primary key is the column or set of columns that define the uniqueness constraint for a table. The columns cannot contain nulls, and only one primary key constraint can exist on a table.

5.14. Literals

A literal is a constant you can use in an expression, in a statement, or as a parameter value. An SQL literal can be one of these data types:

Character String Literals	A series of characters enclosed in single quotes.
Datetime Literals	Example: 'Planning' Begins with keyword DATE, TIME, or TIMESTAMP and followed by a character string.
Interval Literals	Example: DATE '1990-01-22' Begins with keyword INTERVAL and followed by a character string and an interval qualifier.
Numeric Literals	Example: INTERVAL '2-7' YEAR TO MONTH A simple numeric literal (one without an exponent) or a numeric literal in scientific notation. Example: 99E-2

5.14.1. Character String Literals

A character string literal is a series of characters enclosed in single quotes.

You can specify either a string of characters or a set of hexadecimal code values representing the characters in the string.

- `'string' | [character-set | N] X'hex-code-value. . . ' | [character-set | N] X'hex-code-value[hex-code-value. . .][space. . .]' _ character-set_`

specifies the character set ISO88591 or UTF8. The *character-set* specification of the string literal should correspond with the character set of the column definition, which is either ISO88591 or UTF8. If you omit the *_character-set* specification, Trafodion SQL initially assumes the ISO88591 character set if the string literal consists entirely of 7-bit ASCII characters and UTF8 otherwise. (However, the initial assumption will later be changed if the string literal is used in a context that requires a character set different from the initial assumption.)

- `N`

associates the string literal with the character set of the NATIONAL CHARACTER (NCHAR) data type. The character set for NCHAR is determined during the installation of Trafodion SQL. This value can be either UTF8 (the default) or ISO88591.

- `'string'`

is a series of any input characters enclosed in single quotes. A single quote within a string is represented by two single quotes (""). A string can have a length of zero if you specify two single quotes ("") without a space in between.

- `X`

indicates the hexadecimal string.

- `'hex-code-value'`

represents the code value of a character in hexadecimal form enclosed in single quotes. It must contain an even number of hexadecimal digits. For ISO88591, each value must be two digits long. For UTF8, each value can be 2, 4, 6, or 8 hexadecimal digits long. If `hex-code-value` is improperly formatted (for example, it contains an invalid hexadecimal digit or an odd number of hexadecimal digits), an error is returned.

- `space`

is space sequences that can be added before or after `hex-code-value` for readability. The encoding for `space` must be the TERMINAL_CHARSET for an interactive interface and the SQL module character set for the programmatic interface.

Considerations for Character String Literals

Using String Literals

A string literal can be as long as a character column. See [Character String Data Types](#).

You can also use string literals in string value expressions—for example, in expressions that use the concatenation operator (||) or in expressions that use functions returning string values.

When specifying string literals:

- Do not put a space between the character set qualifier and the character string literal. If you use this character string literal in a statement, Trafodion SQL returns an error.
- To specify a single quotation mark within a string literal, use two consecutive single quotation marks.
- To specify a string literal whose length is more than one line, separate the literal into several smaller string literals, and use the concatenation operator (||) to concatenate them.
- Case is significant in string literals. Lowercase letters are not equivalent to the corresponding uppercase letters.

- Leading and trailing spaces within a string literal are significant.
- Alternately, a string whose length is more than one line can be written as a literal followed by a space, CR, or tab character, followed by another string literal.

Examples of Character String Literals

- These data type column specifications are shown with examples of literals that can be stored in the columns.

Character String Data Type	Character String Literal Example
CHAR (12) UPSHIFT	'PLANNING'
VARCHAR (18)	'NEW YORK'

- These are string literals:

```
'This is a string literal.'
'abc^&*'
'1234.56'
'This literal contains '' a single quotation mark.'
```

- This is a string literal concatenated over three lines:

```
'This literal is' ||
in three parts,' ||
specified over three lines.'
```

- This is a hexadecimal string literal representing the VARCHAR pattern of the ISO88591 string 'Strauß':

```
_ISO88591 X'53 74 72 61 75 DF'
```

5.14.2. Datetime Literals

A datetime literal is a DATE, TIME, or TIMESTAMP constant you can use in an expression, in a statement, or as a parameter value. Datetime literals have the same range of valid values as the corresponding datetime data types. You cannot use leading or trailing spaces within a datetime string (within the single quotes).

A datetime literal begins with the DATE, TIME, or TIMESTAMP keyword and can appear in default, USA, or European format.

```
DATE 'date' | TIME 'time' | TIMESTAMP 'timestamp'

date is:
  yyyy-mm-dd                               Default
  | mm/dd/yyyy                                USA
  | dd.mm.yyyy                                European

time is:
  hh:mm:ss.msssss                           Default
  | hh:mm:ss.msssss [am | pm]                 USA
  | hh.mm.ss.msssss                            European

timestamp is:
  yyyy-mm-dd hh:mm:ss.msssss                Default
  | mm/dd/yyyy hh:mm:ss.msssss [am | pm]      USA
  | dd.mm.yyyy hh.mm.ss.msssss                European
```

- *date, time, timestamp*

specify the datetime literal strings whose component fields are:

yyyy	Year, from 0001 to 9999
mm	Month, from 01 to 12
dd	Day, from 01 to 31
hh	Hour, from 00 to 23
mm	Minute, from 00 to 59
ss	Second, from 00 to 59
msssss	Microsecond, from 000000 to 999999
am	AM or am, indicating time from midnight to before noon
pm	PM or pm, indicating time from noon to before midnight

Examples of Datetime Literals

- These are DATE literals in default, USA, and European formats, respectively:

```
DATE '2008-01-22' DATE '01/22/2008' DATE '22.01.2008'
```

- These are TIME literals in default, USA, and European formats, respectively:

```
TIME '13:40:05'  
TIME '01:40:05 PM'  
TIME '13.40.05'
```

- These are TIMESTAMP literals in default, USA, and European formats, respectively:

```
TIMESTAMP '2008-01-22 13:40:05'  
TIMESTAMP '01/22/2008 01:40:05 PM'  
TIMESTAMP '22.01.2008 13.40.05'
```

5.14.3. Interval Literals

An interval literal is a constant of data type INTERVAL that represents a positive or negative duration of time as a year-month or day-time interval; it begins with the keyword INTERVAL optionally preceded or followed by a minus sign (for negative duration). You cannot include leading or trailing spaces within an interval string (within single quotes).

```

[-]INTERVAL [-]{'year-month' | 'day:time'} interval-qualifier

year-month is:
  years [-months] | months

day:time is:
  days [[:]hours [:minutes [:seconds [.fraction]]]]
| hours [:minutes [:seconds [.fraction]]]
| minutes [:seconds [.fraction]]
| seconds [.fraction]

interval-qualifier is:
  start-field TO end-field | single-field

start-field is:
  {YEAR | MONTH | DAY | HOUR | MINUTE} [(leading-precision)]

end-field is:
  YEAR | MONTH | DAY | HOUR | MINUTE | SECOND [(fractional-precision)]

single-field is:
  start-field | SECOND [(leading-precision,fractional-precision)]

```

- *start-field* TO *end-field*

must be year-month or day-time. The *start-field* you specify must precede the *end-field* you specify in the list of field names.

- {YEAR | MONTH | DAY | HOUR | MINUTE} [(*leading-precision*)]

specifies the *start-field*. A *start-field* can have a *leading-precision* up to 18 digits (the maximum depends on the number of fields in the interval). The *leading-precision* is the number of digits allowed in the *start-field*. The default for *leading-precision* is 2.

- YEAR | MONTH | DAY | HOUR | MINUTE | SECOND [(*fractional-precision*)]

specifies the *end-field*. If the *end-field* is SECOND, it can have a *fractional-precision* up to 6 digits. The *fractional-precision* is the number of digits of precision after the decimal point. The default for *fractional-precision* is 6.

- *start-field* | SECOND [(*leading-precision*, *fractional-precision*)]

specifies the *single-field*. If the *single-field* is SECOND, the *leading-precision* is the number of digits of precision before the decimal point, and the *fractional-precision* is the number of digits of precision after the decimal point.

The default for *leading-precision* is 2, and the default for *fractional-precision* is 1. The maximum for *leading-precision* is 18, and the maximum for *fractional-precision* is 6.

See [Interval Data Types](#) and [Interval Value Expressions](#).

- 'year-month' | 'day:time'

specifies the date and time components of an interval literal. The day and hour fields can be separated by a space or a colon. The interval literal strings are:

years	Unsigned integer that specifies a number of years. <i>years</i> can be up to 18 digits, or 16 digits if <i>months</i> is the end-field. The maximum for the <i>leading-precision</i> is specified within the interval qualifier by either YEAR(18) or YEAR(16) TO MONTH.
months	Unsigned integer that specifies a number of months. Used as a starting field, <i>months</i> can have up to 18 digits. The maximum for the <i>leading-precision</i> is specified by MONTH(18). Used as an ending field, the value of <i>months</i> must be in the range 0 to 1 .
days	Unsigned integer that specifies number of days. <i>days</i> can have up to 18 digits if no end-field exists; 16 digits if <i>hours</i> is the end-field; 14 digits if <i>minutes</i> is the end-field; and 13-f digits if <i>seconds</i> is the end-field, where f is the <i>fraction</i> less than or equal to 6. These maximums are specified by DAY(18), DAY(16) TO HOUR, DAY(14) TO MINUTE, and DAY(13-f) TO SECOND(f).
hours	Unsigned integer that specifies a number of hours. Used as a starting field, <i>hours</i> can have up to 18 digits if no end-field exists; 16 digits if <i>minutes</i> is the end-field; and 14-f digits if <i>seconds</i> is the end-field, where f is the <i>fraction</i> less than or equal to 6. These maximums are specified by HOUR(18), HOUR(16) TO MINUTE, and HOUR(14-f) TO SECOND(f). Used as an ending field, the value of <i>hours</i> must be in the range 0 to 23.
minutes	Unsigned integer that specifies a number of minutes. Used as a starting field, <i>minutes</i> can have up to 18 digits if no end-field exists; and 16-f digits if <i>seconds</i> is the end-field, where f is the <i>fraction</i> less than or equal to 6. These maximums are specified by MINUTE(18), and MINUTE(16-f) TO SECOND(f). Used as an ending field, the value of <i>minutes</i> must be in the range 0 to 59.
seconds	Unsigned integer that specifies a number of seconds. Used as a starting field, <i>seconds</i> can have up to 18 digits, minus the number of digits f in the <i>fraction</i> less than or equal to 6. This maximum is specified by SECOND(18-f, f). The value of <i>seconds</i> must be in the range 0 to 59.9(n), where n is the number of digits specified for seconds precision.
fraction	Unsigned integer that specifies a fraction of a second. When <i>seconds</i> is used as an ending field, <i>fraction</i> is limited to the number of digits specified by the <i>fractional-precision</i> field following the SECOND keyword.

Considerations for Interval Literals

Length of Year-Month and Day-Time Strings

An interval literal can contain a maximum of 18 digits, in the string following the INTERVAL keyword, plus a hyphen (-) that separates the year-month fields, and colons (:) that separate the day-time fields. You can also separate day and hour with a space.

Examples of Interval Literals

INTERVAL '1' MONTH	Interval of 1 month
INTERVAL '7' DAY	Interval of 7 days
INTERVAL '2-7' YEAR TO MONTH	Interval of 2 years, 7 months
INTERVAL '5:2:15:36.33' DAY TO SECOND(2)	Interval of 5 days, 2 hours, 15 minutes, and 36.33 seconds
INTERVAL - '5' DAY	Interval that subtracts 5 days
INTERVAL '100' DAY(3)	Interval of 100 days. This example requires an explicit leading precision of 3 because the default is 2.
INTERVAL '364 23' DAY(3) TO HOUR	Interval of 364 days, 23 hours. The separator for the day and hour fields can be a space or a colon.

5.14.4. Numeric Literals

A numeric literal represents a numeric value. Numeric literals can be represented as an exact numeric literal (without an exponent) or as an approximate numeric literal by using scientific notation (with an exponent).

```

exact-numeric-literal is:
  [+|-]unsigned-integer[.[unsigned-integer]]
  | [+|-.]unsigned-integer

approximate-numeric-literal is:
  mantissa{E|e}exponent

mantissa is:
  exact-numeric-literal

exponent is:
  [+|-]unsigned-integer

unsigned-integer is:
  digit. . .

```

- *exact-numeric-literal*

is an exact numeric value that includes an optional plus sign (+) or minus sign (-), up to 128 digits (0 through 9), and an optional period (.) that indicates a decimal point. Leading zeros do not count toward the 128-digit limit; trailing zeros do.

A numeric literal without a sign is a positive number. An exact numeric literal that does not include a decimal point is an integer. Every exact numeric literal has the data type NUMERIC and the minimum precision required to represent its value.

- *approximate-numeric-literal*

is an exact numeric literal followed by an exponent expressed as an uppercase E or lowercase e followed by an optionally signed integer.

Numeric values expressed in scientific notation are treated as data type REAL if they include no more than seven digits before the exponent, but treated as type DOUBLE PRECISION if they include eight or more digits. Because of this factor, trailing zeros after a decimal can sometimes increase the precision of a numeric literal used as a DOUBLE PRECISION value.

+For example, if XYZ is a table that consists of one DOUBLE PRECISION column, the inserted value:

```
INSERT INTO XYZ VALUES (1.0000000E-10)
```

has more precision than:

```
INSERT INTO XYZ VALUES (1.0E-10)
```

Examples of Numeric Literals

These are all numeric literals, along with their display format:

Literal	Display Format
477	477
580.45	580.45
+005	5
-.3175	-.3175
1300000000	1300000000
99.	99
-0.123456789012345678	-.123456789012345678
99E-2	9.9000000E-001
12.3e+5	1.2299999E+006

5.15. Null

Null is a special symbol, independent of data type, that represents an unknown. The Trafodion SQL keyword NULL represents null. Null indicates that an item has no value. For sorting purposes, null is greater than all other values. You cannot store null in a column by using INSERT or UPDATE, unless the column allows null.

A column that allows null can be null at any row position. A nullable column has extra bytes associated with it in each row. A special value stored in these bytes indicates that the column has null for that row.

5.15.1. Using Null Versus Default Values

Various scenarios exist in which a row in a table might contain no value for a specific column. For example:

- A database of telemarketing contacts might have null AGE fields if contacts did not provide their age.
- An order record might have a DATE_SHIPPED column empty until the order is actually shipped.
- An employee record for an international employee might not have a social security number.

You allow null in a column when you want to convey that a value in the column is unknown (such as the age of a telemarketing contact) or not applicable (such as the social security number of an international employee).

In deciding whether to allow nulls or use defaults, also note:

- Nulls are not the same as blanks. Two blanks can be compared and found equal, while the result of a comparison of two nulls is indeterminate.
- Nulls are not the same as zeros. Zeros can participate in arithmetic operations, while nulls are excluded from any arithmetic operation.

5.15.2. Defining Columns That Allow or Prohibit Null

The CREATE TABLE and ALTER TABLE statements define the attributes for columns within tables. A column allows nulls unless the column definition includes the NOT NULL clause or the column is part of the primary key of the table.

Null is the default for a column (other than NOT NULL) unless the column definition includes a DEFAULT clause (other than DEFAULT NULL) or the NO DEFAULT clause. The default value for a column is the value Trafodion SQL inserts in a row when an INSERT statement omits a value for a particular column.

Null in DISTINCT, GROUP BY, and ORDER BY Clauses

In evaluating the DISTINCT, GROUP BY, and ORDER BY clauses, Trafodion SQL considers all nulls to be equal.

Additional considerations for these clauses are:

DISTINCT	Nulls are considered duplicates; therefore, a result has at most one null.
GROUP BY	The result has at most one null group.
ORDER BY	Nulls are considered greater than non-null values.

Null and Expression Evaluation Comparison

Expression Type	Condition	Result
Boolean operators (AND, OR, NOT)	Either operand is null.	For AND, the result is null. For OR, the result is true if the other operand is true, or null if the other operand is null or false. For NOT, the result is null.
Arithmetic operators	Either or both operands are null.	The result is null.
NULL predicate	The operand is null.	The result is true.
Aggregate (or set) functions (except COUNT)	Some rows have null columns. The function is evaluated after eliminating nulls.	The result is null if set is empty.
COUNT(*)	The function does not eliminate nulls.	The result is the number of rows in the table whether or not the rows are null.
COUNT COUNT DISTINCT	The function is evaluated after eliminating nulls.	The result is zero if set is empty.
Comparison: =, <>, <, >, <=, >=, LIKE	Either operand is null.	The result is null.
IN predicate	Some expressions in the IN value list are null.	The result is null if all of the expressions are null.
Subquery	No rows are returned.	The result is null.

5.16. Predicates

A predicate determines an answer to a question about a value or group of values. A predicate returns true, false, or, if the question cannot be answered, unknown. Use predicates within search conditions to choose rows from tables or views.

BETWEEN Predicate	Determines whether a sequence of values is within a range of sequences of values.
Comparison Predicates (=, <>, <, >, <=, >=)	Compares the values of sequences of expressions, or compares the values of sequences of row values that are the result of row subqueries.
EXISTS Predicate	Determines whether any rows are selected by a subquery. If the subquery finds at least one row that satisfies its search condition, the predicate evaluates to true. Otherwise, if the result table of the subquery is empty, the predicate is false.
IN Predicate	Determines if a sequence of values is equal to any of the sequences of values in a list of sequences.
LIKE Predicate	Searches for character strings that match a pattern.
REGEXP Predicate	Searches for character strings that match an extended regular expression.
NULL Predicate	Determines whether all the values in a sequence of values are null.
Quantified Comparison Predicates (ALL, ANY, SOME)	Compares the values of sequences of expressions to the values in each row selected by a table subquery. The comparison is quantified by ALL, ANY, or .

See the individual entry for a predicate or predicate group.

5.16.1. BETWEEN Predicate

The BETWEEN predicate determines whether a sequence of values is within a range of sequences of values.

```
row-value-constructor [NOT] BETWEEN
    row-value-constructor AND row-value-constructor

row-value-constructor is:
    (expression [,expression ]...)
    | row-subquery
```

- *row-value-constructor*

specifies an operand of the BETWEEN predicate. The three operands can be either of:

- (*expression* [,*expression*]...)

is a sequence of SQL value expressions, separated by commas and enclosed in parentheses. *expression* cannot include an aggregate function unless *expression* is in a HAVING clause. *expression* can be a scalar subquery (a subquery that returns a single row consisting of a single column). See [Expressions](#).

- *row-subquery*

is a subquery that returns a single row (consisting of a sequence of values). See [Subquery](#).

The three *row-value-constructors* specified in a BETWEEN predicate must contain the same number of elements. That is, the number of value expressions in each list, or the number of values returned by a row subquery, must be the same.

The data types of the respective values of the three *row-value-constructors* must be comparable. Respective values are values with the same ordinal position in the two lists. See [Comparable and Compatible Data Types](#).

Considerations for BETWEEN

Logical Equivalents Using AND and OR

The predicate *expr1* BETWEEN *expr2* AND *expr3* is true if and only if this condition is true:

```
expr2 <= expr1 AND expr1 <= expr3
```

The predicate *expr1* NOT BETWEEN *expr2* AND *expr3* is true if and only if this condition is true:

```
expr2 > expr1 OR expr1 > expr3
```

Descending Columns in Keys

If a clause specifies a column in a key BETWEEN *expr2* and *expr3*, *expr3* must be greater than *expr2* even if the column is specified as DESCENDING within its table definition.

Examples of BETWEEN

- This predicate is true if the total price of the units in inventory is in the range from \$1,000 to \$10,000:

```
qty_on_hand * price
BETWEEN 1000.00 AND 10000.00
```

- This predicate is true if the part cost is less than \$5 or more than \$800:

```
partcost NOT BETWEEN 5.00 AND 800.00
```

- This BETWEEN predicate selects the part number 6400:

```
SELECT * FROM partsupp
WHERE partnum BETWEEN 6400 AND 6700
    AND partcost > 300.00;

Part/Num Supp/Num Part/Cost      Qty/Rec
----- ----- -----
 6400        1     390.00       50
 6401        2     500.00       20
 6401        3     480.00       38

--- 3 row(s) selected.
```

- Find names between Jody Selby and Gene Wright:

```
(last_name, first_name) BETWEEN
  ('SELBY', 'JODY') AND ('WRIGHT', 'GENE')
```

The name Barbara Swift would meet the criteria; the name Mike Wright would not.

```
SELECT empnum, first_name, last_name
FROM persnl.employee
WHERE (last_name, first_name) BETWEEN
  ('SELBY', 'JODY') AND ('WRIGHT', 'GENE');

EMPNUM FIRST_NAME      LAST_NAME
----- -----
 43      PAUL          WINTER
 72      GLENN          THOMAS
 74      JOHN          WALKER
...
--- 15 row(s) selected.
```

5.16.2. Comparison Predicates

A comparison predicate compares the values of sequences of expressions, or the values of sequences of row values that are the result of row subqueries.

```
row-value-constructor comparison-op row-value-constructor
```

- *comparison-op* is:

=	Equal
<>	Not equal
<	Less than
>	Greater than
<=	Less than or equal to
>=	Greater than or equal to

- *row-value-constructor* is:

```
(expression [,expression]...)
| row-subquery
```

- *row-value-constructor*

specifies an operand of a comparison predicate. The two operands can be either of these:

- *(expression [,expression]...)*

is a sequence of SQL value expressions, separated by commas and enclosed in parentheses.

expression cannot include an aggregate function unless *expression* is in a HAVING clause. *expression* can be a scalar subquery (a subquery that returns a single row consisting of a single column). See [Expressions](#).

- *row-subquery*

is a subquery that returns a single row (consisting of a sequence of values). See [Subquery](#).

- The two *row-value-constructors* must contain the same number of elements. That is, the number of value expressions in each list, or the number of values returned by a row subquery, must be the same.

The data types of the respective values of the two *row-value-constructors* must be comparable. (Respective values are values with the same ordinal position in the two lists.) See [Comparable and Compatible Data Types](#).

Considerations for Comparison Predicates

When a Comparison Predicate Is True

Trafodion SQL determines whether a relationship is true or false by comparing values in corresponding positions in sequence, until it finds the first non-equal pair.

You cannot use a comparison predicate in a WHERE or HAVING clause to compare row value constructors when the value expressions in one row value constructor are equal to null. Use the IS NULL predicate instead.

Suppose that two rows with multiple components exist, X and Y:

```
X=(X1,X2,...,Xn), Y=(Y1,Y2,...,Yn).
```

Predicate $X=Y$ is true if for all $i=1,\dots,n$: $X_i=Y_i$. For this predicate, Trafodion SQL must look through all values. Predicate $X \neq Y$ is false if for some i $X_i \neq Y_i$. When SQL finds non-equal components, it stops and does not look at remaining components.

Predicate $X \neq Y$ is true if $X=Y$ is false. If $X_1 \neq Y_1$, Trafodion SQL does not look at all components. It stops and returns a value of false for the $X=Y$ predicate and a value of true for the $X \neq Y$ predicate. Predicate $X \neq Y$ is false if $X=Y$ is true, or for all $i=1,\dots,n$: $X_i=Y_i$. In this situation, Trafodion SQL must look through all components.

Predicate $X > Y$ is true if for some index m $X_m > Y_m$ and for all $i=1,\dots,m-1$: $X_i=Y_i$. Trafodion SQL does not look through all components. It stops when it finds the first nonequal components, $X_m \neq Y_m$. If $X_m > Y_m$, the predicate is true. Otherwise the predicate is false. The predicate is also false if all components are equal, or $X=Y$.

Predicate $X \geq Y$ is true if $X > Y$ is true or $X=Y$ is true. In this scenario, Trafodion SQL might look through all components and return true if they are all equal. It stops at the first nonequal components, $X_m \neq Y_m$. If $X_m > Y_m$, the predicate is true. Otherwise, it is false.

Predicate $X < Y$ is true if for some index m $X_m < Y_m$, and for all $i=1,\dots,m-1$: $X_i=Y_i$. Trafodion SQL does not look through all components. It stops when it finds the first nonequal components $X_m \neq Y_m$. If $X_m < Y_m$, the predicate is true. Otherwise, the predicate is false. The predicate is also false if all components are equal, or $X=Y$.

Predicate $X \leq Y$ is true if $X < Y$ is true or $X=Y$ is true. In this scenario, Trafodion SQL might need to look through all components and return true if they are all equal. It stops at the first non-equal components, $X_m \neq Y_m$. If $X_m < Y_m$, the predicate is true. Otherwise, it is false.

Comparing Character Data

For comparisons between character strings of different lengths, the shorter string is padded on the right with spaces (HEX 20) until it is the length of the longer string. Both fixed-length and variable-length strings are padded in this way.

For example, Trafodion SQL considers the string 'JOE' equal to a value JOE stored in a column of data type CHAR or VARCHAR of width three or more. Similarly, Trafodion SQL considers a value JOE stored in any column of the CHAR data type equal to the value JOE stored in any column of the VARCHAR data type.

Two strings are equal if all characters in the same ordinal position are equal. Lowercase and uppercase letters are not considered equivalent.

Comparing Numeric Data

Before evaluation, all numeric values in an expression are first converted to the maximum precision needed anywhere in the expression.

Comparing Interval Data

For comparisons of INTERVAL values, Trafodion SQL first converts the intervals to a common unit.

If no common unit exists, Trafodion SQL reports an error. Two INTERVAL values must be both year-month intervals or both day-time intervals.

Comparing Multiple Values

Use multi-value predicates whenever possible; they are generally more efficient than equivalent conditions without multi-value predicates.

Examples of Comparison Predicates

- This predicate is true if the customer number is equal to 3210:

```
custnum = 3210
```

- This predicate is true if the salary is greater than the average salary of all employees:

```
salary > (SELECT AVG (salary) FROM persnl.employee);
```

- This predicate is true if the customer name is BACIGALUPI:

```
custname = 'BACIGALUPI'
```

- This predicate evaluates to unknown for any rows in either CUSTOMER or ORDERS that contain null in the CUSTNUM column:

```
customer.custnum > orders.custnum
```

- This predicate returns information about anyone whose name follows MOSS, DUNCAN in a list arranged alphabetically by last name and, for the same last name, alphabetically by first name:

```
(last_name, first_name) > ('MOSS', 'DUNCAN')
```

REEVES, ANNE meets this criteria, but MOSS, ANNE does not.

This multi-value predicate is equivalent to this condition with three comparison predicates:

```
(last_name > 'MOSS') OR  
(last_name = 'MOSS' AND first_name > 'DUNCAN')
```

- Compare two datetime values START_DATE and the result of the CURRENT_DATE function:

```
START_DATE < CURRENT_DATE
```

- Compare two datetime values START_DATE and SHIP_TIMESTAMP:

```
CAST (start_date AS TIMESTAMP) < ship_timestamp
```

- Compare two INTERVAL values:

```
JOB1_TIME < JOB2_TIME
```

Suppose that JOB1_TIME, defined as INTERVAL DAY TO MINUTE, is 2 days 3 hours, and JOB2_TIME, defined as INTERVAL DAY TO HOUR, is 3 days.

To evaluate the predicate, Trafodion SQL converts the two INTERVAL values to MINUTE. The comparison predicate is true.

- The next examples contain a subquery in a comparison predicate. Each subquery operates on a separate logical copy of the EMPLOYEE table.

The processing sequence is outer to inner. A row selected by an outer query allows an inner query to be evaluated, and a single value is returned. The next inner query is evaluated when it receives a value from its outer query.

Find all employees whose salary is greater than the maximum salary of employees in department 1500:

```
SELECT
    first_name, last_name, deptnum, salary
FROM persnl.employee
WHERE salary >
    (SELECT MAX (salary) FROM persnl.employee WHERE deptnum = 1500);

FIRST_NAME      LAST_NAME          DEPTNUM   SALARY
-----  -----
ROGER           GREEN              9000     175500.00
KATHRYN         HALL               4000     96000.00
RACHEL          MCKAY              4000     118000.00
THOMAS          RUDLOFF            2000     138000.40
JANE            RAYMOND             3000     136000.00
JERRY           HOWARD              1000     137000.10

--- 6 row(s) selected.
```

Find all employees from other departments whose salary is less than the minimum salary of employees (not in department 1500) that have a salary greater than the average salary for department 1500:

```
SELECT first_name, last_name, deptnum, salary
FROM persnl.employee
WHERE deptnum <> 1500
AND salary < (SELECT MIN (salary)
    FROM persnl.employee WHERE deptnum <> 1500
    AND salary > (SELECT AVG (salary) FROM persnl.employee WHERE deptnum = 1500));

FIRST_NAME      LAST_NAME          DEPTNUM   SALARY
-----  -----
JESSICA         CRINER             3500     39500.00
ALAN            TERRY              3000     39500.00
DINAH           CLARK              9000     37000.00
BILL            WINN               2000     32000.00
MIRIAM          KING               2500     18000.00
...
--- 35 row(s) selected.
```

The first subquery of this query determines the minimum salary of employees from other departments whose salary is greater than the average salary for department 1500. The main query then finds the names of employees who are not in department 1500 and whose salary is less than the minimum salary determined by the first subquery.

5.16.3. EXISTS Predicate

The EXISTS predicate determines whether any rows are selected by a subquery. If the subquery finds at least one row that satisfies its search condition, the predicate evaluates to true. Otherwise, if the result table of the subquery is empty, the predicate is false.

[NOT] EXISTS subquery

- *subquery*

specifies the operand of the predicate. A *subquery* is a query expression enclosed in parentheses. An EXISTS subquery is typically correlated with an outer query. See [Subquery](#).

Examples of EXISTS

- Find locations of employees with job code 300:

```
SELECT deptnum, location FROM persnl.dept D WHERE EXISTS
  (SELECT jobcode FROM persnl.employee E
   WHERE D.deptnum = E.deptnum AND jobcode = 300);

DEPTNUM LOCATION
----- -----
 3000 NEW YORK
 3100 TORONTO
 3200 FRANKFURT
 3300 LONDON
 3500 HONG KONG

--- 5 row(s) selected.
```

In the preceding example, the EXISTS predicate contains a subquery that determines which locations have employees with job code 300. The subquery depends on the value of D.DEPTNUM from the outer query and must be evaluated for each row of the result table where D.DEPTNUM equals E.DEPTNUM. The column D.DEPTNUM is an example of an outer reference.

- Search for departments that have no employees with job code 420:

```
SELECT deptname FROM persnl.dept D WHERE NOT EXISTS
  (SELECT jobcode FROM persnl.employee E
   WHERE D.deptnum = E.deptnum AND jobcode = 420);

DEPTNAME
-----
FINANCE
PERSONNEL
INVENTORY

...
--- 11 row(s) selected.
```

- Search for parts with less than 20 units in the inventory:

```
SELECT partnum, suppnum FROM invent.partsupp PS WHERE EXISTS
  (SELECT partnum FROM invent.partloc PL
   WHERE PS.partnum = PL.partnum AND qty_on_hand < 20);

PARTNUM SUPPNUM
----- -----
 212        1
 212        3
 2001       1
 2003       2
...
--- 18 row(s) selected.
```

5.16.4. IN Predicate

The IN predicate determines if a sequence of values is equal to any of the sequences of values in a list of sequences. The NOT operator reverses its truth value. For example, if IN is true, NOT IN is false.

```
row-value-constructor
[NOT] IN {table-subquery | in-value-list}

row-value-constructor is:
  (expression [,expression]...)
  | row-subquery
```

- *in-value-list* is:

```
(expression [,expression_]...)
```

- *row-value-constructor*

specifies the first operand of the IN predicate. The first operand can be either of:

```
(expression [,expression ]....)
```

is a sequence of SQL value expressions, separated by commas and enclosed in parentheses.

expression cannot include an aggregate function unless *expression* is in a HAVING clause. *expression* can be a scalar subquery (a subquery that returns a single row consisting of a single column). See [Expressions](#).

- *row-subquery*

is a subquery that returns a single row (consisting of a sequence of values). See [Subquery](#).

- *table-subquery*

is a subquery that returns a table (consisting of rows of columns). The table specifies rows of values to be compared with the row of values specified by the *row-value-constructor*. The number of values of the *row-value-constructor* must be equal to the number of columns in the result table of the *table-subquery*, and the data types of the values must be comparable.

- *in-value-list*

is a sequence of SQL value expressions, separated by commas and enclosed in parentheses. *expression* cannot include an aggregate function defined on a column. *expression* can be a scalar subquery (a subquery that returns a

single row consisting of a single column). In this case, the result of the *row-value-constructor* is a single value. The data types of the values must be comparable. The number of expressions in the *in-value-list* can have at least 5000 expressions.

Considerations for IN

Logical Equivalent Using ANY (or SOME)

The predicate `expr IN (expr1, expr2, ...)` is true if and only if the following predicate is true:

```
expr = ANY (expr1, expr2, ... )
```

IN Predicate Results

The IN predicate is true if and only if either of these is true:

- The result of the *row-value-constructor* (a row or sequence of values) is equal to any row of column values specified by *table-subquery*.

A table subquery is a query expression and can be specified as a form of a simple table; for example, as the VALUES keyword followed by a list of row values. See [SELECT Statement](#).

- The result of the *row-value-constructor* (a single value) is equal to any of the values specified by the list of expressions *in-value-list*.

In this case, it is helpful to think of the list of expressions as a one-column table—a special case of a table subquery. The degree of the row value constructor and the degree of the list of expressions are both one.

Comparing Character Data

Two strings are equal if all characters in the same ordinal position are equal. Lowercase and uppercase letters are not considered equivalent. For comparisons between character strings of different lengths, the shorter string is padded on the right with spaces (HEX 20) until it is the length of the longer string. Both fixed-length and varying-length strings are padded in this way.

For example, Trafodion SQL considers the string ‘JOE’ equal to a value JOE stored in a column of data type CHAR or VARCHAR of width three or more. Similarly, Trafodion SQL considers a value JOE stored in any column of the CHAR data type equal to the value JOE stored in any column of the VARCHAR data type.

Comparing Numeric Data

Before evaluation, all numeric values in an expression are first converted to the maximum precision needed anywhere in the expression.

Comparing Interval Data

For comparisons of INTERVAL values, Trafodion SQL first converts the intervals to a common unit.

If no common unit exists, Trafodion SQL reports an error. Two INTERVAL values must be both year-month intervals or both day-time intervals.

Examples of IN

- Find those employees whose EMPNUM is 39, 337, or 452:

```
SELECT last_name, first_name, empnum
FROM persnl.employee
WHERE empnum IN (39, 337, 452);

LAST_NAME          FIRST_NAME        EMPNUM
-----            -----           -----
CLARK              DINAH             337
SAFFERT            KLAUS            39

--- 2 row(s) selected.
```

- Find those items in PARTS whose part number is not in the PARTLOC table:

```
SELECT partnum, partdesc FROM sales.parts
WHERE partnum NOT IN (SELECT partnum
FROM invent.partloc);

PARTNUM PARTDESC
----- -----
186      186 MegaByte Disk

--- 1 row(s) selected.
```

- Find those items (and their suppliers) in PARTS that have a supplier in the PARTSUPP table:

```
SELECT P.partnum, P.partdesc, S.supplnum, S.supplname
FROM sales.parts P, invent.supplier S
WHERE P.partnum, S.supplnum IN
(SELECT partnum, supplnum FROM invent.partsupp);
```

- Find those employees in EMPLOYEE whose last name and job code match the list of last names and job codes:

```
SELECT empnum, last_name, first_name
FROM persnl.employee
WHERE (last_name, jobcode)
IN (VALUES ('CLARK', 500), ('GREEN', 200));
```

5.16.5. LIKE Predicate

The LIKE predicate searches for character strings that match a pattern.

Syntax

```
match-value [NOT] LIKE pattern [ESCAPE esc-char-expression]
```

- *match-value*

is a character value expression that specifies a set of strings to search for that match the *pattern*.

- *pattern*

is a character value expression that specifies the pattern string for the search.

- *esc-char-expression*

is a character value expression that must evaluate to a single character. The escape character value is used to turn off the special meaning of percent (%) and underscore (_). See [Wild-Card Characters. \[escape_characters\]](#).

See [Character Value Expressions](#).

Considerations

Comparing the Value to the Pattern

The values that you compare must be character strings. Lowercase and uppercase letters are not equivalent. To make lowercase letters match uppercase letters, use the UPSHIFT function. A blank is compared in the same way as any other character.

When a LIKE Predicate Is True

When you refer to a column, the LIKE predicate is true if the *pattern* matches the column value. If the value of the column reference is null, the LIKE predicate evaluates to unknown for that row.

If the values that you compare are both empty strings (that is, strings of zero length), the LIKE predicate is true.

Using NOT

If you specify NOT, the predicate is true if the *pattern* does not match any string in the *match-value* or is not the same length as any string in the *match-value*. For example, NAME NOT LIKE '_Z' is true if the string is not two characters long or the last character is not Z. In a search condition, the predicate NAME NOT LIKE '_Z' is equivalent to NOT (NAME LIKE '_Z').

Wild-Card Characters

You can look for similar values by specifying only part of the characters of *pattern* combined with these wild-card characters:

- Percent Sign (%)

Use a percent sign to indicate zero or more characters of any type. For example, '%ART%' matches 'SMART', 'ARTIFICIAL', and 'PARTICULAR', but not 'smart'.

- Underscore (_)

Use an underscore to indicate any single character. For example, 'BOO_' matches 'BOOK' and 'BOOT' but not 'BOO', 'BOOKLET', or 'book'.

- Escape Characters

To search for a string containing a percent sign (%) or an underscore (), *define an escape character, using ESCAPE _esc-char-expression*, to turn off the special meaning of the percent sign and underscore.

To include a percent sign or an underscore in a comparison string, type the escape character immediately preceding the percent sign or underscore. For example, to locate the value 'A_B', type:

```
NAME LIKE 'A\_B' ESCAPE '\'
```

To include the escape character itself in the comparison string, type two escape characters. For example, to locate 'A_B\C%', type:

```
NAME LIKE 'A\_B\\C\%' ESCAPE '\'
```

The escape character must precede only the percent sign, underscore, or escape character itself. For example, the pattern RA\BS is an invalid LIKE pattern if the escape character is defined to be '\'. Error 8410 will be returned if this kind of pattern is used in an SQL query.

Comparing the Pattern to CHAR Columns

Columns of data type CHAR are fixed length. When a value is inserted into a CHAR column, Trafodion SQL pads the value in the column with blanks if necessary. The value 'JOE' inserted into a CHAR(4) column becomes 'JOE ' (three characters plus one blank). The LIKE predicate is true only if the column value and the comparison value are the same length. The column value 'JOE ' does not match 'JOE' but does match 'JOE%'.

Comparing the Pattern to VARCHAR Columns

Columns of variable-length character data types do not include trailing blanks unless blanks are specified when data is entered. For example, the value 'JOE' inserted in a VARCHAR(4) column is 'JOE' with no trailing blanks. The value matches both 'JOE' and 'JOE%'.

If you cannot locate a value in a variable-length character column, it might be because trailing blanks were specified when the value was inserted into the table. For example, a value of '5MB ' (with one trailing blank) will not be located by LIKE '%MB' but will be located by LIKE '%MB%'.

Examples

- Find all employee last names beginning with ZE:

```
last_name LIKE 'ZE%'
```

- Find all part descriptions that are not 'FLOPPY_DISK':

```
partdesc NOT LIKE 'FLOPPY\_DISK' ESCAPE '\'
```

The escape character indicates that the underscore in 'FLOPPY_DISK' is part of the string to search for, not a wild-card character.

5.16.6. REGEXP Predicate

Performs a pattern match of a string expression against a pattern . The pattern can be an extended regular expression. Returns 1 if expression matches pattern; otherwise it returns 0. If either expression or pattern is NULL, the result is NULL.

Syntax

```
match-value [NOT] REGEXP regular-expression
```

- *match-value*

is a character value expression that specifies a set of strings to search for that match the *regular-expression*.

- *regular-expression*

is a character value expression that specifies a regular expression. Trafodion regular expressions follow POSIX regular expression rules.

Using NOT

If you specify NOT, the predicate is true if the *regular-expression* does not match any string in the *match-value*.

Examples

- Find valid numbers

```
col REGEXP '^[0-9]*\s*$'
```

- Find valid words, no numbers

```
col REGEXP '^[A-Za-z]+*\s*$'
```

- Find valid email address

```
col REGEXP '\w+([-.]\w+)*@\w+([-.]\w+)*\.\w+([-.]\w+)*\s*'
```

5.16.7. NULL Predicate

The NULL predicate determines whether all the expressions in a sequence are null. See [Null](#).

```
row-value-constructor IS [NOT] NULL  
  
row-value-constructor is:  
  (expression [,expression]...)  
  | row-subquery
```

- *row-value-constructor*

specifies the operand of the NULL predicate. The operand can be either of these:

```
(expression [,expression ]...)
```

is a sequence of SQL value expressions, separated by commas and enclosed in parentheses.

expression cannot include an aggregate function unless *expression* is in a HAVING clause. *expression* can be a scalar subquery (a subquery that returns a single row consisting of a single column). See [Expressions](#).

- *row-subquery*

is a subquery that returns a single row (consisting of a sequence of values). See [Subquery](#).

If all of the expressions in the *row-value-constructor* are null, the IS NULL predicate is true. Otherwise, it is false. If none of the expressions in the *row-value-constructor* are null, the IS NOT NULL predicate is true. Otherwise, it is false.

Considerations for NULL

Summary of NULL Results

Let rvc be the value of the *row-value-constructor*. This table summarizes the results of NULL predicates. The degree of a rvc is the number of values in the rvc .

Expressions	$rvc \text{ IS NULL}$	$rvc \text{ IS NOT NULL}$	$\text{NOT } rvc \text{ IS NULL}$	$\text{NOT } rvc \text{ IS NOT NULL}$
degree 1: null	TRUE	FALSE	FALSE	TRUE
degree 1: not null	FALSE	TRUE	TRUE	FALSE
degree>1: all null	TRUE	FALSE	FALSE	TRUE
degree>1: some null	FALSE	FALSE	TRUE	TRUE
degree>1: none null	FALSE	TRUE	TRUE	FALSE

The $rvc \text{ IS NOT NULL}$ predicate is not equivalent to $\text{NOT } rvc \text{ IS NULL}$.

Examples of NULL

- Find all rows with null in the SALARY column:

```
salary IS NULL
```

- This predicate evaluates to true if the expression (PRICE + TAX) evaluates to null:

```
(price + tax) IS NULL
```

- Find all rows where both FIRST_NAME and SALARY are null:

```
(first_name, salary) IS NULL
```

5.16.8. Quantified Comparison Predicates

A quantified comparison predicate compares the values of sequences of expressions to the values in each row selected by a table subquery. The comparison operation is quantified by the logical quantifiers ALL, ANY, or SOME.

```

row-value-constructor comparison-op quantifier table-subquery

row-value-constructor is:
  (expression [,expression]...)
| row-subquery

comparison-op is:
  = Equal
| <> Not equal
| != Not equal
| < Less than
| > Greater than
| <= Less than or equal to
| >= Greater than or equal to

quantifier is:
  ALL | ANY | SOME

```

- *row-value-constructor*

specifies the first operand of a quantified comparison predicate. The first operand can be either of:

- (*expression* [,*expression*]...)

is a sequence of SQL value expressions, separated by commas and enclosed in parentheses. *expression* cannot include an aggregate function unless *expression* is in a HAVING clause. *expression* can be a scalar subquery (a subquery that returns a single row consisting of a single column). See [Expressions](#).

- *row-subquery*

is a subquery that returns a single row (consisting of a sequence of values). See [Subquery](#) .

- ALL

specifies that the predicate is true if the comparison is true for every row selected by

table-subquery (or if *table-subquery* selects no rows), and specifies that the predicate is false if the comparison is false for at least one row selected.

- ANY | SOME

specifies that the predicate is true if the comparison is true for at least one row selected by the *table-subquery* and specifies that the predicate is false if the comparison is false for every row selected (or if *table-subquery* selects no rows).

- *table-subquery*

provides the values for the comparison. The number of values returned by the *row-value-constructor* must be equal to the number of values specified by the *table-subquery*, and the data types of values returned by the *row-value-constructor* must be comparable to the data types of values returned by the *table-subquery*. See “Subquery” .

Considerations for ALL, ANY, SOME

Let R be the result of the *row-value-constructor*, T the result of the *table-subquery*, and RT a row in T .

Result of $R \text{comparison-op} \text{ALL } T$

If T is empty or if $R \text{ comparison-op } RT$ is true for every row RT in T , the *comparison-op ALL* predicate is true.

If $R \text{ comparison-op } RT$ is false for at least one row RT in T , the *comparison-op ALL* predicate is false.

Result of $R \text{comparison-op ANY } T$ or $R \text{comparison-op SOME } T$

If T is empty or if $R \text{ comparison-op } RT$ is false for every row RT in T , the *comparison-op ANY* predicate is false.

If $R \text{ comparison-op } RT$ is true for at least one row RT in T , the *comparison-op ANY* predicate is true.

Examples of ALL, ANY, SOME

- This predicate is true if the salary is greater than the salaries of all the employees who have a jobcode of 420:

```
salary > ALL (SELECT salary
                FROM persnl.employee
               WHERE jobcode = 420)
```

Consider this SELECT statement using the preceding predicate:

```
SELECT empnum, first_name, last_name, salary FROM persnl.employee
WHERE salary > ALL (SELECT salary
                      FROM persnl.employee WHERE jobcode = 420);
```

The inner query providing the comparison values yields these results:

```
SELECT salary
FROM persnl.employee WHERE jobcode = 420;

SALARY
-----
33000.00
36000.00
18000.10

--- 3 row(s) selected.
```

The SELECT statement using this inner query yields these results. The salaries listed are greater than the salary of every employees with jobcode equal to 420—that is, greater than \$33,000.00, \$36,000.00, and \$18,000.10:

```
SELECT empnum, first_name, last_name, salary FROM persnl.employee
WHERE salary > ALL (SELECT salary
                      FROM persnl.employee WHERE jobcode = 420);

FIRST_NAME      LAST_NAME          SALARY
-----  -----
ROGER           GREEN             175500.00
JERRY           HOWARD            137000.10
JANE            RAYMOND           136000.00
...
ALAN             TERRY             39500.00
BEN              HENDERSON         65000.00
JESSICA          CRINER            39500.00

--- 23 row(s) selected.
```

- This predicate is true if the part number is equal to any part number with more than five units in stock:

```
partnum = ANY (SELECT partnum  
                FROM sales.odetail  
               WHERE qty_ordered > 5)
```

Consider this SELECT statement using the preceding predicate:

```
SELECT ordernum, partnum, qty_ordered FROM sales.odetail  
WHERE partnum = ANY (SELECT partnum  
                      FROM sales.odetail WHERE qty_ordered > 5);
```

The inner query providing the comparison values yields these results:

```
SELECT partnum FROM sales.odetail  
WHERE qty_ordered > 5;
```

```
Part / Num  
-----  
2403  
5100  
5103  
6301  
6500  
....  
--- 60 row(s) selected.
```

The SELECT statement using this inner query yields these results. All of the order numbers listed have part number equal to any part number with more than five total units in stock—that is, equal to 2403, 5100, 5103, 6301, 6500, and so on:

```
SELECT ordernum, partnum, qty_ordered FROM sales.odetail  
WHERE partnum = ANY (SELECT partnum  
FROM sales.odetail WHERE qty_ordered > 5);
```

Order/Num Part/Num Qty/Ord

Order/Num	Part/Num	Qty/Ord
100210	244	3
100210	2001	3
100210	2403	6
100210	5100	10
100250	244	4
100250	5103	10
100250	6301	15
100250	6500	10
.....

--- 71 row(s) selected.

5.17. Privileges

A privilege provides authorization to perform a specific operation for a specific object. A privilege can be granted to or revoked from a user or role in many ways:

- Implicit privileges are granted to an owner of an object when the object is created. The owner retains implicit privileges for the lifespan of the object.
- Explicit privileges can be granted to or revoked from a user or role. Explicit privileges can be granted or revoked by a database user administrator, an object owner, or a user who has been granted the privilege with the WITH GRANT OPTION option.
- The privileges granted to a user can come from various sources. Privileges can be directly granted to a user or they can be inherited through a role. For example, a user gets the SELECT privilege on table T1 from two different roles. If one of the roles is revoked from the user, the user will still be able to select from T1 via the SELECT privilege granted to the remaining role.
- A user who is granted a role is thereby conferred all privileges of the role. The only way to revoke any such privilege is to revoke the role from the user. For more information, see [Roles](#).
- Privileges granted on an object can be for all the columns of the object or just a subset of the columns. Only the following subset of privileges is applicable at the column-level: INSERT, REFERENCES, SELECT, and UPDATE.

You can manage privileges by using the GRANT and REVOKE statements.

For more information on GRANT, see:

- [GRANT Statement](#)
- [GRANT COMPONENT PRIVILEGE Statement](#)
- [GRANT ROLE Statement](#)

For more information on REVOKE, see:

- [REVOKE Statement](#)
- [REVOKE COMPONENT PRIVILEGE Statement](#)
- [REVOKE ROLE Statement](#)

5.18. Roles

A role offers the flexibility of implicitly assigning a set of privileges to users, instead of assigning privileges individually. A user can be granted one or more roles. A role can be granted to one or more users. A role can be granted by or revoked by a database user administrator, a role owner, or a member of the role.

Privileges are granted to a role. When a role is granted to a user, the privileges granted to the role become available to the user. If new privileges are granted to the role, those privileges become available to all users who have been granted the role. When a role is revoked from a user, the privileges granted to the role are no longer available to the user. The change in privileges is automatically propagated to and detected by active sessions, so there is no need for users to disconnect from and reconnect to a session to see the updated set of privileges. For more information about privileges, see [Privileges](#).

A role name is an authorization ID. A role name cannot be identical to a registered database user name. For more information, see [Authorization IDs](#).

To manage roles, see these SQL statements:

- [CREATE ROLE Statement](#)
- [DROP ROLE Statement](#)
- [GRANT ROLE Statement](#)
- [REVOKE ROLE Statement](#)

5.19. Schemas

The ANSI SQL:1999 schema name is an SQL identifier that is unique for a given ANSI catalog name. Trafodion SQL automatically qualifies the schema name with the current default catalog name, TRAFODION.

The logical name of the form *schema.object* is an ANSI name. The part *schema* denotes the ANSI-defined schema.

To be compliant with ANSI SQL:1999, Trafodion SQL provides support for ANSI object names.

By using these names, you can develop ANSI-compliant applications that access all SQL objects. You can access Trafodion SQL objects with the name of the actual object. See [SET SCHEMA Statement](#).

5.19.1. Creating and Dropping Schemas

You create a schema using the CREATE SCHEMA command and drop a schema using the DROP SCHEMA statement.

For more information, see the [CREATE SCHEMA Statement](#) and the [DROP SCHEMA Statement](#).

5.20. Search Condition

A search condition is used to choose rows from tables or views, depending on the result of applying the condition to rows.

The condition is a Boolean expression consisting of predicates combined together with OR, AND, and NOT operators.

You can use a search condition in the WHERE clause of a SELECT, DELETE, or UPDATE statement, the HAVING clause of a SELECT statement, the searched form of a CASE expression, the ON clause of a SELECT statement that involves a join, a CHECK constraint, or a ROWS SINCE sequence function.

```
search-condition is:  
    boolean-term | search-condition OR boolean-term  
  
boolean-term is:  
    boolean-factor | boolean-term AND boolean-factor  
  
boolean-factor is:  
    [NOT] boolean-primary  
  
boolean-primary is:  
    predicate | (search-condition)
```

- OR

specifies the resulting search condition is true if and only if either of the surrounding predicates or search conditions is true.

- AND

specifies the resulting search condition is true if and only if both the surrounding predicates or search conditions are true.

- NOT

reverses the truth value of its operand—the following predicate or search condition. predicate is a BETWEEN, comparison, EXISTS, IN, LIKE, NULL, or quantified comparison predicate. A predicate specifies conditions that must be satisfied for a row to be chosen. See [Predicates](#) and individual entries.

5.20.1. Considerations for Search Condition

Order of Evaluation

SQL evaluates search conditions in this order:

1. Predicates within parentheses
2. NOT
3. AND
4. OR

Column References

Within a search condition, a reference to a column refers to the value of that column in the row currently being evaluated by the search condition.

Subqueries

If a search condition includes a subquery and the subquery returns no values, the predicate evaluates to null. See [Subquery](#).

5.20.2. Examples of Search Condition

- Select rows by using a search condition composed of three comparison predicates joined by AND operators:

```

SELECT O.ordernum, O.deliv_date, OD.qty_ordered
FROM sales.orders O, sales.odetail OD
WHERE qty_ordered < 9
    AND deliv_date <= DATE '2008-11-01'
    AND O.ordernum = OD.ordernum;

ORDERNUM      DELIV_DATE  QTY_ORDERED
-----  -----  -----
 100210  2008-04-10      3
 100210  2008-04-10      3
 100210  2008-04-10      6
 100250  2008-06-15      4
 101220  2008-12-15      3
...
--- 28 row(s) selected.

```

- Select rows by using a search condition composed of three comparison predicates, two of which are joined by an OR operator (within parentheses), and where the result of the OR and the first comparison predicate are joined by an AND operator:

```

SELECT partnum, S.supplnum, supplname
FROM invent.supplier S, invent.partsupp PS
WHERE S.supplnum = PS.supplnum
    AND (partnum < 3000 OR partnum = 7102);

SUPPLNAME
-----
NEW COMPUTERS INC
NEW COMPUTERS INC
NEW COMPUTERS INC
...
LEVERAGE INC
--- 18 row(s) selected.

```

5.21. Subquery

A subquery is a query expression enclosed in parentheses. Its syntactic form is specified in the syntax of a SELECT statement. For further information about query expressions, see [SELECT Statement](#).

A subquery is used to provide values for a BETWEEN, comparison, EXISTS, IN, or quantified comparison predicate in a search condition. It is also used to specify a derived table in the FROM clause of a SELECT statement.

A subquery can be a table, row, or scalar subquery. Therefore, its result table can be a table consisting of multiple rows and columns, a single row of column values, or a single row consisting of only one column value.

5.21.1. SELECT Form of a Subquery

A subquery is typically specified as a special form of a SELECT statement enclosed in parentheses that queries (or selects) to provide values in a search condition or to specify a derived table as a table reference.

The form of a subquery specified as a SELECT statement is *query-expr*.

Neither the ORDER BY clause nor [FIRST N] / [ANY N] clause is allowed in a subquery.

5.21.2. Using Subqueries to Provide Comparison Values

When a subquery is used to provide comparison values, the SELECT statement that contains the subquery is called an outer query. The subquery within the SELECT is called an *inner query*.

In this case, the differences between the SELECT statement and the SELECT form of a subquery are:

- A subquery is always enclosed in parentheses.
- A subquery cannot contain an ORDER BY clause.
- If a subquery is not part of an EXISTS, IN, or quantified comparison predicate, and the subquery evaluates to more than one row, a run-time error occurs.

5.21.3. Nested Subqueries When Providing Comparison Values

An outer query (a main SELECT statement) can have nested subqueries. Subqueries within the same WHERE or HAVING clause are at the same level. For example, this query has one level of nesting:

```
SELECT * FROM table1
WHERE A = (SELECT P FROM table2 WHERE q = 1)
    AND b = (SELECT x FROM table3 WHERE y = 2);
```

A subquery within the WHERE clause of another subquery is at a different level, however, so this query has two levels of nesting:

```
SELECT * FROM table1
WHERE a = (SELECT p FROM table2
    WHERE q = (SELECT x FROM table3
        WHERE y = 2))
```

The maximum level of nested subqueries might depend on:

- The complexity of the subqueries.
- Whether the subquery is correlated and if so, whether it can be un-nested.
- Amount of available memory.

Other factors may affect the maximum level of subqueries.

5.21.4. Correlated Subqueries When Providing Comparison Values

In a subquery, when you refer to columns of any table or view defined in an outer query, the reference is called an outer reference. A subquery containing an outer reference is called a correlated subquery.

If you refer to a column name that occurs in more than one outer query, you must qualify the column name with the correlation name of the table or view to which it belongs. Similarly, if you refer to

a column name that occurs in the subquery and in one or more outer queries, you must qualify the column name with the correlation name of the table or view to which it belongs. The correlation name is known to other subqueries at the same level, or to inner queries but not to outer queries.

If you use the same correlation name at different levels of nesting, an inner query uses the one from the nearest outer level.

5.22. Tables

A table is a logical representation of data in which a set of records is represented as a sequence of rows, and the set of fields common to all rows is represented by columns. A column is a set of values of the same data type with the same definition. The intersection of a row and column represents the data value of a particular field in a particular record.

Every table must have one or more columns, but the number of rows can be zero. No inherent order of rows exists within a table.

You create a Trafodion SQL user table by using the CREATE TABLE statement. See the [CREATE TABLE Statement](#). The definition of a user table within the statement includes this information:

- Name of the table
- Name of each column of the table
- Type of data you can store in each column of the table
- Other information about the table, including the physical characteristics of the file that stores the table (for example, the storage order of rows within the table)

A Trafodion SQL table is described in an SQL schema and stored as an HBase table. Trafodion SQL tables have regular ANSI names in the catalog TRAFODION. A Trafodion SQL table name can be a fully qualified ANSI name of the form TRAFODION.*schema-name.object-name*. A Trafodion SQL table's metadata is stored in the schema TRAFODION."*MD*".

Because Trafodion defines the encodings for column values in Trafodion SQL tables, those tables support various Trafodion SQL statements. See [Supported SQL Statements With HBase Tables](#).

Internally, Trafodion SQL tables use a single HBase column family and shortened column names to conserve space. Their encoding allows keys consisting of multiple columns and preserves the order of key values as defined by SQL. The underlying HBase column model makes it very easy to add and remove columns from Trafodion SQL tables. HBase columns that are not recorded in the Trafodion metadata are ignored, and missing columns are considered NULL values.

5.22.1. Base Tables and Views

In some descriptions of SQL, tables created with a CREATE TABLE statement are called base tables to distinguish them from views, which are called logical tables.

A view is a named logical table defined by a query specification that uses one or more base tables or other views. See [Views](#).

5.22.2. Example of a Base Table

For example, this EMPLOYEE table is a base table in a sample database:

EMPNUM	FIRST_NAME	LAST_NAME	DEPTNUM	JOBCODE	SALARY
1	ROGER	GREEN	9000	100	175500.00
23	JERRY	HOWARD	1000	100	137000.00
75	TIM	WALKER	3000	300	32000.00
...

In this sample table, the columns are EMPNUM, FIRST_NAME, LAST_NAME, DEPTNUM, JOBCODE, and SALARY. The values in each column have the same data type.

5.23. Views

A view provides an alternate way of looking at data in one or more tables. A view is a named specification of a result table, which is a set of rows selected or generated from one or more base tables or other views. The specification is a SELECT statement that is executed whenever the view is referenced.

A view is a logical table created with the CREATE VIEW statement and derived by projecting a subset of columns, restricting a subset of rows, or both, from one or more base tables or other views.

5.23.1. SQL Views

A view's name must be unique among table and view names within the schema that contains it. Single table views can be updatable. Multi-table views are not updatable.

For information about SQL views, see [CREATE VIEW Statement](#) and [DROP VIEW Statement](#).

5.23.2. Example of a View

You can define a view to show only part of the data in a table. For example, this EMPLIST view is defined as part of the EMPLOYEE table:

EMPNUM	FIRST_NAME	LAST_NAME	DEPTNUM	JOBCODE
1	ROGER	GREEN	9000	100
23	JERRY	HOWARD	1000	100
75	TIM	WALKER	3000	300
...

In this sample view, the columns are EMPNUM, FIRST_NAME, LAST_NAME, DEPTNUM, and JOBCODE. The SALARY column in the EMPLOYEE table is not part of the EMPLIST view.

Chapter 6. SQL Clauses

Clauses are used by Trafodion SQL statements to specify default values, ways to sample or sort data, how to store physical data, and other details.

This section describes:

- [DEFAULT Clause](#) specifies a default value for a column being created.
- [FORMAT Clause](#) specifies the format to use.
- [SAMPLE Clause](#) specifies the sampling method used to select a subset of the intermediate result table of a SELECT statement.
- [SEQUENCE BY Clause](#) specifies the order in which to sort rows of the intermediate result table for calculating sequence functions.
- [TRANSPOSE Clause](#) generates, for each row of the SELECT source table, a row for each item in the transpose item list.

6.1. DEFAULT Clause

The DEFAULT option of the CREATE TABLE or ALTER TABLE *table-name* ADD COLUMN statement specifies a default value for a column being created.

The default value is used when a row is inserted in the table without a value for the column.

```
DEFAULT default | NO DEFAULT

default is:
literal
| NULL
| CURRENTDATE
| CURRENTTIME
| CURRENTTIMESTAMP
```

- NO DEFAULT

specifies the column has no default value. You cannot specify NO DEFAULT in an ALTER TABLE statement. See [ALTER TABLE Statement](#).

6.1.1. Syntax for Default Clause

- `DEFAULT literal`

is a literal of a data type compatible with the data type of the associated column.

For a character column, *literal* must be a string literal of no more than 240 characters or the length of the column, whichever is less. The maximum length of a default value for a character column is 240 bytes (minus control characters) or the length of the column, whichever is less. Control characters consist of character set prefixes and single quote delimiter found in the text itself.

For a numeric column, *literal* must be a numeric literal that does not exceed the defined length of the column. The number of digits to the right of the decimal point must not exceed the scale of the column, and the number of digits to the left of the decimal point must not exceed the number in the length (or length minus scale, if you specified scale for the column).

For a datetime column, *literal* must be a datetime literal with a precision that matches the precision of the column.

For an INTERVAL column, *literal* must be an INTERVAL literal that has the range of INTERVAL fields defined for the column.

- `DEFAULT NULL`

specifies NULL as the default. This default can occur only with a column that allows null.

- `DEFAULT CURRENT_DATE`

specifies the default value for the column as the value returned by the CURRENT_DATE function at the time of the operation that assigns a value to the column. This default can occur only with a column whose data type is DATE.

- `DEFAULT CURRENT_TIME`

specifies the default value for the column as the value returned by the CURRENT_TIME function at the time of the operation that assigns a value to the column. This default can occur only with a column whose data type is TIME.

- `DEFAULT CURRENT_TIMESTAMP`

specifies the default value for the column as the value returned by the CURRENT_TIMESTAMP function at the time of the operation that assigns a value to the column. This default can occur only with a column whose data type is TIMESTAMP.

6.1.2. Examples of DEFAULT

- This example uses DEFAULT clauses on CREATE TABLE to specify default column values:

```
CREATE TABLE items
( item_id CHAR(12) NO DEFAULT
, description CHAR(50) DEFAULT NULL
, num_on_hand INTEGER DEFAULT 0 NOT NULL
) ;
```

- This example uses DEFAULT clauses on CREATE TABLE to specify default column values:

```
CREATE TABLE persnl.project
( projcode NUMERIC (4) UNSIGNED NO DEFAULT NOT NULL
, empnum NUMERIC (4) UNSIGNED NO DEFAULT NOT NULL
, projdesc VARCHAR (18) DEFAULT NULL
, start_date DATE DEFAULT CURRENT_DATE
, ship_timestamp TIMESTAMP DEFAULT CURRENT_TIMESTAMP
, est_complete INTERVAL DAY DEFAULT INTERVAL '30' DAY
, PRIMARY KEY (projcode)
) ;
```

6.2. FORMAT Clause

The FORMAT clause specifies the output format for DATE values. It can also be used to specify the length of character output or to specify separating the digits of integer output with colons.

- Date Formats:

```
(FORMAT 'format-string') |
(DATE, FORMAT 'format-string')

format-string for Date Formats is:
YYYY-MM-DD
MM/DD/YYYY
YY/MM/DD
YYYY/MM/DD
YYYYMMDD
DD.MM.YYYY
DD-MM-YYYY
DD-MMM-YYYY
```

- Other Formats:

```
(FORMAT 'format-string')

format-string for other formats is:
XXX
99:99:99:99
-99:99:99:99
```

- YYYY-MM-DD

specifies that the FORMAT clause output format is *year-month-day*.

- MM/DD/YYYY

specifies that the FORMAT clause output format is *month/day/year*

- YY/MM/DD

specifies that the FORMAT clause output format is *year/month/day*.

- YYYY/MM/DD

specifies that the FORMAT clause output format is *year/month/day*.

- YYYYMMDD

specifies that the FORMAT clause output format is *yearmonthday*.

- DD.MM.YYYY

specifies that the FORMAT clause output format is *day.month.year*.

- DD-MM-YYYY

specifies that the FORMAT clause output format is *day-month-year*.

- DD-MMM-YYYY

specifies that the FORMAT clause output format is *day-month-year*.

- XXX

specifies that the FORMAT clause output format is a string format. The input must be a numeric or string value.

- 99:99:99:99

specifies that the FORMAT clause output format is a timestamp. The input must be a numeric value.

- -99:99:99:99

specifies that the FORMAT clause output format is a timestamp. The input must be a numeric value.

6.2.1. Considerations for Date Formats

The expression preceding the (FORMAT "format-string") clause must be a DATE value.

The expression preceding the (DATE, FORMAT 'format-string') clause must be a quoted string in the USA, EUROPEAN, or DEFAULT date format.

Considerations for Other Formats

For XXX, the expression preceding the (FORMAT 'format-string') clause must be a numeric value or a string value.

For 99:99:99:99 and -99:99:99:99, the expression preceding the (FORMAT 'format-string') clause must be a numeric value.

6.2.2. Examples of FORMAT

- The format string 'XXX' in this example will yield a sample result of abc:

```
SELECT 'abcde' (FORMAT 'XXX') FROM (VALUES(1)) t;
```

- The format string 'YYYY-MM_DD' in this example will yield a sample result of 2008-07-17.

```
SELECT CAST('2008-07-17' AS DATE) (FORMAT 'YYYY-MM-DD') FROM (VALUES(1)) t;
```

- The format string 'MM/DD/YYYY' in this example will yield a sample result of 07/17/2008.

```
SELECT '2008-07-17' (DATE, FORMAT 'MM/DD/YYYY') FROM (VALUES(1)) t;
```

- The format string 'YY/MM/DD' in this example will yield a sample result of 08/07/17.

```
SELECT '2008-07-17' (DATE, FORMAT 'YY/MM/DD') FROM (VALUES(1)) t;
```

- The format string 'YYYY/MM/DD' in this example will yield a sample result of 2008/07/17.

```
SELECT '2008-07-17' (DATE, FORMAT 'YYYY/MM/DD') FROM (VALUES(1)) t;
```

- The format string 'YYYYMMDD' in this example will yield a sample result of 20080717.

```
SELECT '2008-07-17' (DATE, FORMAT 'YYYYMMDD') FROM (VALUES(1)) t;
```

- The format string 'DD.MM.YYYY' in this example will yield a sample result of 17.07.2008.

```
SELECT '2008-07-17' (DATE, FORMAT 'DD.MM.YYYY') FROM (VALUES(1)) t;
```

- The format string 'DD-MMM-YYYY' in this example will yield a sample result of 17-JUL-2008.

```
SELECT '2008-07-17' (DATE, FORMAT 'DD-MMM-YYYY') FROM (VALUES(1)) t;
```

- The format string '99:99:99:99' in this example will yield a sample result of 12:34:56:78.

```
SELECT 12345678 (FORMAT '99:99:99:99') FROM (VALUES(1)) t;
```

- The format string '-99:99:99:99' in this example will yield a sample result of -12:34:56:78.

```
SELECT (-12345678) (FORMAT '-99:99:99:99') FROM (VALUES(1)) t;
```

6.3. SAMPLE Clause

The SAMPLE clause of the SELECT statement specifies the sampling method used to select a subset of the intermediate result table of a SELECT statement. The intermediate result table consists of the rows returned by a WHERE clause or, if no WHERE clause exists, the FROM clause. See [SELECT Statement](#).

SAMPLE is a Trafodion SQL extension.

```

SAMPLE sampling-method is:
  RANDOM percent-size
  | FIRST rows-size
    [ SORT BY colname [ASC[ENDING] | DESC[ENDING]]
      [,colname [ASC[ENDING] | DESC[ENDING]]]... ]
  | PERIODIC rows-size EVERY number-rows ROWS
    [ SORT BY colname [ASC[ENDING] | DESC[ENDING]]
      [,colname [ASC[ENDING] | DESC[ENDING]]]... ]

percent-size is:
  percent-result PERCENT [ROWS]
  | BALANCE WHEN condition
    THEN percent-result PERCENT [ROWS]
    [WHEN condition THEN percent-result PERCENT [ROWS]]...
    [ELSE percent-result PERCENT [ROWS]] END

rows-size is:
  number-rows ROWS
  | BALANCE WHEN condition THEN number-rows ROWS
    [WHEN condition THEN number-rows ROWS]...
    [ELSE number-rows ROWS] END

```

- *RANDOM percent-size*

directs Trafodion SQL to choose rows randomly (each row having an unbiased probability of being chosen) without replacement from the result table. The sampling size is determined by the *percent-size*, defined as:

- *percent-result PERCENT [ROWS] | BALANCE WHEN condition THEN percent-result PERCENT [ROWS] [WHEN condition THEN percent-result PERCENT [ROWS]]... [ELSE percent-result PERCENT [ROWS]] END*

specifies the value of the size for RANDOM sampling by using a percent of the result table. The value *percent-result* must be a numeric literal.

You can determine the actual size of the sample. Suppose that N rows exist in the intermediate result table. Each row is picked with a probability of $r\%$, where r is the sample size in PERCENT. Therefore, the actual size of the resulting sample is approximately $r\%$ of N . The number of rows picked follows a binomial distribution with mean equal to r

`*c_N_/100.`

If you specify a sample size greater than 100 PERCENT, Trafodion SQL returns all the rows in the result table plus duplicate rows. The duplicate rows are picked from the result table according to the specified sampling method. This technique is called oversampling.

- ROWS

specifies row sampling. Row sampling is the default.

- BALANCE

If you specify a BALANCE expression, Trafodion SQL performs stratified sampling. The intermediate result table is divided into disjoint strata based on the WHEN conditions.

Each stratum is sampled independently by using the sampling size. For a given row, the stratum to which it belongs is determined by the first WHEN condition that is true for that row—if a true condition exists. If no true condition exists, the row belongs to the ELSE stratum.

- FIRST *rows-size* [SORT BY *colname* [ASC[ENDING] | DESC[ENDING]] [, *colname* [ASC[ENDING] | DESC[ENDING]]]...]]

directs Trafodion SQL to choose the first rows from the result table. You can specify the order of the rows to sample. Otherwise, Trafodion SQL chooses an arbitrary order. The sampling size is determined by the *rows-size*, defined as:

- *number-rows* ROWS | BALANCE WHEN *condition* THEN *number-rows* ROWS [WHEN *condition* THEN *number-rows* ROWS]... [ELSE *number-rows* ROWS] END

specifies the value of the size for FIRST sampling by using the number of rows intended in the sample. The value *number-rows* must be an integer literal.

You can determine the actual size of the sample. Suppose that *N* rows exist in the intermediate result table. If the size *s* of the sample is specified as a number of rows, the actual size of the resulting sample is the minimum of *s* and *N*.

- PERIODIC *rows-size* EVERY *number-rows* ROWS [SORT BY *colname* [ASC[ENDING] | DESC[ENDING]] [, *colname* [ASC[ENDING] | DESC[ENDING]]]...]]

directs Trafodion SQL to choose the first rows from each block (or period) of contiguous rows. This sampling method is equivalent to a separate FIRST sampling for each period, and the *rows-size* is defined as in FIRST sampling.

The size of the period is specified as a number of rows. You can specify the order of the rows to sample. Otherwise, Trafodion SQL chooses an arbitrary order.

You can determine the actual size of the sample. Suppose that N rows exist in the intermediate result table. If the size s of the sample is specified as a number of rows and the size p of the period is specified as a number of rows, the actual size of the resulting sample is calculated as:

```
FLOOR (N/p) * s + _minimum_ (MOD (N, p), s)
```

minimum in this expression is used simply as the mathematical minimum of two values.

6.3.1. Considerations for SAMPLE

Sample Rows

In general, when you use the SAMPLE clause, the same query returns different sets of rows for each execution. The same set of rows is returned only when you use the FIRST and PERIODIC sampling methods with the SORT BY option, where no duplicates exist in the specified column combination for the sort.

6.3.2. Examples of SAMPLE

- Suppose that the data-mining tables SALESPER, SALES, and DEPT have been created as:

```
CREATE TABLE trafodion.mining.salesper
( empid NUMERIC (4) UNSIGNED NOT NULL
, dnum NUMERIC (4) UNSIGNED NOT NULL
, salary NUMERIC (8,2) UNSIGNED
, age INTEGER
, sex CHAR (6)
, PRIMARY KEY (empid) );

CREATE TABLE trafodion.mining.sales
( empid NUMERIC (4) UNSIGNED NOT NULL
, product VARCHAR (20)
, region CHAR (4)
, amount NUMERIC (9,2) UNSIGNED
, PRIMARY KEY (empid) );

CREATE TABLE trafodion.mining.dept
( dnum NUMERIC (4) UNSIGNED NOT NULL
, name VARCHAR (20)
, PRIMARY KEY (dnum) );
```

Suppose, too, that sample data is inserted into this database.

- Return the SALARY of the youngest 50 sales people:

```
SELECT salary
FROM salesperson
SAMPLE FIRST 50 ROWS
SORT BY age;

SALARY
-----
90000.00
90000.00
28000.00
27000.12
136000.00
37000.40
...
--- 50 row(s) selected.
```

- Return the SALARY of 50 sales people. In this case, the table is clustered on EMPID. If the optimizer chooses a plan to access rows using the primary access path, the result consists of salaries of the 50 sales people with the smallest employee identifiers.

```
SELECT salary
FROM salesperson
SAMPLE FIRST 50 ROWS;

SALARY
-----
175500.00
137000.10
136000.00
138000.40
75000.00
90000.00
...
--- 50 row(s) selected.
```

- Return the SALARY of the youngest five sales people, skip the next 15 rows, and repeat this process until no more rows exist in the intermediate result table. You cannot specify periodic sampling with the sample size larger than the period.

```
SELECT salary
FROM salesperson
SAMPLE PERIODIC 5 ROWS
EVERY 20 ROWS
SORT BY age;

SALARY
-----
90000.00
90000.00
28000.00
27000.12
136000.00
36000.00
...
--- 17 row(s) selected.
```

In this example, 62 rows exist in the SALESPERSON table. For each set of 20 rows, the first five rows are selected.

The last set consists of two rows, both of which are selected.

- Compute the average salary of a random 10 percent of the sales people. You will get a different result each time you run this query because it is based on a random sample.

```
SELECT AVG(salary)
FROM salesperson
SAMPLE RANDOM 10 PERCENT;

(EXPR)
-----
61928.57

--- 1 row(s) selected.
```

- This query illustrates sampling after execution of the WHERE clause has chosen the qualifying rows. The query computes the average salary of a random 10 percent of the sales people over 35 years of age. You will get a different result each time you run this query because it is based on a random sample.

```
SELECT AVG(salary)
FROM salesperson
WHERE age > 35
SAMPLE RANDOM 10 PERCENT;

(EXPR)
-----
      58000.00

--- 1 row(s) selected.
```

- Compute the average salary of a random 10 percent of sales people belonging to the CORPORATE department. The sample is taken from the join of the SALESPERSON and DEPARTMENT tables. You will get a different result each time you run this query because it is based on a random sample.

```
SELECT AVG(salary)
FROM salesperson S, department D
WHERE S.DNUM = D.DNUM AND D.NAME = 'CORPORATE'
SAMPLE RANDOM 10 PERCENT;

(EXPR)
-----
      106250.000

--- 1 row(s) selected.
```

- In this example, the SALESPERSON table is first sampled and then joined with the DEPARTMENT table. This query computes the average salary of all the sales people belonging to the CORPORATE department in a random sample of 10 percent of the sales employees.

```

SELECT AVG(salary)
FROM
  ( SELECT salary, dnum FROM salesperson SAMPLE RANDOM 10 PERCENT ) AS S
  , department D
WHERE S.DNUM = D.DNUM
  AND D.NAME = 'CORPORATE' ;

(EXPR)
-----
37000.000
--- 1 row(s) selected.

```

The results of this query and some of the results of previous queries might return null:

```

SELECT AVG(salary)
FROM
  ( SELECT salary, dnum FROM salesperson SAMPLE RANDOM 10 PERCENT ) AS S
  , department D
WHERE S.DNUM = D.DNUM AND D.NAME = 'CORPORATE' ;

(EXPR)
-----
?

--- 1 row(s) selected.

```

For this query execution, the number of rows returned by the embedded query is limited by the total number of rows in the SALESPERSON table. Therefore, it is possible that no rows satisfy the search condition in the WHERE clause.

- In this example, both the tables are sampled first and then joined. This query computes the average salary and the average sale amount generated from a random 10 percent of all the sales people and 20 percent of all the sales transactions.

```

SELECT AVG(salary), AVG(amount)
FROM ( SELECT salary, empid
      FROM salesperson
      SAMPLE RANDOM 10 PERCENT ) AS S,
( SELECT amount, empid FROM sales
      SAMPLE RANDOM 20 PERCENT ) AS T
WHERE S.empid = T.empid;

(EXPR)      (EXPR)
-----
45000.00    31000.00

--- 1 row(s) selected.

```

- This example illustrates oversampling. This query retrieves 150 percent of the sales transactions where the amount exceeds \$1000. The result contains every row at least once, and 50 percent of the rows, picked randomly, occur twice.

```

SELECT *
FROM sales
WHERE amount > 1000
SAMPLE RANDOM 150 PERCENT;

EMPID PRODUCT          REGION AMOUNT
----- -----
  1 PCGOLD, 30MB        E     30000.00
 23 PCDIAMOND, 60MB    W     40000.00
 23 PCDIAMOND, 60MB    W     40000.00
 29 GRAPHICPRINTER, M1 N     11000.00
 32 GRAPHICPRINTER, M2 S     15000.00
 32 GRAPHICPRINTER, M2 S     15000.00
...
...
--- 88 row(s) selected.

```

- The BALANCE option enables stratified sampling. Retrieve the age and salary of 1000 sales people such that 50 percent of the result are male and 50 percent female.

```
SELECT age, sex, salary
FROM salesperson
SAMPLE FIRST
BALANCE
WHEN sex = 'male' THEN 15 ROWS
WHEN sex = 'female' THEN 15 ROWS
END
ORDER BY age;
```

AGE	SEX	SALARY
22	male	28000.00
22	male	90000.00
22	female	136000.00
22	male	37000.40
...

--- 30 row(s) selected.

- Retrieve all sales records with the amount exceeding \$10000 and a random sample of 10 percent of the remaining records:

```
SELECT *
FROM sales SAMPLE RANDOM
BALANCE
WHEN amount > 10000
THEN 100 PERCENT
ELSE 10 PERCENT
END;

PRODUCT          REGION AMOUNT
-----  -----
PCGOLD, 30MB    E      30000.00
PCDIAMOND, 60MB W      40000.00
GRAPHICPRINTER, M1 N      11000.00
GRAPHICPRINTER, M2 S      15000.00
...
MONITORCOLOR, M2 N      10500.00
...
...
--- 32 row(s) selected.
```

- This query shows an example of stratified sampling where the conditions are not mutually exclusive:

```
SELECT *
FROM sales SAMPLE RANDOM
BALANCE
WHEN amount > 10000 THEN 100 PERCENT
WHEN product = 'PCGOLD, 30MB' THEN 25 PERCENT
WHEN region = 'W' THEN 40 PERCENT
ELSE 10 PERCENT END;

PRODUCT          REGION AMOUNT
-----  -----  -----
PCGOLD, 30MB    E      30000.00
PCDIAMOND, 60MB W      40000.00
GRAPHICPRINTER, M1 N      11000.00
GRAPHICPRINTER, M2 S      15000.00
GRAPHICPRINTER, M3 S      20000.00
LASERPRINTER, X1 W      42000.00
...
...
--- 30 row(s) selected.
```

6.4. SEQUENCE BY Clause

The SEQUENCE BY clause of the SELECT statement specifies the order in which to sort the rows

of the intermediate result table for calculating sequence functions. This option is used for processing time-sequenced rows in data mining applications. See [SELECT Statement](#).

Sequence by is a Trafodion SQL extension.

```
SEQUENCE BY colname[ASC[ENDING] | DESC[ENDING]]
[,colname [ASC[ENDING] | DESC[ENDING]]]...
```

- *colname* _ names a column in *select-list* or a column in a table reference in the FROM clause of the SELECT statement. *colname* is optionally qualified by a table, view, or correlation name; for example, CUSTOMER.CITY.
- ASC | DESC

specifies the sort order. ASC is the default. For ordering an intermediate result table on a column that can contain null, nulls are considered equal to one another but greater than all other non-null values.

You must include a SEQUENCE BY clause if you include a sequence function in the select list of the SELECT statement. Otherwise, Trafodion SQL returns an error. Further, you cannot include a SEQUENCE BY clause if no sequence function exists in the select list. See [Sequence Functions](#) .

6.4.1. Considerations for SEQUENCE BY

- Sequence functions behave differently from set (or aggregate) functions and mathematical (or scalar) functions.
- If you include both SEQUENCE BY and GROUP BY clauses in the same SELECT statement, the values of the sequence functions must be evaluated first and then become input for aggregate functions in the statement.
 - For a SELECT statement that contains both SEQUENCE BY and GROUP BY clauses, you can nest the sequence function in the aggregate function:

```
SELECT
  ordernum
, MAX(MOVINGSUM(qty_ordered, 3)) AS maxmovsum_qty
, AVG(unit_price) AS avg_price
FROM odetail
SEQUENCE BY partnum
GROUP BY ordernum;
```

- To use a sequence function as a grouping column, you must use a derived table for the SEQUENCE BY query and use the derived column in the GROUP BY clause:

```

SELECT
    ordernum
    , movsum_qty
    , AVG(unit_price)
FROM
    ( SELECT ordernum, MOVINGSUM(qty_ordered, 3), unit_price
        FROM odetail SEQUENCE BY partnum )
    AS tab2 (ordernum, movsum_qty, unit_price)
GROUP BY ordernum, movsum_qty;

```

- To use an aggregate function as the argument to a sequence function, you must also use a derived table:

```

SELECT MOVINGSUM(avg_price,2)
FROM
    ( SELECT ordernum, AVG(unit_price) FROM odetail
        GROUP BY ordernum )
    AS tab2 (ordernum, avg_price)
SEQUENCE BY ordernum;

```

- Like aggregate functions, sequence functions generate an intermediate result. If the query has a WHERE clause, its search condition is applied during the generation of the intermediate result. Therefore, you cannot use sequence functions in the WHERE clause of a SELECT statement.

- This query returns an error:

```

SELECT ordernum, partnum, RUNNINGAVG(unit_price)
FROM odetail
WHERE ordernum > 800000 AND RUNNINGAVG(unit_price) > 350
SEQUENCE BY qty_ordered;

```

- Apply a search condition to the result of a sequence function, use a derived table for the SEQUENCE BY query, and use the derived column in the WHERE clause:

```

SELECT ordernum, partnum, runavg_price
FROM
    ( SELECT ordernum, partnum, RUNNINGAVG(unit_price)
        FROM odetail SEQUENCE BY qty_ordered )
    AS tab2 (ordernum, partnum, runavg_price)
WHERE ordernum > 800000 AND
runavg_price > 350;

```

6.4.2. Examples of SEQUENCE BY

- Sequentially number each row for the entire result and also number the rows for each part number:

```

SELECT
    RUNNINGCOUNT(*) AS RCOUNT
    , MOVINGCOUNT(*,ROWS SINCE (d.partnum<>THIS(d.partnum))) AS MCOUNT
    , d.partnum
FROM orders o, odetail d
WHERE o.ordernum=d.ordernum
SEQUENCE BY d.partnum, o.order_date, o.ordernum
ORDER BY d.partnum, o.order_date, o.ordernum;

```

RCOUNT	MCOUNT	Part/Num
1		212
2		212
3		244
4		244
5		244
...
67	1	7301
68	2	7301
69	3	7301
70	4	7301

--- 70 row(s) selected.

- Show the orders for each date, the amount for each order item and the moving total for each order, and the running total of all the orders. The query sequences orders by date, order number, and part number. (The CAST function is used for readability only.)

```

SELECT
  o.ordernum
, CAST (MOVINGCOUNT(*,ROWS SINCE(THIS(o.ordernum) <> o.ordernum)) AS INT) AS MCOUNT
, d.partnum
, o.order_date
, (d.unit_price * d.qty_ordered) AS AMOUNT
, MOVINGSUM (d.unit_price * d.qty_ordered, SEQUENCE BY Clause 269 ROWS
SINCE(THIS(o.ordernum)<>o.ordernum) ) AS ORDER_TOTAL
, RUNNINGSUM (d.unit_price * d.qty_ordered) AS TOTAL_SALES
FROM orders o, odetail d
WHERE o.ordernum=d.ordernum
SEQUENCE BY o.order_date, o.ordernum, d.partnum
ORDER BY o.order_date, o.ordernum, d.partnum;

```

Order/Num	MCOUNT	Part/Num	Order/Date	AMOUNT	ORDER_TOTAL	TOTAL_SALES
100250	1	244	2008-01-23	14000.00	14000.00	14000.00
100250	2	5103	2008-01-23	4000.00	18000.00	18000.00
100250	3	6500	2008-01-23	950.00	18950.00	18950.00
200300	1	244	2008-02-06	28000.00	28000.00	46950.00
200300	2	2001	2008-02-06	10000.00	38000.00	56950.00
200300	3	2002	2008-02-06	14000.00	52000.00	70950.00
...
800660	18	7102	2008-10-09	1650.00	187360.00	113295.00
800660	19	7301	2008-10-09	5100.00	192460.00	1118395.00

--- 69 row(s) selected.

For example, for order number 200300, the ORDER_TOTAL is a moving sum within the order date 2008-02-06, and the TOTAL_SALES is a running sum for all orders. The current window for the moving sum is defined as ROWS SINCE (THIS(o.ordernum)<>o.ordernum), which restricts the ORDER_TOTAL to the current order number.

- Show the amount of time between orders by calculating the interval between two dates:

```
SELECT RUNNINGCOUNT(*),o.order_date,DIFF1(o.order_date)
FROM orders o
SEQUENCE BY o.order_date, o.ordernum
ORDER BY o.order_date, o.ordernum ;
```

(EXPR)	Order/Date (EXPR)	
1	2008-01-23	?
2	2008-02-06	14
3	2008-02-17	11
4	2008-03-03	14
5	2008-03-19	16
6	2008-03-19	0
7	2008-03-27	8
8	2008-04-10	14
9	2008-04-20	10
10	2008-05-12	22
11	2008-06-01	20
12	2008-07-21	50
13	2008-10-09	80

```
--- 13 row(s) selected.
```

6.5. TRANSPOSE Clause

The TRANSPOSE clause of the SELECT statement generates for each row of the SELECT source table a row for each item in the transpose item list. The result table of the TRANSPOSE clause has all the columns of the source table plus, for each transpose item list, a value column or columns and an optional key column.

TRANSPOSE is a Trafodion SQL extension.

```

TRANSPOSE transpose-set [transpose-set]...
  [KEY BY key-colname]

transpose-set is:
  transpose-item-list AS transpose-col-list

transpose-item-list is:
  expression-list
| (expression-list) [, (expression-list)]...

expression-list is:
  expression [, expression]...

transpose-col-list is:
  colname | (colname-list)

colname-list is:
  colname [, colname]...

```

- *transpose-item-list AS transpose-col-list*

specifies a *transpose-set*, which correlates a *transpose-item-list* with a *transpose-col-list*. The *transpose-item-list* can be a list of expressions or a list of expression lists enclosed in parentheses. The *transpose-col-list* can be a single column name or a list of column names enclosed in parentheses.

For example, in the *transpose-set* TRANSPOSE (A,X),(B,Y),(C,Z) AS (V1,V2), the items in the *transpose-item-list* are (A,X),(B,Y), and (C,Z), and the *transpose-col-list* is (V1,V2). The number of expressions in each item must be the same as the number of value columns in the column list.

In the example TRANSPOSE A,B,C AS V, the items are A,B, and C, and the value column is V. This form can be thought of as a shorter way of writing TRANSPOSE (A),(B),© AS (V).

- *transpose-item-list*

specifies a list of items. An item is a value expression or a list of value expressions enclosed in parentheses.

- *expression-list*

specifies a list of SQL value expressions, separated by commas. The expressions must have compatible data types.

For example, in the transpose set TRANPOSE A,B,C AS V, the expressions A,B, and C have compatible data types.

- *(expression-list) [, (expression-list)]&8230;*

specifies a list of expressions enclosed in parentheses, followed by another list of expressions enclosed in parentheses, and so on. The number of expressions within parentheses must be equal for each list. The expressions in the same ordinal position within the parentheses must have compatible data types.

For example, in the transpose set TRANPOSE (A,X),(B,Y),(C,Z) AS (V1,V2), the expressions A,B, and C have compatible data types, and the expressions X,Y, and Z have compatible data types.

- *transpose-col-list*

specifies the columns that consist of the evaluation of expressions in the item list as the expressions are applied to rows of the source table.

- *colname*

is an SQL identifier that specifies a column name. It identifies the column consisting of the values in *expression-list*.

For example, in the transpose set TRANPOSE A,B,C AS V, the column V corresponds to the values of the expressions A,B, and C.

- *(colname-list)*

specifies a list of column names enclosed in parentheses. Each column consists of the values of the expressions in the same ordinal position within the parentheses in the transpose item list.

For example, in the transpose set TRANPOSE (A,X),(B,Y),(C,Z) AS (V1,V2), the column V1 corresponds to the expressions A,B, and C, and the column V2 corresponds to the expressions X,Y, and Z.

- KEY BY *key-colname*

optionally specifies which expression (the value in the transpose column list corresponds to) by its position in the item list. *key-colname* is an SQL identifier. The data type of the key column is exact numeric, and the value is NOT NULL.

6.5.1. Considerations for TRANSPOSE

Multiple TRANSPOSE Clauses and Sets

- Multiple TRANSPOSE clauses can be used in the same query. For example:

```
SELECT keycol1, valcol1, keycol2, valcol2
FROM mytable
TRANSPOSE a, b, c AS valcol1 KEY BY keycol1
TRANSPOSE d, e, f AS valcol2 KEY BY keycol2
```

- A TRANSPOSE clause can contain multiple transpose sets. For example:

```
SELECT keycol, valcol1, valcol2
FROM mytable
TRANSPOSE a, b, c AS valcol1
      d, e, f AS valcol2
KEY BY keycol
```

Degree and Column Order of the TRANSPOSE Result

The degree of the TRANSPOSE result is the degree of the source table (the result table derived from the table reference or references in the FROM clause and a WHERE clause if specified), plus one if the key column is specified, plus the cardinalities of all the transpose column lists.

The columns of the TRANSPOSE result are ordered beginning with the columns of the source table, followed by the key column if specified, and then followed by the list of column names in the order in which they are specified.

Data Type of the TRANSPOSE Result

The data type of each of the value columns is the union compatible data type of the corresponding expressions in the *transpose-item-list*. You cannot have expressions with data types that are not compatible in a *transpose-item-list*.

For example, in TRANSPOSE (A,X),(B,Y),(C,Z) AS (V1,V2), the data type of V1 is the union compatible type for A, B, and C, and the data type of V2 is the union compatible type for X, Y, and Z.

See [Comparable and Compatible Data Types](#).

Cardinality of the TRANSPOSE Result

The items in each *transpose-item-list* are enumerated from 1 to N, where N is the total number of items in all the item lists in the transpose sets.

In this example with a single transpose set, the value of N is 3:

```
TRANSPOSE (a,x),(b,y),(c,z) AS (v1,v2)
```

In this example with two transpose sets, the value of N is 5:

```
TRANSPOSE (a,x),(b,y),(c,z) AS (v1,v2) l,m AS v3
```

The values 1 to N are the key values *k_i*. The items in each *_transpose-item-list* are the expression values *v_i*.

The cardinality of the result of the TRANSPOSE clause is the cardinality of the source table times N, the total number of items in all the transpose item lists.

For each row of the source table and for each value in the key values *k_i*, the TRANSPOSE result contains a row with all the attributes of the source table, the key value *k_i* in the key column, the expression values *v_i* in the value columns of the corresponding transpose set, and NULL in the value columns of other transpose sets.

For example, consider this TRANSPOSE clause:

```
TRANSPOSE (a,x),(b,y),(c,z) AS (v1,v2)
      l,m AS v3
KEY BY k
```

The value of N is 5. One row of the SELECT source table produces this TRANSPOSE result:

columns-of-source	K	V1	V2	V3
source-row	1	value-of-A	value-of-X	NULL
source-row	2	value-of-B	value-of-Y	NULL
source-row	3	value-of-C	value-of-Z	NULL
source-row	4	NULL	NULL	value-of-L
source-row	5	NULL	NULL	value-of-M

6.5.2. Examples of TRANSPOSE

- Suppose that MYTABLE has been created as:

```
CREATE TABLE mining.mytable
( A INTEGER, B INTEGER, C INTEGER, D CHAR(2), E CHAR(2), F CHAR(2) );
```

The table MYTABLE has columns A, B, C, D, E, and F with related data. The columns A, B, and C are type INTEGER, and columns D, E, and F are type CHAR.

A	B	C	D	E	F
1	10	100	d1	e1	f1
2	20	200	d2	e2	f2

- Suppose that MYTABLE has only the first three columns: A, B, and C. The result of the TRANSPOSE clause has three times as many rows (because three items exist in the transpose item list) as rows exist in MYTABLE:

```
SELECT * FROM mytable
TRANSPOSE a, b, c AS valcol KEY BY keycol;
```

The result table of the TRANSPOSE query is:

A	B	C	D	E	F	KEYCOL	VALCOL
1	10	100	d1	e1	f1	1	1
1	10	100	d1	e1	f1	2	10
1	10	100	d1	e1	f1	3	100
2	20	200	d2	e2	f2	1	2
2	20	200	d2	e2	f2	2	20
2	20	200	d2	e2	f2	3	200

- This query shows that the items in the transpose item list can be any valid scalar expressions:

```
SELECT keycol, valcol, a, b, c FROM mytable
TRANSPOSE a + b, c + 3, 6 AS valcol KEY BY keycol;
```

The result table of the TRANSPOSE query is:

KEYCOL	VALCOL	A	B	C
1	1	1	10	100
2	103	1	10	100
3	6	1	10	100
1	22	2	20	200
2	203	2	20	200
3	6	2	20	200

- This query shows how the TRANSPOSE clause can be used with a GROUP BY clause. This query is typical of queries used to obtain cross-table information, where A, B, and C are the independent variables, and D is the dependent variable.

```
SELECT keycol, valcol, d, COUNT(*)
FROM mytable
TRANSPOSE a, b, c AS valcol
KEY BY keycol
GROUP BY keycol, valcol, d;
```

The result table of the TRANSPOSE query is:

KEYCOL	VALCOL	D	COUNT(*)
1	1	d1	1
2	10	d1	1
3	100	d1	1
1	2	d2	1
2	20	d2	1
3	200	d2	1

- This query shows how to use COUNT applied to VALCOL. The result table of the TRANSPOSE query shows the number of distinct values in VALCOL.

```
SELECT COUNT(DISTINCT valcol) FROM mytable
TRANSPOSE a, b, c AS valcol KEY BY keycol
GROUP BY keycol;

(EXPR)
-----
2
2
2

--- 3 row(s) selected.
```

- This query shows how multiple TRANSPOSE clauses can be used in the same query. The result table from this query has nine times as many rows as rows exist in MYTABLE:

```
SELECT keycol1, valcol1, keycol2, valcol2 FROM mytable
TRANSPOSE a, b, c AS valcol1 KEY BY keycol1
TRANSPOSE d, e, f AS valcol2 KEY BY keycol2;
```

The result table of the TRANSPOSE query is:

KEYCOL1	VALCOL1	KEYCOL2	VALCOL2
1	1	1	d1
1	1	2	e1
1	1	3	f1
2	10	1	d1
2	10	2	e1
2	10	3	f1
3	100	1	d1
3	100	2	e1
3	100	3	f1
1	2	1	d2
1	2	2	e2
1	2	3	f2
2	20	1	d2
2	20	2	e2
2	20	3	f2
3	200	1	d2
3	200	2	e2
3	200	3	f2

- This query shows how a TRANSPOSE clause can contain multiple transpose sets—that is, multiple *transpose-item-list* AS *transpose-col-list*. The expressions A, B, and C are of type integer, and expressions D, E, and F are of type character.

```
SELECT keycol, valcol1, valcol2
FROM mytable
TRANSPOSE a, b, c AS valcol1
          d, e, f AS valcol2
KEY BY keycol;
```

The result table of the TRANSPOSE query is:

KEYCOL	VALCOL1	VALCOL2
1	1	?
2	10	?
3	100	?
4	?	d1
5	?	e1
6	?	f1
1	2	?
2	20	?
3	200	?
4	?	d2
5	?	e2
6	?	f2

A question mark (?) in a value column indicates no value for the given KEYCOL.

- This query shows how the preceding query can include a GROUP BY clause:

```
SELECT keycol, valcol1, valcol2, COUNT(*)
FROM mytable
TRANSPOSE a, b, c AS valcol1
          d, e, f AS valcol2
KEY BY keycol
GROUP BY keycol, valcol1, valcol2;
```

The result table of the TRANSPOSE query is:

KEYCOL	VALCOL1	VALCOL2	(EXPR)
1	1	?	1
2	10	?	1
3	100	?	1
1	2	?	1

KEYCOL	VALCOL1	VALCOL2	(EXPR)
2	20	?	1
3	200	?	1
4	?	d2	1
5	?	e2	1
6	?	f2	1
4	?	d1	1
5	?	e1	1
6	?	f1	1

- This query shows how an item in the transpose item list can contain a list of expressions and that the KEY BY clause is optional:

```
SELECT * FROM mytable
TRANSPOSE (1, A, 'abc'), (2, B, 'xyz') AS (VALCOL1, VALCOL2, VALCOL3);
```

The result table of the TRANSPOSE query is:

A	B	C	D	E	F	VALCOL1	VALCOL2	VALCOL3
1	10	100	d1	e1	f1	1	1	abc
1	10	100	d1	e1	f1	2	10	xyz
2	20	200	d2	e2	f2	1	2	abc
2	20	200	d2	e2	f2	2	20	xyz

Chapter 7. SQL Functions and Expressions

This section describes the syntax and semantics of specific functions and expressions that you can use in Trafodion SQL statements. The functions and expressions are categorized according to their functionality.

7.1. Standard Normalization

For datetime functions, the definition of standard normalization is: If the ending day of the resulting date is invalid, the day will be rounded DOWN to the last day of the result month.

7.2. Aggregate (Set) Functions

An aggregate (or set) function operates on a group or groups of rows retrieved by the SELECT statement or the subquery in which the aggregate function appears.

AVG Function	Computes the average of a group of numbers derived from the evaluation of the expression argument of the function.
COUNT Function	Counts the number of rows that result from a query (by using *) or the number of rows that contain a distinct value in the one-column table derived from the expression argument of the function (optionally distinct values).
GROUP_CONCAT Function	This function returns a string result with the concatenated non-NULL values from a group.
MAX/MAXIMUM Function	Determines a maximum value from the group of values derived from the evaluation of the expression argument.
MIN Function	Determines a minimum value from the group of values derived from the evaluation of the expression argument.
STDDEV Function	Computes the statistical standard deviation of a group of numbers derived from the evaluation of the expression argument of the function. The numbers can be weighted.
SUM Function	Computes the sum of a group of numbers derived from the evaluation of the expression argument of the function. "VARIANCE Function" Computes the statistical variance of a group of numbers derived from the evaluation of the expression argument of the function. The numbers can be weighted.

Columns and expressions can be arguments of an aggregate function. The expressions cannot contain aggregate functions or subqueries.

An aggregate function can accept an argument specified as DISTINCT, which eliminates duplicate values before the aggregate function is applied. See [DISTINCT Aggregate Functions](#).

If you include a GROUP BY clause in the SELECT statement, the columns you refer to in the select list must be either grouping columns or arguments of an aggregate function. If you do not include a GROUP BY clause but you specify an aggregate function in the select list, all rows of the SELECT result table form the one and only group.

See the individual entry for the function.

7.3. Character String Functions

These functions manipulate character strings and use a character value expression as an argument or return a result of a character data type. Character string functions treat each single-byte or multi-byte character in an input string as one character, regardless of the byte length of the character.

ASCII Function	Returns the ASCII code value of the first character of a character value expression.
CHAR Function	Returns the specified code value in a character set.
CHAR_LENGTH Function	Returns the number of characters in a string. You can also use CHARACTER_LENGTH.
CODE_VALUE Function	Returns an unsigned integer that is the code point of the first character in a character value expression that can be associated with one of the supported character sets.
CONCAT Function	Returns the concatenation of two character value expressions as a string value. You can also use the concatenation operator ().
INSERT Function	Returns a character string where a specified number of characters within the character string have been deleted and then a second character string has been inserted at a specified start position.
LCASE Function	Down-shifts alphanumeric characters. You can also use LOWER.
LEFT Function	Returns the leftmost specified number of characters from a character expression.
LOCATE Function	Returns the position of a specified substring within a character string. You can also use POSITION.
LOWER Function	Down-shifts alphanumeric characters. You can also use LCASE.
LPAD Function	Replaces the leftmost specified number of characters in a character expression with a padding character.
LTRIM Function	Removes leading spaces from a character string.
OCTET_LENGTH Function	Returns the length of a character string in bytes.
POSITION Function	Returns the position of a specified substring within a character string. You can also use LOCATE.
REPEAT Function	Returns a character string composed of the evaluation of a character expression repeated a specified number of times.
REPLACE Function	Returns a character string where all occurrences of a specified character string in the original string are replaced with another character string.
RIGHT Function	Returns the rightmost specified number of characters from a character expression.
RPAD Function	Replaces the rightmost specified number of characters in a character expression with a padding character.
RTRIM Function	Removes trailing spaces from a character string.
SPACE Function	Returns a character string consisting of a specified number of spaces.
SUBSTRING/SUBSTR Function	Extracts a substring from a character string.
TRANSLATE Function	Translates a character string from a source character set to a target character set.
TRIM Function	Removes leading or trailing characters from a character string.
UCASE Function	Up-shifts alphanumeric characters. You can also use UPSHIFT or UPPER.
UPPER Function	Up-shifts alphanumeric characters. You can also use UPSHIFT or UCASE.
UPSHIFT Function	Up-shift alphanumeric characters. You can also use UPPER or UCASE.

See the individual entry for the function.

7.4. Datetime Functions

These functions use either a datetime value expression as an argument or return a result of datetime data type:

ADD_MONTHS Function	Adds the integer number of months specified by <i>intr_expr</i> to <i>datetime_expr</i> and normalizes the result.
CONVERTTIMESTAMP Function	Converts a Julian timestamp to a TIMESTAMP value.
CURRENT Function	Returns the current timestamp. You can also use the CURRENT_TIMESTAMP Function .
CURRENT_DATE Function	Returns the current date.
CURRENT_TIME Function	Returns the current time.
CURRENT_TIMESTAMP Function	Returns the current timestamp. You can also use the CURRENT Function .
DATE_ADD Function	Adds the interval specified by <i>interval_expression</i> to <i>datetime_expr</i> .
DATE_PART Function (of an Interval)	Extracts the datetime field specified by <i>text</i> from the interval value specified by <i>interval</i> and returns the result as an exact numeric value.
DATE_PART Function (of a Timestamp)	Extracts the datetime field specified by <i>text</i> from the datetime value specified by <i>timestamp</i> and returns the result as an exact numeric value.
DATE_SUB Function	Subtracts the specified <i>interval_expression</i> from <i>datetime_expr</i> .
DATE_TRUNC Function	Returns the date with the time portion of the day truncated.
DATEADD Function	Adds the interval specified by <i>datepart</i> and <i>num_expr</i> to <i>datetime_expr</i> .
DATEDIFF Function	Returns the integer value for the number of <i>datepart</i> units of time between <i>startdate</i> and <i>enddate</i> .
DATEFORMAT Function	Formats a datetime value for display purposes.
DAY Function	Returns an integer value in the range 1 through 31 that represents the corresponding day of the month. You can also use DAYOFMONTH.
DAYNAME Function	Returns the name of the day of the week from a date or timestamp expression.
DAYOFMONTH Function	Returns an integer value in the range 1 through 31 that represents the corresponding day of the month. You can also use DAY.
DAYOFWEEK Function	Returns an integer value in the range 1 through 7 that represents the corresponding day of the week.
DAYOFYEAR Function	Returns an integer value in the range 1 through 366 that represents the corresponding day of the year.
EXTRACT Function	Returns a specified datetime field from a datetime value expression or an interval value expression.
HOUR Function	Returns an integer value in the range 0 through 23 that represents the corresponding hour of the day.
JULIANTIMESTAMP Function	Converts a datetime value to a Julian timestamp.
MINUTE Function	Returns an integer value in the range 0 through 59 that represents the corresponding minute of the hour.
MONTH Function	Returns an integer value in the range 1 through 12 that represents the corresponding month of the year.
MONTHNAME Function	Returns a character literal that is the name of the month of the year (January, February, and so on).
QUARTER Function	Returns an integer value in the range 1 through 4 that represents the corresponding quarter of the year.

SECOND Function	Returns an integer value in the range 0 through 59 that represents the corresponding second of the minute.
TIMESTAMPADD Function	Adds the interval of time specified by <i>interval-ind</i> and <i>num_expr</i> to <i>datetime_expr</i> .
TIMESTAMPDIFF Function	Returns the integer value for the number of <i>interval-ind</i> units of time between <i>startdate</i> and <i>enddate</i> .
TO_CHAR Function	Converts a datetime value to a character value.
TO_DATE Function	Converts a character value to a date or timestamp value.
TO_TIME Function	Converts a character value to a time value.
TO_TIMESTAMP Function	Converts a character value to a timestamp value.
WEEK Function	Returns an integer value in the range 1 through 54 that represents the corresponding week of the year.
YEAR Function	Returns an integer value that represents the year.

See the individual entry for the function.

7.5. Mathematical Functions

Use these mathematical functions within an SQL numeric value expression:

ABS Function	Returns the absolute value of a numeric value expression.
ACOS Function	Returns the arccosine of a numeric value expression as an angle expressed in radians.
ASIN Function	Returns the arcsine of a numeric value expression as an angle expressed in radians.
ATAN Function	Returns the arctangent of a numeric value expression as an angle expressed in radians.
ATAN2 Function	Returns the arctangent of the x and y coordinates, specified by two numeric value expressions, as an angle expressed in radians.
CEILING Function	Returns the smallest integer greater than or equal to a numeric value expression.
COS Function	Returns the cosine of a numeric value expression, where the expression is an angle expressed in radians.
CRC32 Function	Returns CRC32 checksum
COSH Function	Returns the hyperbolic cosine of a numeric value expression, where the expression is an angle expressed in radians.
DEGREES Function	Converts a numeric value expression expressed in radians to the number of degrees.
EXP Function	Returns the exponential value (to the base e) of a numeric value expression.
FLOOR Function	Returns the largest integer less than or equal to a numeric value expression.
LOG Function	Returns the natural logarithm of a numeric value expression.
LOG10 Function	Returns the base 10 logarithm of a numeric value expression.
MOD Function	Returns the remainder (modulus) of an integer value expression divided by an integer value expression.
NULLIFZERO Function	Returns the value of the operand unless it is zero, in which case it returns NULL.
PI Function	Returns the constant value of pi as a floating-point value.
POWER Function	Returns the value of a numeric value expression raised to the power of an integer value expression. You can also use the exponential operator <code>**</code> .
RADIANS Function	Converts a numeric value expression expressed in degrees to the number of radians.
ROUND Function	Returns the value of <i>numeric_expr</i> round to <i>num</i> places to the right of the decimal point.

SIGN Function	Returns an indicator of the sign of a numeric value expression. If value is less than zero, returns -1 as the indicator. If value is zero, returns 0. If value is greater than zero, returns 1.
SIN Function	Returns the sine of a numeric value expression, where the expression is an angle expressed in radians.
SINH Function	Returns the hyperbolic sine of a numeric value expression, where the expression is an angle expressed in radians.
SQRT Function	Returns the square root of a numeric value expression.
TAN Function	Returns the tangent of a numeric value expression, where the expression is an angle expressed in radians.
TANH Function	Returns the hyperbolic tangent of a numeric value expression, where the expression is an angle expressed in radians.
ZEROIFNULL Function	Returns the value of the operand unless it is NULL, in which case it returns zero.

See the individual entry for the function.

== Encryption Functions

Use these functions within an SQL value expression to do data encryption or hashing:

[cols="25%, 75%"]	
===	
<<md5_function,MD5 Function>>	Returns MD5 checksum
<<sha_function,SHA Function>>	Returns SHA-1 160-bit checksum
<<sha2_function,SHA2 Function>>	Returns SHA-2 checksum
===	

7.6. Sequence Functions

Sequence functions operate on ordered rows of the intermediate result table of a SELECT statement that includes a SEQUENCE BY clause. Sequence functions are categorized generally as difference, moving, offset, or running.

Some sequence functions, such as ROWS SINCE, require sequentially examining every row in the history buffer until the result is computed. Examining a large history buffer in this manner for a condition that has not been true for many rows could be an expensive operation. In addition, such operations may not be parallelized because the entire sorted result set must be available to compute the result of the sequence function.

7.6.1. Difference sequence functions

DIFF1 Function	Calculates differences between values of a column expression in the current row and previous rows.
DIFF2 Function	Calculates differences between values of the result of DIFF1 of the current row and DIFF1 of previous rows.

7.6.2. Moving sequence functions

MOVINGCOUNT Function	Returns the number of non-null values of a column expression in the current window.
MOVINGMAX Function	Returns the maximum of non-null values of a column expression in the current window.
MOVINGMIN Function	Returns the minimum of non-null values of a column expression in the current window.
MOVINGSTDDEV Function	Returns the standard deviation of non-null values of a column expression in the current window.
MOVINGSUM Function	Returns the sum of non-null values of a column expression in the current window.
MOVINGVARIANCE Function	Returns the variance of non-null values of a column expression in the current window.

Offset sequence function === Offset sequence function

OFFSET Function	Retrieves columns from previous rows.
-----------------	---------------------------------------

7.6.3. Running sequence functions

RUNNINGAVG Function	Returns the average of non-null values of a column expression up to and including the current row.
RUNNINGCOUNT Function	Returns the number of rows up to and including the current row.
RUNNINGMAX Function	Returns the maximum of values of a column expression up to and including the current row.
RUNNINGMIN Function	Returns the minimum of values of a column expression up to and including the current row.
RUNNINGRANK Function	Returns the rank of the given value of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement.
RUNNINGSTDDEV Function	Returns the standard deviation of non-null values of a column expression up to and including the current row.
RUNNINGSUM Function	Returns the sum of non-null values of a column expression up to and including the current row.
RUNNINGVARIANCE Function	Returns the variance of non-null values of a column expression up to and including the current row.

7.6.4. Other sequence functions

LASTNOTNULL Function	Returns the last non-null value for the specified column expression. If only null values have been returned, returns null.
ROWS SINCE Function	Returns the number of rows counted since the specified condition was last true.
ROWS SINCE CHANGED Function	Returns the number of rows counted since the specified set of values last changed.
THIS Function	Used in ROWS SINCE to distinguish between the value of the column in the current row and the value of the column in previous rows.

See [SEQUENCE BY Clause](#) and the individual entry for each function.

7.7. Other Functions and Expressions

Use these other functions and expressions in an SQL value expression:

AUTHNAME Function	Returns the authorization name associated with the specified authorization ID number.
BITAND Function	Performs 'and' operation on corresponding bits of the two operands.
CASE (Conditional) Expression	A conditional expression. The two forms of the CASE expression are simple and searched.
CAST Expression	Converts a value from one data type to another data type that you specify.
COALESCE Function	Returns the value of the first expression in the list that does not have a NULL value or if all the expressions have NULL values, the function returns a NULL value.
CONVERTTOHEX Function	Converts the specified value expression to hexadecimal for display purposes.
CURRENT_USER Function	Returns the database user name of the current user who invoked the function.
DECODE Function	Compares <i>expr</i> to each <i>test_expr</i> value one by one in the order provided.
EXPLAIN Function	Generates a result table describing an access plan for a SELECT, INSERT, DELETE, or UPDATE statement.
ISNULL Function	Returns the first argument if it is not null, otherwise it returns the second argument.
IS_IPV4 Function	Returns 1 if the argument is a valid IPv4 address specified as a string, 0 otherwise.
IS_IPV6 Function	Returns 1 if the argument is a valid IPv6 address specified as a string, 0 otherwise.
INET_ATON Function	Given the dotted-quad representation of an IPv4 network address as a string, returns an integer that represents the numeric value of the address in network byte order (big endian). INET_ATON() returns NULL if it does not understand its argument.
INET_NTOA Function	Given a numeric IPv4 network address in network byte order, returns the dotted-quad string representation of the address as a nonbinary string in the connection character set. INET_NTOA() returns NULL if it does not understand its argument.
NULLIF Function	Returns the value of the first operand if the two operands are not equal, otherwise it returns NULL.
NVL Function	Returns the value of the first operand unless it is NULL, in which case it returns the value of the second operand.
USER Function	Returns either the database user name of the current user who invoked the function or the database user name associated with the specified user ID number.

See the individual entry for the function.

7.8. ABS Function

The ABS function returns the absolute value of a numeric value expression. ABS is a Trafodion SQL extension.

```
ABS (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the ABS function. The result is returned as an unsigned numeric value if the precision of the argument is less than 10 or as a LARGEINT if the precision of the argument is greater than or equal to 10. See [Numeric Value Expressions](#).

7.8.1. Examples of ABS

- This function returns the value 8:

```
ABS (-20 + 12)
```

7.9. ACOS Function

The ACOS function returns the arccosine of a numeric value expression as an angle expressed in radians.

ACOS is a Trafodion SQL extension.

```
ACOS (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the ACOS function. The range for the value of the argument is from -1 to +1. See [Numeric Value_Expressions](#).

7.9.1. Examples of ACOS

- The ACOS function returns the value 3.49044274380724416E-001 or approximately 0.3491 in radians (which is 20 degrees).

```
ACOS (0.9397)
```

- This function returns the value 0.3491. The function ACOS is the inverse of the function COS.

```
ACOS (COS (0.3491))
```

7.9.2. ADD_MONTHS Function

The ADD_MONTHS function adds the integer number of months specified by *int_expr* to *datetime_expr* and normalizes the result. ADD_MONTHS is a Trafodion SQL extension.

```
ADDMONTHS (datetimeexpr, intexpr [, int2 ])
```

- *datetime_expr*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. The return value is the same type as the *datetime_expr*. See [Datetime Value Expressions](#).

- *int_expr*

is an SQL numeric value expression of data type SMALLINT or INTEGER that specifies the number of months. See [Numeric Value Expressions](#).

- *int2*

is an unsigned integer constant. If *int2* is omitted or is the literal 0, the normalization is the standard normalization. If *int2* is the literal 1, the normalization includes the standard normalization and if the starting day (the day part of *datetime_expr*) is the last day of the starting month, then the ending day (the day part of the result value) is set to the last valid day of the result month. See [Standard Normalization](#). See [Numeric Value Expressions](#).

7.9.3. Examples of ADD_MONTHS

- This function returns the value DATE '2007-03-31':

```
ADD_MONTHS(DATE '2007-02-28', 1, 1)
```

- This function returns the value DATE '2007-03-28':

```
ADD_MONTHS(DATE '2007-02-28', 1, 0)
```

- This function returns the value DATE '2008-03-28':

```
ADD_MONTHS(DATE '2008-02-28', 1, 1)
```

- This function returns the timestamp '2009-02-28 00:00:00':

```
ADD_MONTHS(timestamp '2008-02-29 00:00:00', 12, 1)
```

7.10. ASCII Function

The ASCII function returns the integer that is the ASCII code of the first character in a character string expression associated with either the ISO8891 character set or the UTF8 character set.

ASCII is a Trafodion SQL extension.

```
ASCII (character-expression)
```

- *_character-expression*

is an SQL character value expression that specifies a string of characters. See [Character Value Expressions](#).

7.10.1. Considerations For ASCII

For a string expression in the UTF8 character set, if the value of the first byte in the string is greater than 127, Trafodion SQL returns this error message:

```
ERROR[8428] The argument to function ASCII is not valid.
```

7.10.2. Examples of ASCII

- Select the column JOBDESC and return the ASCII code of the first character of the job description:

```
SELECT jobdesc, ASCII (jobdesc) FROM persnl.job;
```

JOBDESC	(EXPR)
MANAGER	77
PRODUCTION SUPV	80
ASSEMBLER	65
SALESREP	83
...	...
--- 10 row(s) selected.	

7.11. ASIN Function

The ASIN function returns the arcsine of a numeric value expression as an angle expressed in radians.

ASIN is a Trafodion SQL extension.

```
ASIN (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the ASIN function. The range for the value of the argument is from -1 to +1. See [Numeric Value Expressions](#).

7.11.1. Considerations for ASCII

For a string expression in the UTF8 character set, if the value of the first byte in the string is greater than 127, Trafodion SQL returns this error message:

```
ERROR[8428] The argument to function ASCII is not valid.
```

7.11.2. Examples of ASCII

- Select the column JOBDESC and return the ASCII code of the first character of the job description:

```
SELECT jobdesc, ASCII (jobdesc) FROM persnl.job;
```

JOBDESC	(EXPR)
MANAGER	77
PRODUCTION SUPV	80
ASSEMBLER	65
SALESREP	83
...	...
--- 10 row(s) selected.	

7.12. ASIN Function

The ASIN function returns the arcsine of a numeric value expression as an angle expressed in radians.

ASIN is a Trafodion SQL extension.

```
ASIN (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the ASIN function. The range for the value of the argument is from -1 to +1. See [Numeric Value Expressions](#).

7.12.1. Examples of ASIN

- This function returns the value 3.49044414403046400e-001 or approximately 0.3491 in radians (which is 20 degrees):

```
ASIN(0.3420)
```

- This function returns the value 0.3491. The function ASIN is the inverse of the function SIN.

```
ASIN(SIN(0.3491))
```

7.13. ATAN Function

The ATAN function returns the arctangent of a numeric value expression as an angle expressed in radians.

ATAN is a Trafodion SQL extension.

```
ATAN ( numeric-expression )
```

- numeric-expression

is an SQL numeric value expression that specifies the value for the argument of the atan function. See [Numeric Value Expressions](#).

7.13.1. Examples of ATAN

- This function returns the value 8.72766423249958272E-001 or approximately 0.8727 in radians (which is 50 degrees):

```
ATAN (1.192)
```

- This function returns the value 0.8727. The function ATAN is the inverse of the function TAN.

```
ATAN (TAN (0.8727))
```

7.14. ATAN2 Function

The ATAN2 function returns the arctangent of the x and y coordinates, specified by two numeric value expressions, as an angle expressed in radians.

ATAN2 is a Trafodion SQL extension.

```
ATAN2 (numeric-expression-x, numeric-expression-y)
```

- *numeric-expression-x, numeric-expression-y*

are SQL numeric value expressions that specify the value for the x and y coordinate arguments of the ATAN2 function.

See [Numeric Value Expressions](#).

7.14.1. Examples of ATAN2

- This function returns the value 2.66344329881899520E+000, or approximately 2.6634:

```
ATAN2 (1.192,-2.3)
```

7.15. AUTHNAME Function

The AUTHNAME function returns the name of the authorization ID that is associated with the specified authorization ID number.

```
AUTHNAME (auth-id)
```

- *auth-id*

is the 32-bit number associated with an authorization ID. See [Authorization IDs](#).

The AUTHNAME function is similar to the [USER Function](#).

7.15.1. Considerations for AUTHNAME

- This function can be specified only in the top level of a SELECT statement.
- The value returned is string data type VARCHAR(128) and is in ISO8859-1 encoding.

7.15.2. Examples of AUTHNAME

- This example shows the authorization name associated with the authorization ID number, 33333:

```
>>SELECT AUTHNAME (33333) FROM (values(1)) x(a);  
  
(EXPR)  
-----  
DB ROOT  
  
--- 1 row(s) selected.
```

7.16. AVG Function

AVG is an aggregate function that returns the average of a set of numbers.

```
AVG ([ALL | DISTINCT] expression)
```

- ALL | DISTINCT

specifies whether duplicate values are included in the computation of the AVG of the *expression*. The default option is ALL, which causes duplicate values to be included. If you specify DISTINCT, duplicate values are eliminated before the AVG function is applied.

- *expression*

specifies a numeric or interval value *expression* that determines the values to average. The *expression* cannot contain an aggregate function or a subquery. The DISTINCT clause specifies that the AVG function operates on distinct values from the one-column table derived from the evaluation of *expression*.

See [Numeric Value Expressions](#) and [Interval Value Expressions](#).

7.16.1. Considerations for AVG

Data Type of the Result

The data type of the result depends on the data type of the argument. If the argument is an exact numeric type, the result is LARGEINT. If the argument is an approximate numeric type, the result is DOUBLE PRECISION. If the argument is INTERVAL data type, the result is INTERVAL with the same precision as the argument.

The scale of the result is the same as the scale of the argument. If the argument has no scale, the result is truncated.

Operands of the Expression

The expression includes columns from the rows of the SELECT result table but cannot include an aggregate function. These expressions are valid:

```
AVG (SALARY)
AVG (SALARY * 1.1)
AVG (PARTCOST * QTY_ORDERED)
```

Nulls

All nulls are eliminated before the function is applied to the set of values. If the result table is empty, AVG returns NULL.

Examples of AVG

- Return the average value of the SALARY column:

```
SELECT AVG (salary) FROM persnl.employee;
(EXPR)
-----
49441.52
--- 1 row(s) selected.
```

- Return the average value of the set of unique SALARY values:

```
SELECT AVG(DISTINCT salary) AS Avg_Distinct_Salary FROM persnl.employee;
AVG_DISTINCT_SALARY
-----
53609.89
--- 1 row(s) selected.
```

- Return the average salary by department:

```
SELECT deptnum, AVG (salary) AS "AVERAGE SALARY"
FROM persnl.employee
WHERE deptnum < 3000 GROUP BY deptnum;

Dept/Num "AVERAGE SALARY"
-----
1000      52000.17
2000      50000.10
1500      41250.00
2500      37000.00
--- 4 row(s) selected.
```

7.17. BITAND Function

The BITAND function performs an AND operation on corresponding bits of the two operands. If both bits are 1, the result bit is 1. Otherwise the result bit is 0.

```
BITAND (expression, expression)
```

- *expression*

The result data type is a binary number. Depending on the precision of the operands, the data type of the result can either be an INT (32-bit integer) or a LARGEINT (64-bit integer).

If the max precision of either operand is greater than 9, LARGEINT is chosen (numbers with precision greater than 9 are represented by LARGEINT). Otherwise, INT is chosen.

If both operands are unsigned, the result is unsigned. Otherwise, the result is signed. Both operands are converted to the result data type before performing the bit operation.

7.17.1. Considerations for BITAND

BITAND can be used anywhere in an SQL query where an expression could be used. This includes SELECT lists, WHERE predicates, VALUES clauses, SET statement, and so on.

This function returns a numeric data type and can be used in arithmetic expressions.

Numeric operands can be positive or negative numbers. All numeric data types are allowed with the exceptions listed in the [Restrictions for BITAND](#) section.

Restrictions for BITAND

The following are BITAND restrictions:

- Must have two operands
- Operands must be binary or decimal exact numerics
- Operands must have scale of zero
- Operands cannot be floating point numbers
- Operands cannot be an extended precision numeric (the maximum precision of an extended numeric data type is 128)

7.17.2. Examples of BITAND

```
>>select bitand(1,3) from (values(1)) x(a);  
  
(EXPR)  
-----  
1  
--- 1 row(s) selected  
  
>>select 1 & 3 from (values(1)) x(a);  
  
(EXPR)  
-----  
1  
--- 1 row(s) selected  
  
>>select bitand(1,3) + 0 from (values(1)) x(a);  
  
(EXPR)  
-----  
1  
--- 1 row(s) selected
```

7.18. CASE (Conditional) Expression

The CASE expression is a conditional expression with two forms: simple and searched.

In a simple CASE expression, Trafodion SQL compares a value to a sequence of values and sets the CASE expression to the value associated with the first match — if a match exists. If no match exists, Trafodion SQL returns the value specified in the ELSE clause (which can be null).

In a searched CASE expression, Trafodion SQL evaluates a sequence of conditions and sets the CASE expression to the value associated with the first condition that is true — if a true condition exists. If no true condition exists, Trafodion SQL returns the value specified in the ELSE clause (which can be null).

Simple CASE is:

```
CASE case-expression
  WHEN expression-1 THEN {result-expression-1 | NULL}
  WHEN expression-2 THEN {result-expression-2 | NULL}
  ...
  WHEN expression-n THEN {result-expression-n | NULL}
    [ELSE {result-expression | NULL}]
END
```

Searched CASE is:

```
CASE
  WHEN _condition-1_ THEN {_result-expression-1_ | NULL}
  WHEN _condition-2_ THEN {_result-expression-2_ | NULL}
  ...
  WHEN _condition-n_ THEN {_result-expression-n_ | NULL}
    [ELSE {_result-expression_ | NULL}]
END
```

- *case-expression*

specifies a value expression that is compared to the value expressions in each WHEN clause of a simple CASE. The data type of each *expression* in the WHEN clause must be comparable to the data type of *case-expression*.

- *expression-1 ... expression-n*

specifies a value associated with each *result-expression*. If the value of an *expression* in a WHEN clause matches the value of *case-expression*, simple CASE returns the associated *result-expression* value. If no match exists, the CASE expression returns the value expression specified in the ELSE clause, or NULL if the ELSE value is not specified.

- *result-expression-1* ... *result-expression-n*

specifies the result value expression associated with each *expression* in a WHEN clause of a simple CASE, or with each *condition* in a WHEN clause of a searched CASE. All of the *result-expressions* must have comparable data types, and at least one of the *result-expressions* must return non-null.

- *result-expression*

follows the ELSE keyword and specifies the value returned if none of the expressions in the WHEN clause of a simple CASE are equal to the case expression, or if none of the conditions in the WHEN clause of a searched CASE are true. If the ELSE *result-expression* clause is not specified, CASE returns NULL. The data type of *result-expression* must be comparable to the other results.

- *condition-1* ... *condition-n*

specifies conditions to test for in a searched CASE. If a *condition* is true, the CASE expression returns the associated *result-expression* value. If no *condition* is true, the CASE expression returns the value expression specified in the ELSE clause, or NULL if the ELSE value is not specified.

7.18.1. Considerations for CASE

Data Type of the CASE Expression

The data type of the result of the CASE expression depends on the data types of the result expressions. If the results all have the same data type, the CASE expression adopts that data type. If the results have comparable but not identical data types, the CASE expression adopts the data type of the union of the result expressions. This result data type is determined in these ways.

Character Data Type

If any data type of the result expressions is variable-length character string, the result data type is variable-length character string with maximum length equal to the maximum length of the result expressions.

Otherwise, if none of the data types is variable-length character string, the result data type is fixed-length character string with length equal to the maximum of the lengths of the result expressions.

Numeric Data Type

If all of the data types of the result expressions are exact numeric, the result data type is exact numeric with precision and scale equal to the maximum of the precisions and scales of the result expressions.

For example, if *result-expression-1* and *result-expression-2* have data type NUMERIC(5) and *result-expression-3* has data type NUMERIC(8,5), the result data type is NUMERIC(10,5).

If any data type of the result expressions is approximate numeric, the result data type is approximate numeric with precision equal to the maximum of the precisions of the result expressions.

Datetime Data Type

If the data type of the result expressions is datetime, the result data type is the same datetime data type.

Interval Data Type

If the data type of the result expressions is interval, the result data type is the same interval data type (either year-month or day-time) with the start field being the most significant of the start fields of the result expressions and the end field being the least significant of the end fields of the result expressions.

7.18.2. Examples of CASE

- Use a simple CASE to decode JOBCODE and return NULL if JOBCODE does not match any of the listed values:

```

SELECT
    last_name
,   first_name
,   CASE jobcode
        WHEN 100 THEN 'MANAGER'
        WHEN 200 THEN 'PRODUCTION SUPV'
        WHEN 250 THEN 'ASSEMBLER'
        WHEN 300 THEN 'SALESREP'
        WHEN 400 THEN 'SYSTEM ANALYST'
        WHEN 420 THEN 'ENGINEER'
        WHEN 450 THEN 'PROGRAMMER'
        WHEN 500 THEN 'ACCOUNTANT'
        WHEN 600 THEN 'ADMINISTRATOR ANALYST'
        WHEN 900 THEN 'SECRETARY'
        ELSE NULL
    END
FROM persnl.employee;

```

LAST_NAME	FIRST_NAME	(EXPR)
GREEN	ROGER	MANAGER
HOWARD	JERRY	MANAGER
RAYMOND	JANE	MANAGER
...		
CHOU	JOHN	SECRETARY
CONRAD	MANFRED	PROGRAMMER
HERMAN	JIM	SALESREP
CLARK	LARRY	ACCOUNTANT
HALL	KATHRYN	SYSTEM ANALYST
...		

--- 62 row(s) selected.

- Use a searched CASE to return LAST_NAME, FIRST_NAME and a value based on SALARY that depends on the value of DEPTNUM:

```
SELECT
    last_name
,   first_name
,   deptnum
,   CASE
        WHEN deptnum = 9000 THEN salary * 1.10
        WHEN deptnum = 1000 THEN salary * 1.12 ELSE salary
    END
FROM persnl.employee;
```

LAST_NAME	FIRST_NAME	DEPTNUM	(EXPR)
GREEN	ROGER	9000	193050.0000
HOWARD	JERRY	1000	153440.1120
RAYMOND	JANE	3000	136000.0000

...

--- 62 row(s) selected.

7.19. CAST Expression

The CAST expression converts data to the data type you specify.

```
CAST ({expression | NULL} AS data-type)
```

- *expression* | *NULL*

specifies the operand to convert to the data type *data-type*.

If the operand is an *expression*, then *data-type* depends on the data type of *expression* and follows the rules outlined in [Valid Conversions for CAST](#).

If the operand is *NULL*, or if the value of the *expression* is *null*, the result of CAST is *NULL*, regardless of the data type you specify.

- *data-type*

specifies a data type to associate with the operand of CAST. See [Data Types](#).

When casting data to a CHAR or VARCHAR data type, the resulting data value is left justified. Otherwise, the resulting data value is right justified. Further, when you are casting to a CHAR or VARCHAR data type, you must specify the length of the target value.

7.19.1. Considerations for CAST

- Fractional portions are discarded when you use CAST of a numeric value to an INTERVAL type.
- Depending on how your file is set up, using CAST might cause poor query performance by preventing the optimizer from choosing the most efficient plan and requiring the executor to perform a complete table or index scan.

Valid Conversions for CAST

- An exact or approximate numeric value to any other numeric data type.
- An exact or approximate numeric value to any character string data type.
- An exact numeric value to either a single-field year-month or day-time interval such as INTERVAL DAY(2).
- A character string to any other data type, with one restriction:

The contents of the character string to be converted must be consistent in meaning with the data type of the result. For

example, if you are converting to DATE, the contents of the character string must be 10 characters consisting of the year, a hyphen, the month, another hyphen, and the day.

- A date value to a character string or to a TIMESTAMP (Trafodion SQL fills in the time part with 00:00:00.00).
- A time value to a character string or to a TIMESTAMP (Trafodion SQL fills in the date part with the current date).
- A timestamp value to a character string, a DATE, a TIME, or another TIMESTAMP with different fractional seconds precision.
- A year-month interval value to a character string, an exact numeric, or to another year-month INTERVAL with a different start field precision.
- A day-time interval value to a character string, an exact numeric, or to another day-time INTERVAL with a different start field precision.

7.19.2. Examples of CAST

- In this example, the fractional portion is discarded:

```
CAST (123.956 as INTERVAL DAY(18))
```

- This example returns the difference of two timestamps in minutes:

```
CAST((d.step_end - d.step_start) AS INTERVAL MINUTE)
```

- Suppose that your database includes a log file of user information. This example converts the current timestamp to a character string and concatenates the result to a character literal. Note the length must be specified.

```
INSERT INTO stats.logfile (user_key, user_info)
VALUES (001, 'User JBrook, executed at ' || CAST (CURRENT_TIMESTAMP AS CHAR(26)));
```

7.20. CEILING Function

The CEILING function returns the smallest integer, represented as a FLOAT data type, greater than or equal to a numeric value expression.

CEILING is a Trafodion SQL extension.

```
CEILING (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the CEILING function. See [Numeric Value Expressions](#).

7.20.1. Examples of CEILING

- This function returns the integer value 3.000000000000000E+000, represented as a FLOAT data type:

```
CEILING (2.25)
```

7.20.2. CHAR Function

The CHAR function returns the character that has the specified code value, which must be of exact numeric with scale 0.

CHAR is a Trafodion SQL extension.

```
CHAR(code-value, [ ,char-set-name ])
```

- *code-value*

is a valid code value in the character set in use.

- *char-set-name*

can be ISO88591 or UTF8. The returned character will be associated with the character set specified by *char-set-name*.

The default for *char-set-name* is ISO88591.

7.20.3. Considerations for CHAR

- For the ISO88591 character set, the return type is VARCHAR(1).
- For the UTF8 character set, the return type is VARCHAR(1).

7.20.4. Examples of CHAR

- Select the column CUSTNAME and return the ASCII code of the first character of the customer name and its CHAR value:

```
SELECT custname, ASCII (custname), CHAR (ASCII (custname))
FROM sales.customer;
```

CUSTNAME	(EXPR) (EXPR)
CENTRAL UNIVERSITY	67 C
BROWN MEDICAL CO	66 B
STEVENS SUPPLY	83 S
PREMIER INSURANCE	80 P
...
--- 15 row(s) selected.	

7.21. CHAR_LENGTH Function

The CHAR_LENGTH function returns the number of characters in a string. You can also use CHARACTER_LENGTH. Every character, including multi-byte characters, counts as one character.

```
CHAR[ACTER]_LENGTH (string-value-expression)
```

- *string-value-expression*

specifies the string value expression for which to return the length in characters. Trafodion SQL returns the result as a two-byte signed integer with a scale of zero. If *string-value-expression* is null, Trafodion SQL returns a length of null.

See [Character Value Expressions](#).

7.21.1. Considerations for CHAR_LENGTH

CHAR and VARCHAR Operands

For a column declared as fixed CHAR, Trafodion SQL returns the maximum length of that column. For a VARCHAR column, Trafodion SQL returns the actual length of the string stored in that column.

7.21.2. Examples of CHAR_LENGTH

- This function returns 12 as the result. The concatenation operator is denoted by two vertical bars (|||).

```
CHAR_LENGTH ('ROBERT' || ' ' || 'SMITH')
```

- The string " is the null (or empty) string. This function returns 0 (zero):

```
CHAR_LENGTH ('')
```

- The DEPTNAME column has data type CHAR(12). Therefore, this function always returns 12:

```
CHAR_LENGTH (deptname)
```

- The PROJDESC column in the PROJECT table has data type VARCHAR(18). This function returns the actual length of the column value — not 18 for shorter strings — because it is a VARCHAR value:

```
SELECT CHAR_LENGTH (projdesc) FROM persnl.project;  
( EXPR )  
-----  
    14  
    13  
    13  
    17  
     9  
     9  
--- 6 row(s) selected.
```

7.22. COALESCE Function

The COALESCE function returns the value of the first expression in the list that does not have a NULL value or if all the expressions have NULL values, the function returns a NULL value.

```
COALESCE (expr1, expr2, ...)
```

- *expr1*

an expression to be compared.

- *expr2*

an expression to be compared.

7.22.1. Examples of COALESCE

- COALESCE returns the value of the first operand that is not NULL:

```
SELECT COALESCE (office_phone, cell_phone, home_phone, pager, fax_num, '411')
from emptbl;
```

7.23. CODE_VALUE Function

The CODE_VALUE function returns an unsigned integer (INTEGER UNSIGNED) that is the code point of the first character in a character value expression that can be associated with one of the supported character sets.

CODE_VALUE is a Trafodion SQL extension.

```
CODE_VALUE(character-value-expression)
    character-set
```

- *character-value-expression*

is a character string.

7.23.1. Examples of CODE_VALUE Function

- This function returns 97 as the result:

```
>>select code_value('abc') from (values(1))x;
(EXPR)
-----
97
```

7.23.2. CONCAT Function

The CONCAT function returns the concatenation of two character value expressions as a character string value. You can also use the concatenation operator (||).

CONCAT is a Trafodion SQL extension.

```
CONCAT (character-expr-1, character-expr-2)
```

- *character-expr-1, character-expr-2*

are SQL character value expressions (of data type CHAR or VARCHAR) that specify two strings of characters. Both character value expressions must be either ISO8859-1 character expressions or UTF8 character expressions. The result of the CONCAT function is the concatenation of *character-expr-1* with *character-expr-2*. The result type is CHAR if both expressions are of type CHAR and it is VARCHAR if either of the expressions is of type VARCHAR. See [Character Value Expressions](#).

7.23.3. Concatenation Operator (||)

The concatenation operator, denoted by two vertical bars (||), concatenates two string values to form a new string value. To indicate that two strings are concatenated, connect the strings with two vertical bars (|||):

```
character-expr-1 || character-expr-2
```

An operand can be any SQL value expression of data type CHAR or VARCHAR.

7.23.4. Considerations for CONCAT

7.23.5. Operands

A string value can be specified by any character value expression, such as a character string literal, character string function, column reference, aggregate function, scalar subquery, CASE expression, or CAST expression. The value of the operand must be of type CHAR or VARCHAR.

If you use the CAST expression, you must specify the length of CHAR or VARCHAR.

7.23.6. SQL Parameters

You can concatenate an SQL parameter and a character value expression. The concatenated parameter takes on the data type attributes of the character value expression. Consider this example, where ?p is assigned a string value of '5 March':

```
?p || ' 2002'
```

The type assignment of the parameter ?p becomes CHAR(5), the same data type as the character literal ' 2002'. Because you assigned a string value of more than five characters to ?p, Trafodion SQL returns a truncation warning, and the result of the concatenation is 5 Mar 2002.

To specify the type assignment of the parameter, use the CAST expression on the parameter as:

```
CAST(?p AS CHAR(7)) || '2002'
```

In this example, the parameter is not truncated, and the result of the concatenation is 5 March 2002.

7.23.7. Examples of CONCAT

- Insert information consisting of a single character string. Use the CONCAT function to construct and insert the value:

```
INSERT INTO stats.logfile (user_key, user_info)
VALUES (001, CONCAT ('Executed at ', CAST (CURRENT_TIMESTAMP AS CHAR(26))));
```

- Use the concatenation operator || to construct and insert the value:

```
INSERT INTO stats.logfile (user_key, user_info)
VALUES (002, 'Executed at ' || CAST (CURRENT_TIMESTAMP AS CHAR(26)));
```

7.24. CONVERTTOHEX Function

The CONVERTTOHEX function converts the specified value expression to hexadecimal for display purposes.

CONVERTTOHEX is a Trafodion SQL extension.

```
CONVERTTOHEX (expression)
```

expression

is any numeric, character, datetime, or interval expression.

The primary purpose of the CONVERTTOHEX function is to eliminate any doubt as to the exact value in a column. It is particularly useful for character expressions where some characters may be from character sets that are not supported by the client terminal's locale or may be control codes or other non-displayable characters.

7.24.1. Considerations for CONVERTTOHEX

Although CONVERTTOHEX is usable on datetime and interval expressions, the displayed output shows the internal value and is, consequently, not particularly meaningful to general users and is subject to change in future releases.

CONVERTTOHEX returns ASCII characters in ISO8859-1 encoding.

7.24.2. Examples of CONVERTTOHEX

- Display the contents of a smallint, integer, and largeint in hexadecimal:

```

CREATE TABLE EG (S1 smallint, I1 int, L1 largeint);

INSERT INTO EG VALUES( 37, 2147483647, 2305843009213693951);

SELECT CONVERTTOHEX(S1), CONVERTTOHEX(I1), CONVERTTOHEX(L1) from EG;

(EXPR) (EXPR)      EXPR)
-----
0025    7FFFFFFF 1FFFFFFFFFFFFFFF

```

- Display the contents of a CHAR(4) column, a VARCHAR(4) column, and a CHAR(4) column that uses the UTF8 character set. The varchar column does not have a trailing space character as the fixed-length columns have:

```

CREATE TABLE EG_CH (FC4 CHAR(4), VC4 VARCHAR(4), FC4U CHAR(4) CHARACTER SET UTF8);

INSERT INTO EG_CH values('ABC', 'abc', _UTF8'abc');

SELECT CONVERTTOHEX(FC4), CONVERTTOHEX(VC4), CONVERTTOHEX(FC4U) from EG_CH;

(EXPR)      (EXPR)      (EXPR)
-----
41424320    616263  0061006200630020

```

- Display the internal values for a DATE column, a TIME column, a TIMESTAMP(2) column, and a TIMESTAMP(6) column:

```

CREATE TABLE DT (D1 date, T1 time, TS1 timestamp(2), TS2 timestamp(6) );
INSERT INTO DT values(current_date, current_time, current_timestamp,
current_timestamp);

SELECT CONVERTTOHEX(D1), CONVERTTOHEX(T1), CONVERTTOHEX(TS1), CONVERTTOHEX(TS2) from DT;

(EXPR)      (EXPR)      (EXPR)      (EXPR)
-----
07D8040F    0E201E    07D8040F0E201E00000035    07D8040F0E201E00081ABB

```

- Display the internal values for an INTERVAL YEAR column, an INTERVAL YEAR(2) TO MONTH column, and an INTERVAL DAY TO SECOND column:

```
CREATE TABLE IVT ( IV1 interval year, IV2 interval year(2) to month, IV3 interval day to second);
```

```
INSERT INTO IVT values( interval '1' year, interval '3-2' year(2) to month, interval '31:14:59:58' day to second);
```

```
SELECT CONVERTTOHEX(IV1), CONVERTTOHEX(IV2), CONVERTTOHEX(IV3) from IVT;
```

```
(EXPR) (EXPR) (EXPR)
```

```
-----  
0001      0026      0000027C2F9CB780
```

7.25. CONVERTTIMESTAMP Function

The CONVERTTIMESTAMP function converts a Julian timestamp to a value with data type TIMESTAMP.

CONVERTTIMESTAMP is a Trafodion SQL extension.

```
CONVERTTIMESTAMP (julian-timestamp)
```

- *julian-timestamp*

is an expression that evaluates to a Julian timestamp, which is a LARGEINT value.

7.25.1. Considerations for CONVERTTIMESTAMP

The *julian-timestamp* value must be in the range from 148731 63200000000 to 274927348799999999.

Relationship to the JULIANTIMESTAMP Function

The operand of CONVERTTIMESTAMP is a Julian timestamp, and the function result is a value of data type TIMESTAMP.

The operand of the CONVERTTIMESTAMP function is a value of data type TIMESTAMP, and the function result is a Julian timestamp. That is, the two functions have an inverse relationship to one another.

Use of CONVERTTIMESTAMP

You can use the inverse relationship between the JULIANTIMESTAMP and CONVERTTIMESTAMP functions to insert Julian timestamp columns into your database and display these column values in a TIMESTAMP format.

7.25.2. Examples of CONVERTTIMESTAMP

- Suppose that the EMPLOYEE table includes a column, named HIRE_DATE, which contains the hire date of each employee as a Julian timestamp. Convert the Julian timestamp into a TIMESTAMP value:

```
SELECT CONVERTTIMESTAMP (hire_date) FROM persnl.employee;
```

- This example illustrates the inverse relationship between JULIANTIMESTAMP and CONVERTTIMESTAMP.

```
SELECT CONVERTTIMESTAMP (JULIANTIMESTAMP (ship_timestamp)) FROM persnl.project;
```

If, for example, the value of SHIP_TIMESTAMP is 2008-04-03 21:05:36.143000, the result of CONVERTTIMESTAMP(JULIANTIMESTAMP(ship_timestamp)) is the same value, 2008-04-03 21:05:36.143000.

7.26. COS Function

The COS function returns the cosine of a numeric value expression, where the expression is an angle expressed in radians.

COS is a Trafodion SQL extension.

```
COS (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the COS function.

See [Numeric Value Expressions](#).

7.26.1. Examples of COS

- This function returns the value 9.39680940386503680E-001, or approximately 0.9397, the cosine of 0.3491 (which is 20 degrees):

```
COS (0.3491)
```

7.26.2. COSH Function

The COSH function returns the hyperbolic cosine of a numeric value expression, where the expression is an angle expressed in radians.

COSH is a Trafodion SQL extension.

```
COSH (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the COSH function. See [Numeric Value Expressions](#).

7.26.3. Examples of COSH

- This function returns the value 1.88842387716101568E+000, or approximately 1.8884, the hyperbolic cosine of 1.25 in radians:

```
COSH (1.25)
```

7.26.4. COUNT Function

The COUNT function counts the number of rows that result from a query or the number of rows that contain a distinct value in a specific column. The result of COUNT is data type LARGEINT. The result can never be NULL.

```
COUNT { (*) | ([ALL | DISTINCT] expression) }
```

- COUNT (*)

returns the number of rows in the table specified in the FROM clause of the SELECT statement that contains COUNT (*). If the result table is empty (that is, no rows are returned by the query) COUNT (*) returns zero.

- ALL | DISTINCT

returns the number of all rows or the number of distinct rows in the one-column table derived from the evaluation of *expression*. The default option is ALL, which causes duplicate values to be included. If you specify DISTINCT, duplicate values are eliminated before the COUNT function is applied.

- *expression*

specifies a value expression that determines the values to count. The *expression* cannot contain an aggregate function or a subquery. The DISTINCT clause specifies that the COUNT function operates on distinct values from the one-column table derived from the evaluation of *expression*. See [Expressions](#).

7.26.5. Considerations for COUNT

Operands of the Expression

The operand of COUNT is either * or an expression that includes columns from the result table specified by the SELECT statement that contains COUNT. However, the expression cannot include an aggregate function or a subquery. These expressions are valid:

```
COUNT ( * )
COUNT (DISTINCT JOBCODE)
COUNT (UNIT_PRICE * QTY_ORDERED)
```

Nulls

COUNT is evaluated after eliminating all nulls from the one-column table specified by the operand. If the table has no rows, COUNT returns zero.

COUNT(*) does not eliminate null rows from the table specified in the FROM clause of the SELECT statement. If all rows in a table are null, COUNT(*) returns the number of rows in the table.

7.26.6. Examples of COUNT

- Count the number of rows in the EMPLOYEE table:

```
SELECT COUNT (*) FROM persnl.employee;
(EXPR)
-----
62
--- 1 row(s) selected.
```

- Count the number of employees who have a job code in the EMPLOYEE table:

```
SELECT COUNT (jobcode) FROM persnl.employee;
(EXPR)
-----
56
--- 1 row(s) selected.

SELECT COUNT(*)
FROM persnl.employee
WHERE jobcode IS NOT NULL;

(EXPR)
-----
56
--- 1 row(s) selected.
```

- Count the number of distinct departments in the EMPLOYEE table:

```
SELECT COUNT (DISTINCT deptnum) FROM persnl.employee;  
(EXPR)  
-----  
11  
--- 1 row(s) selected.
```

```
--= CRC32 Function
```

Computes a cyclic redundancy check value and returns a 32-bit unsigned value. The result is NULL if the argument is NULL. The argument is expected to be a string and (if possible) is treated as one if it is not.

```
CRC32{ expression ) }
```

- *expression*

specifies a value expression that determines the values to count. The *expression* cannot contain an aggregate function or a subquery. See [Expressions](#).

7.26.7. examples of CR32

```
>>SELECT CRC32('Trafodion') from dual;  
  
(EXPR)  
-----  
1960931967  
  
>>SELECT CRC32(2016) from dual;  
  
(EXPR)  
-----  
2177070256
```

7.27. CURRENT Function

The CURRENT function returns a value of type TIMESTAMP based on the current local date and time.

The function is evaluated once when the query starts execution and is not reevaluated (even if it is a long running query).

You can also use [CURRENT_TIMESTAMP Function](#).

```
CURRENT [ (precision) ]
```

- *precision*

is an integer value in the range 0 to 6 that specifies the precision of (the number of decimal places in) the fractional seconds in the returned value. The default is 6.

For example, the function CURRENT (2) returns the current date and time as a value of data type TIMESTAMP, where the precision of the fractional seconds is 2, for example, 2008-06-26 09:01:20.89. The value returned is not a string value.

7.27.1. Examples of CURRENT

- The PROJECT table contains a column SHIP_TIMESTAMP of data type TIMESTAMP. Update a row by using the CURRENT value:

```
UPDATE persnl.project  
SET ship_timestamp = CURRENT WHERE projcode = 1000;
```

7.28. CURRENT_DATE Function

The CURRENT_DATE function returns the local current date as a value of type DATE.

The function is evaluated once when the query starts execution and is not reevaluated (even if it is a long running query).

```
CURRENT_DATE
```

The CURRENT_DATE function returns the current date, such as 2008-09-28. The value returned is a value of type DATE, not a string value.

7.28.1. Examples of CURRENT_DATE

- Select rows from the ORDERS table based on the current date:

```
SELECT * FROM sales.orders  
WHERE deliv_date >= CURRENT_DATE;
```

- The PROJECT table has a column EST_COMPLETE of type INTERVAL DAY. If the current date is the start date of your project, determine the estimated date of completion:

```
SELECT projdesc, CURRENT_DATE + est_complete FROM persnl.project;  
  
Project/Description (EXPR)  
-----  
SALT LAKE CITY      2008-01-18  
ROSS PRODUCTS        2008-02-02  
MONTANA TOOLS        2008-03-03  
AHAUS TOOL/SUPPLY    2008-03-03  
THE WORKS            2008-02-02  
THE WORKS            2008-02-02  
  
--- 6 row(s) selected.
```

7.29. CURRENT_TIME Function

The CURRENT_TIME function returns the current local time as a value of type TIME.

The function is evaluated once when the query starts execution and is not reevaluated (even if it is a long running query).

```
CURRENT_TIME [(precision)]
```

- *precision*

is an integer value in the range 0 to 6 that specifies the precision of (the number of decimal places in) the fractional seconds in the returned value. The default is 0.

For example, the function CURRENT_TIME (2) returns the current time as a value of data type TIME, where the precision of the fractional seconds is 2, for example, 14:01:59.30. The value returned is not a string value.

7.29.1. Examples of CURRENT_TIME

- Use CURRENT_DATE and CURRENT_TIME as a value in an inserted row:

```
INSERT INTO stats.logfile (user_key, run_date, run_time, user_name)
VALUES (001, CURRENT_DATE, CURRENT_TIME, 'JuBrock');
```

7.30. CURRENT_TIMESTAMP Function

The CURRENT_TIMESTAMP function returns a value of type TIMESTAMP based on the current local date and time.

The function is evaluated once when the query starts execution and is not reevaluated (even if it is a long running query).

You can also use the [CURRENT Function](#).

```
CURRENT_TIMESTAMP [({_precision_})]
```

- *precision*

is an integer value in the range 0 to 6 that specifies the precision of (the number of decimal places in) the fractional seconds in the returned value. The default is 6.

For example, the function CURRENT_TIMESTAMP (2) returns the current date and time as a value of data type TIMESTAMP, where the precision of the fractional seconds is 2; for example, 2008-06-26 09:01:20.89. The value returned is not a string value.

7.30.1. Examples of CURRENT_TIMESTAMP

- The PROJECT table contains a column SHIP_TIMESTAMP of data type TIMESTAMP. Update a row by using the CURRENT_TIMESTAMP value:

```
UPDATE persnl.project  
SET ship_timestamp = CURRENT_TIMESTAMP WHERE projcode = 1000;
```

7.31. CURRENT_USER Function

The CURRENT_USER function returns the database user name of the current user who invoked the function. The current user is the authenticated user who started the session. That database user name is used for authorization of SQL statements in the current session.

```
CURRENT_USER
```

The CURRENT_USER function is similar to the [USER Function](#).

7.31.1. Considerations for CURRENT_USER

- This function can be specified only in the top level of a SELECT statement.
- The value returned is string data type VARCHAR(128) and is in ISO8859-1 encoding.

7.31.2. Examples of CURRENT_USER

- This example retrieves the database user name for the current user:

```
SELECT CURRENT_USER FROM (values(1)) x(a);  
(EXPR)  
-----  
TSHAW  
--- 1 row(s) selected.
```

7.32. DATE_ADD Function

The DATE_ADD function adds the interval specified by *interval_expression* to *datetime_expr*. If the specified interval is in years or months, DATE_ADD normalizes the result. See [Standard Normalization](#). The type of the *datetime_expr* is returned, unless the *interval_expression* contains any time components, then a timestamp is returned.

DATE_ADD is a Trafodion SQL extension.

```
DATE_ADD (datetime-expr, interval-expression)
```

- *datetime-expr*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

- *interval-expression*

is an expression that can be combined in specific ways with addition operators. The *interval_expression* accepts all interval expression types that the Trafodion database software considers as valid interval expressions. See [Interval Value Expressions](#).

7.32.1. Examples of DATE_ADD

- This function returns the value DATE '2007-03-07'

```
DATE_ADD(DATE '2007-02-28', INTERVAL '7' DAY)
```

- This function returns the value DATE '2008-03-06'

```
DATE_ADD(DATE '2008-02-28', INTERVAL '7' DAY)
```

- This function returns the timestamp '2008-03-07 00:00:00'

```
DATE_ADD(timestamp '2008-02-29 00:00:00', INTERVAL '7' DAY)
```

- This function returns the timestamp '2008-02-28 23:59:59'

```
DATE_ADD(timestamp '2007-02-28 23:59:59', INTERVAL '12' MONTH)
```



compare this example with the last example under DATE_SUB.

7.33. DATE_SUB Function

The DATE_SUB function subtracts the specified *interval_expression* from *datetime_expr*. If the specified interval is in years or months, DATE_SUB normalizes the result. See [Standard Normalization](#).

The type of the *datetime_expr* is returned, unless the *interval_expression* contains any time components, then a timestamp is returned.

DATE_SUB is a Trafodion SQL extension.

```
DATE_SUB (datetime-expr, interval-expression)
```

- *datetime-expr*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. See [Datetime_Value_Expression](#).

- *interval-expression*

is an expression that can be combined in specific ways with subtraction operators. The *interval_expression* accepts all interval expression types that the Trafodion database software considers as valid interval expressions. see [Interval Value Expressions](#).

7.33.1. Examples of DATE_SUB

- This function returns the value DATE '2009-02-28'

```
DATE_SUB(DATE '2009-03-07', INTERVAL '7' DAY)
```

- This function returns the value DATE '2008-02-29'

```
DATE_SUB(DATE '2008-03-07', INTERVAL '7' DAY)
```

- This function returns the timestamp '2008-02-29 00:00:00'

```
DATE_SUB(timestamp '2008-03-31 00:00:00', INTERVAL '31' DAY)
```

- This function returns the timestamp '2007-02-28 23:59:59'

```
DATE_SUB(timestamp '2008-02-29 23:59:59', INTERVAL '12' MONTH)
```

7.34. DATEADD Function

The DATEADD function adds the interval of time specified by *datepart* and *num-expr* to *datetime-expr*. If the specified interval is in years or months, DATEADD normalizes the result. See [Standard Normalization](#). The type of the *datetime-expr* is returned, unless the interval expression contains any time components, then a timestamp is returned.

DATEADD is a Trafodion SQL extension.

```
DATEADD(datepart, num-expr, datetime-expr)
```

- *datepart*

is YEAR, MONTH, DAY, HOUR, MINUTE, SECOND, QUARTER, WEEK, or one of the following abbreviations:

YEAR	YY and YYYY
MONTH	M and MM
DAY	D and DD
HOUR	HH
MINUTE	MI and M
SECOND	SS and S
QUARTER	Q and QQ
WEEK	WW and WK

- *num-expr*

is an SQL exact numeric value expression that specifies how many *datepart* units of time are to be added to *datetime_expr*. If *num_expr* has a fractional portion, it is ignored. If *num_expr* is negative, the return value precedes *datetime_expr* by the specified amount of time. See [Numeric Value Expressions](#).

- *datetime-expr*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. The type of the *datetime_expression* is returned, unless the interval expression contains any time components, then a timestamp is returned. See [Datetime Value Expressions](#).

7.34.1. Examples of DATEADD

- This function adds seven days to the date specified in *start_date*

```
DATEADD(DAY, 7, start_date)
```

- This function returns the value DATE '2009-03-07'

```
DATEADD(DAY, 7, DATE '2009-02-28')
```

- This function returns the value DATE '2008-03-06'

```
DATEADD(DAY, 7, DATE '2008-02-28')
```

- This function returns the timestamp '2008-03-07 00:00:00'

```
DATEADD(DAY, 7, timestamp'2008-02-29 00:00:00')
```

7.35. DATEDIFF Function

The DATEDIFF function returns the integer value for the number of *datepart* units of time between *startdate* and *enddate*. If *enddate* precedes *startdate*, the return value is negative or zero.

DATEDIFF is a Trafodion SQL extension.

```
DATEDIFF (datepart, startdate, enddate)
```

- *datepart*

is YEAR, MONTH, DAY, HOUR, MINUTE, SECOND, QUARTER, WEEK, or one of the following abbreviations:

YEAR	YY and YYYY
MONTH	M and MM
DAY	D and DD
HOUR	HH
MINUTE	MI and M
SECOND	SS and S
QUARTER	Q and QQ
WEEK	WW and WK

- *startdate*

may be of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

- *enddate*

may be of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

The method of counting crossed boundaries such as days, minutes, and seconds makes the result given by DATEDIFF consistent across all data types. The result is a signed integer value equal to the number of *datepart* boundaries crossed between the first and second date.

For example, the number of weeks between Sunday, January 4, and Sunday, January 1 , is 1. The number of months between March 31 and April 1 would be 1 because the month boundary is crossed from March to April. The DATEDIFF function generates an error if the result is out of range for integer values. For seconds, the maximum number is equivalent to approximately 68 years. The DATEDIFF function generates an error if a difference in weeks is requested and one of the two dates precedes January 7 of the year 0001.

7.35.1. Examples of DATEDIFF

- This function returns the value of 0 because no one-second boundaries are crossed.

```
DATEDIFF( SECOND
    , TIMESTAMP '2006-09-12 11:59:58.999998'
    , TIMESTAMP '2006-09-12 11:59:58.999999'
)
```

- This function returns the value 1 because a one-second boundary is crossed even though the two timestamps differ by only one microsecond.

```
DATEDIFF( SECOND
    , TIMESTAMP '2006-09-12 11:59:58.999999'
    , TIMESTAMP '2006-09-12 11:59:59.000000'
)
```

- This function returns the value of 0.

```
DATEDIFF( YEAR
    , TIMESTAMP '2006-12-31 23:59:59.999998'
    , TIMESTAMP '2006-12-31 23:59:59.999999'
)
```

- This function returns the value of 1 because a year boundary is crossed.

```
DATEDIFF( YEAR
    , TIMESTAMP '2006-12-31 23:59:59.999999'
    , TIMESTAMP '2007-01-01 00:00:00.000000'
)
```

- This function returns the value of 2 because two WEEK boundaries are crossed.

```
DATEDIFF(WEEK, DATE '2006-01-01', DATE '2006-01-09')
```

- This function returns the value of -29.

```
DATEDIFF(DAY, DATE '2008-03-01', DATE '2008-02-01')
```

7.35.2. DATEFORMAT Function

The DATEFORMAT function returns a datetime value as a character string literal in the DEFAULT, USA, or EUROPEAN format. The data type of the result is CHAR.

DATEFORMAT is a Trafodion SQL extension.

```
DATEFORMAT (datetime-expression,{DEFAULT | USA | EUROPEAN})
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type DATE, TIME, or TIMESTAMP. See [Datetime Value Expressions](#).

- DEFAULT | USA | EUROPEAN

specifies a format for a datetime value. See [Datetime Literals](#).

7.35.3. Considerations for DATEFORMAT

The DATEFORMAT function returns the datetime value in ISO8859-1 encoding.

7.35.4. Examples of DATEFORMAT

- Convert a datetime literal in DEFAULT format to a string in USA format: DATEFORMAT (TIMESTAMP '2008-06-20 14:20:20.00', USA) The function returns this string literal:

```
'06/20/2008 02:20:20.00 PM'
```

- Convert a datetime literal in DEFAULT format to a string in European format: DATEFORMAT (TIMESTAMP '2008-06-20 14:20:20.00', EUROPEAN) The function returns this string literal:

```
'20.06.2008 14.20.20.00'
```

7.36. DATE_PART Function (of an Interval)

The DATE_PART function extracts the datetime field specified by *text* from the *interval* value specified by *interval* and returns the result as an exact numeric value. The DATE_PART function accepts the specification of 'YEAR', 'MONTH', 'DAY', 'HOUR', 'MINUTE', or 'SECOND' for *text*.

DATE_PART is a Trafodion SQL extension.

```
DATEPART (text, interval)
```

- *text*

specifies YEAR, MONTH, DAY, HOUR, MINUTE, or SECOND. The value must be enclosed in single quotes.

- *interval*

interval accepts all interval expression types that the Trafodion database software considers as valid interval expressions. See [Interval Value Expressions](#).

The DATE_PART(*text, interval*) is equivalent to EXTRACT(*text, interval*), except that the DATE_PART function requires single quotes around the text specification, where EXTRACT does not allow single quotes.

When SECOND is specified the fractional part of the second is returned.

7.36.1. Examples of DATE_PART

- This function returns the value of 7.

```
DATE_PART( 'DAY' , INTERVAL '07:04' DAY TO HOUR )
```

- This function returns the value of 6.

```
DATE_PART( 'MONTH' , INTERVAL '6' MONTH )
```

- This function returns the value of 36.33.

```
DATE_PART( 'SECOND' , INTERVAL '5:2:15:36.33' DAY TO SECOND(2) )
```

7.37. DATE_PART Function (of a Timestamp)

The DATE_PART function extracts the datetime field specified by *text* from the datetime value specified by *datetime_expr* and returns the result as an exact numeric value. The DATE_PART function accepts the specification of 'YEAR', 'YEARQUARTER', 'YEARMONTH', 'YEARWEEK', 'MONTH', 'DAY', 'HOUR', 'MINUTE', or 'SECOND' for *text*.

The DATE_PART function of a timestamp can be changed to DATE_PART function of a datetime because the second argument can be either a timestamp or a date expression.

DATE_PART is a Trafodion extension.

```
DATEPART(text, datetime-expr)
```

- *text*

specifies YEAR, YEARQUARTER, YEARMONTH, YEARWEEK, MONTH, DAY, HOUR, MINUTE, or SECOND. The value must be enclosed in single quotes.

- **YEARMONTH**: Extracts the year and the month, as a 6-digit integer of the form yyyy-mm (100 * year + month).
- **YEARQUARTER**: Extracts the year and quarter, as a 5-digit integer of the form yyyy-q, (10 * year + quarter) with q being 1 for the first quarter, 2 for the second, and so on.
- **YEARWEEK**: Extracts the year and week of the year, as a 6-digit integer of the form yyyy-w (100 * year + week).

The week number will be computed in the same way as in the WEEK function.

- *datetime-expr*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

DATE_PART(*text*, *datetime-expr*) is mostly equivalent to EXTRACT(*text*, *datetime-expr*), except that DATE_PART requires single quotes around the text specification where EXTRACT does not allow single quotes. In addition, you cannot use the YEARQUARTER, YEARMONTH, and YEARWEEK text specification with EXTRACT.

7.37.1. Examples of DATE_PART

- This function returns the value of 12.

```
DATE_PART( 'month' , date'12/05/2006' )
```

- This function returns the value of 2006.

```
DATE_PART( 'year' , date'12/05/2006' )
```

- This function returns the value of 31.

```
DATE_PART( 'day' , TIMESTAMP '2006-12-31 11:59:59.999999' )
```

- This function returns the value 201 07.

```
DATE_PART( 'YEARMONTH' , date '2011-07-25' )
```

7.38. DATE_TRUNC Function

The DATE_TRUNC function returns a value of type TIMESTAMP, which has all fields of lesser precision than *text* set to zero (or 1 in the case of months or days).

DATE_TRUNC is a Trafodion SQL extension.

```
DATE_TRUNC(text, datetime-expr)
```

- *text*

specifies 'YEAR', 'MONTH', 'DAY', 'HOUR', 'MINUTE', or 'SECOND'. The DATE_TRUNC function also accepts the specification of 'CENTURY' or 'DECADE'.

- *datetime_expr*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. DATE_TRUNC returns a value of type TIMESTAMP which has all fields of lesser precision than *text* set to zero (or 1 in the case of months or days). See [Datetime Value Expressions](#).

7.38.1. Examples of DATE_TRUNC

- This function returns the value of TIMESTAMP '2006-12-31 00:00:00'.

```
DATE_TRUNC('day', TIMESTAMP '2006-12-31 11:59:59')
```

- This function returns the value of TIMESTAMP '2006-01-01 00:00:00'

```
DATE_TRUNC('YEAR', TIMESTAMP '2006-12-31 11:59:59')
```

- This function returns the value of TIMESTAMP '2006-12-01 00:00:00'

```
DATE_TRUNC('MONTH', DATE '2006-12-31')
```

Restrictions:

- DATE_TRUNC('DECADE', ...) cannot be used on years less than 10.
- DATE_TRUNC('CENTURY', ...) cannot be used on years less than 100.

7.39. DAY Function

The DAY function converts a DATE or TIMESTAMP expression into an INTEGER value in the range 1 through 31 that represents the corresponding day of the month. The result returned by the DAY function is equal to the result returned by the DAYOFMONTH function.

DAY is a Trafodion SQL extension.

```
DAY (datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

7.39.1. Examples of Day

- Return an integer that represents the day of the month from the start date column of the project table:

```
SELECT start_date, ship_timestamp, DAY(start_date)
FROM persnl.project
WHERE projcode = 1000;
```

Start/Date	Time/Shipped	(EXPR)
2008-04-10	2008-04-21 08:15:00.000000	10

7.40. DAYNAME Function

The DAYNAME function converts a DATE or TIMESTAMP expression into a character literal that is the name of the day of the week (Sunday, Monday, and so on).

DAYNAME is a Trafodion SQL extension.

```
DAYNAME (datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

7.40.1. Considerations for DAYNAME

The DAYNAME function returns the name of the day in ISO8859-1.

7.40.2. Examples of DAYNAME

Return the name of the day of the week from the start date column in the project table:

+

```
SELECT start_date, ship_timestamp, DAYNAME(start_date)
FROM persnl.project
WHERE projcode = 1000;

Start/Date Time/Shipped          (EXPR)
-----
2008-04-10 2008-04-21 08:15:00.000000 Thursday
```

7.41. DAYOFMONTH Function

The DAYOFMONTH function converts a DATE or TIMESTAMP expression into an INTEGER value in the range 1 through 31 that represents the corresponding day of the month. The result returned by the DAYOFMONTH function is equal to the result returned by the DAY function.

DAYOFMONTH is a Trafodion SQL extension.

```
DAYOFMONTH (datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

7.41.1. Examples of DAYOFMONTH

- Return an integer that represents the day of the month from the start date column of the project table:

```
SELECT start_date, ship_timestamp, DAYOFMONTH(start_date)
FROM persnl.project
WHERE projcode = 1000;
```

Start/Date	Time/Shipped	(EXPR)
2008-04-10	2008-04-21 08:15:00.000000	10

7.42. DAYOFWEEK Function

The DAYOFWEEK function converts a DATE or TIMESTAMP expression into an INTEGER value in the range 1 through 7 that represents the corresponding day of the week. The value 1 represents Sunday, 2 represents Monday, and so forth.

DAYOFWEEK is a Trafodion SQL extension.

```
DAYOFWEEK (datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

7.42.1. Examples of DAYOFWEEK

- Return an integer that represents the day of the week from the START_DATE column in the PROJECT table:

```
SELECT start_date, ship_timestamp, DAYOFWEEK(start_date)
FROM persnl.project
WHERE projcode = 1000;

Start/Date Time/Shipped      (EXPR)
-----
2008-04-10 2008-04-21 08:15:00.000000      5
```

The value returned is 5, representing Thursday. The week begins on Sunday.

7.43. DAYOFYEAR Function

The DAYOFYEAR function converts a DATE or TIMESTAMP expression into an INTEGER value in the range 1 through 366 that represents the corresponding day of the year.

DAYOFYEAR is a Trafodion SQL extension.

```
DAYOFYEAR (datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

7.43.1. Examples of DAYOFYEAR

- Return an integer that represents the day of the year from the start date column in the project table:

```
SELECT start_date, ship_timestamp, DAYOFYEAR(start_date)
FROM persnl.project
WHERE projcode = 1000;

Start/Date Time/Shipped          (EXPR)
-----
2008-04-10 2008-04-21 08:15:00.000000 | 101
```

7.44. DECODE Function

The DECODE function compares *expr* to each *test_expr* value one by one in the order provided. If *expr* is equal to a *test_expr*, then the corresponding *retval* is returned. If no match is found, *default* is returned. If no match is found and *default* is omitted, NULL is returned.

DECODE is a Trafodion SQL extension.

```
DECODE (expr, test-expr, retval [, test-expr2, retval2 ... ] [ , default ] )
```

- *expr*

is an SQL expression.

- *test-expr*, *test-expr*, ...

are each an SQL expression of a type comparable to that of *expr*.

- *retval*

is an SQL expression.

- *default*, *retval2*, …

are each an SQL expression of a type comparable to that of *retval*.

7.44.1. Considerations for DECODE

In a DECODE function, two nulls are considered to be equivalent. If *expr* is null, then the returned value is the *retval* of the first *test-expr* that is also null.

The *expr*, *test-expr*, *retval*, and *default* values can be derived from expressions.

The arguments can be any of the numeric types or character types. However, *expr* and each *test-expr* value must be of comparable types. If *expr* and *test-expr* values are character types, they must be in the same character set (to be comparable types.)

All the *retval* values and the *default* value, if any, must be of comparable types.

If *expr* and a *test-expr* value are character data, the comparison is made using non-padded comparison semantics.

If *expr* and a *test-expr* value are numeric data, the comparison is made with a temporary copy of one of the numbers, according to defined rules of conversion. For example, if one number is INTEGER and the other is DECIMAL, the comparison is made with a temporary copy of the integer converted to a decimal.

If all the possible return values are of fixed-length character types, the returned value is a fixed-length character string with size equal to the maximum size of all the possible return value types.

If any of the possible return values is a variable-length character type, the returned value is a variable-length character string with maximum size of all the possible return value types.

If all the possible return values are of integer types, the returned value is the same type as the largest integer type of all the possible return values.

If the returned value is of type FLOAT, the precision is the maximum precision of all the possible return values.

If all the possible returned values are of the same non-integer, numeric type (REAL, FLOAT, DOUBLE PRECISION, NUMERIC, or DECIMAL), the returned value is of that same type.

If all the possible return values are of numeric types but not all the same, and at least one is REAL, FLOAT, or DOUBLE PRECISION, then the returned value is of type DOUBLE PRECISION.

If all the possible return values are of numeric types but not all the same, none are REAL, FLOAT, or DOUBLE PRECISION, and at least one is of type NUMERIC, then the returned value is of type NUMERIC.

If all the possible return values are of numeric types, none are NUMERIC, REAL, FLOAT, or DOUBLE PRECISION, and at least one is of type DECIMAL, then the returned value will be of type DECIMAL.

If the returned value is of type NUMERIC or DECIMAL, it has a precision equal to the sum of:

- The maximum scale of all the possible return value types and
- The maximum value of (precision - scale) for all the possible return value types. However, the precision will not exceed 18.

The scale of the returned value is the minimum of:

- The maximum scale of all the possible return value types and
- 18 - (the maximum value of (precision - scale) for all the possible return value types).

The number of components in the DECODE function, including *expr*, *test-exprs*, *retvals*, and *default*, has no limit other than the general limit of how big an SQL expression can be. However, large lists do not perform well.

The syntax

```
DECODE (expr, test_expr, retval [, test_expr2, retval2 ... ] [, default ] ):
```

is logically equivalent to the following:

```
CASE
  WHEN (expr IS NULL AND test-expr IS NULL) OR expr = test-expr THEN retval
  WHEN (expr IS NULL AND test-expr2 IS NULL) OR expr = test_expr2 THEN retval2
  ...
  ELSE default /* or ELSE NULL if _default_ not specified */
END
```

No special conversion of *expr*, *test-exprN*, or *retvalN* exist other than what a CASE statement normally does.

7.44.2. Examples of DECODE

- Example of the DECODE function:

```

SELECT
    emp_name
, DECODE( CAST (( yrs_of_service + 3 ) / 4 AS INT )
    , 0,0.04
    , 1,0.04
    , 0.06
) as perc_value
FROM employees;

SELECT
    supplier_name
, DECODE( supplier_id
    , 10000
    , 'Company A'
    , 10001
    , 'Company B'
    , 10002
    , 'Company C'
    , 10003
    , 'Company D'
) as result
FROM suppliers;

```

- This example shows a different way of handling NULL specified as default and not specified as default explicitly:

```

SELECT DECODE( (?p1 || ?p2), trim(?p1), 'Hi', ?p3, null ) from emp;
..
*** ERROR[4049] A CASE expression cannot have a result data type of both CHAR(2) and
NUMERIC(18,6).
*** ERROR[4062] The preceding error actually occurred in function DECODE((?P1 ||
?P2),( ' ' TRIM ?P1), 'Hi', ?P3, NULL)
*** ERROR[8822] The statement was not prepared.

```

The last *ret-val* is an explicit NULL. When Trafodion SQL encounters this situation, it assumes that the return value will be NUMERIC(18,6). Once Trafodion SQL determines that the return values are numeric, it determines that all possible return values must be numeric. When 'Hi' is encountered in a *ret-val* position, the error is produced because the CHAR(2) type argument is not comparable with a NUMERIC(18,6) type return value.

This statement is equivalent and will not produce an error:

```
SELECT DECODE( (?p1 || ?p2), trim(?p1), 'Hi' ) from emp;
```

7.45. DEGREES Function

The DEGREES function converts a numeric value expression expressed in radians to the number of degrees.

DEGREES is a Trafodion SQL extension.

```
DEGREES (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the DEGREES function. See [Numeric Value Expressions](#).

7.45.1. Examples of Degrees

- This function returns the value 45.0001059971939008 in degrees:

```
DEGREES(0.78540)
```

- This function returns the value of 45. The function degrees is the inverse of the function radians.

```
DEGREES(RADIANS(45))
```

7.46. DIFF1 Function

The DIFF1 function is a sequence function that calculates the amount of change in an expression from row to row in an intermediate result table ordered by a sequence by clause in a select statement. See [SEQUENCE BY Clause](#).

DIFF1 is a Trafodion SQL extension.

```
DIFF1 (column-expression-a [,column-expression-b])
```

- *column-expression-a*

specifies a derived column determined by the evaluation of the column expression. If you specify only one column as an argument, DIFF1 returns the difference between the value of the column in the current row and its value in the previous row; this version calculates the unit change in the value from row to row.

- *column-expression-b*

specifies a derived column determined by the evaluation of the column expression. If you specify two columns as arguments, DIFF1 returns the difference in consecutive values in *column-expression-a* divided by the difference in consecutive values in *column-expression-b*.

The purpose of the second argument is to distribute the amount of change from row to row evenly over some unit of change (usually time) in another column.

7.46.1. Considerations for DIFF1

Equivalent Result

If you specify one argument, the result of DIFF1 is equivalent to: *column-expression-a* - OFFSET(*column-expression-a*, 1)

If you specify two arguments, the result of DIFF1 is equivalent to:

```
DIFF1(column-expression-a) / DIFF1(column-expression-b)
```

The two-argument version involves division by the result of the DIFF1 function. To avoid divide-by-zero errors, be sure that *column-expression-b* does not contain any duplicate values whose DIFF1 computation could result in a divisor of zero.

Datetime Arguments

In general, Trafodion SQL does not allow division by a value of INTERVAL data type. However, to permit use of the two-argument version of DIFF1 with times and dates, Trafodion SQL relaxes this restriction and allows division by a value of INTERVAL data type.

7.46.2. Examples of DIFF1

- Retrieve the difference between the I1 column in the current row and the I1 column in the previous row:

```
SELECT DIFF1 (I1) AS DIFF1_I1
FROM mining.seqfcn SEQUENCE BY TS;

DIFF1_I1
-----
?
21959
-9116
-14461
7369

--- 5 row(s) selected.
```

The first row retrieved displays null because the offset from the current row does not fall within the results set.

- Retrieve the difference between the TS column in the current row and the TS column in the previous row:

```
SELECT DIFF1 (TS) AS DIFF1_TS
FROM mining.seqfcn SEQUENCE BY TS;

DIFF1_TS
-----
?
30002620.000000
134157861.000000
168588029.000000
114055223.000000

--- 5 row(s) selected.
```

The results are expressed as the number of seconds. For example, the difference between TIMESTAMP '1951-02-15 14:35:49' and TIMESTAMP '1950-03-05 08:32:09' is approximately 347 days. The difference between TIMESTAMP '1955-05-18 08:40:10' and TIMESTAMP '1951-02-15 14:35:49' is approximately 4 years and 3 months, and so on.

- This query retrieves the difference in consecutive values in I1 divided by the difference in consecutive values in TS:

```
SELECT DIFF1 (I1,TS) AS DIFF1_I1TS
FROM mining.seqfcn SEQUENCE BY TS;
```

```
DIFF1_I1TS
-----
?
.0007319
-.0000679
-.0000857
.0000646
```

```
--- 5 row(s) selected.
```

The results are equivalent to the quotient of the results from the two preceding examples. For example, in the second row of the output of this example, 0.0007319 is equal to 21959 divided by 30002620.

7.47. DIFF2 Function

The DIFF2 function is a sequence function that calculates the amount of change in a DIFF1 value from row to row in an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

DIFF2 is a Trafodion SQL extension.

```
DIFF2 (column-expression-a [,column-expression-b])
```

- *column-expression-a*

specifies a derived column determined by the evaluation of the column expression. If you specify only one column as an argument, DIFF2 returns the difference between the value of DIFF1(*column-expression-a*) in the current row and the same result in the previous row.

- *column-expression-b*

specifies a derived column determined by the evaluation of the column expression. If you specify two columns as arguments, DIFF2 returns the difference in consecutive values of DIFF1(*column-expression-a*) divided by the difference in consecutive values in *column-expression-b*. See [DIFF1 Function](#).

7.47.1. Considerations for DIFF2

Equivalent Result

- If you specify one argument, the result of DIFF2 is equivalent to:

```
DIFF1(column-expression-a) - OFFSET(DIFF1(column-expression-a),1)
```

- If you specify two arguments, the result of DIFF2 is equivalent to:

```
DIFF2(column-expression-a) / DIFF1(column-expression-b)
```

The two-argument version involves division by the result of the DIFF1 function. To avoid divide-by-zero errors, be sure that *column-expression-b* does not contain any duplicate values whose DIFF1 computation could result in a divisor of zero.

Datetime Arguments

In general, Trafodion SQL does not allow division by a value of INTERVAL data type. However, to permit use of the two-argument version of DIFF2 with times and dates, Trafodion SQL relaxes this restriction and allows division by a value of INTERVAL data type.

7.47.2. Examples of DIFF2

- Retrieve the difference between the value of DIFF1(I1) in the current row and the same result in the previous row:

```
SELECT DIFF2 (I1) AS DIFF2_I1
FROM mining.seqfcn SEQUENCE BY TS;

DIFF2_I1
-----
?
?
-31075
-5345
21830

--- 5 row(s) selected.
```

The results are equal to the difference of DIFF1(I1) for the current row and DIFF1(I1) of the previous row. For example, in the third row of the output of this example, -31075 is equal to -91 6 minus 21959. The value -91 6 is the result of DIFF1(I1) for the current row, and the value 21959 is the result of DIFF1(I1) for the previous row. See [Examples of DIFF1](#).

- Retrieve the difference in consecutive values of DIFF1(I1) divided by the difference in consecutive values of TS:

```
SELECT DIFF2 (I1,TS) AS DIFF2_I1TS
FROM mining.seqfcn SEQUENCE BY TS;

DIFF2_I1TS
-----
?
?
-.000231
-.000031
.000191

--- 5 row(s) selected.
```

7.48. EXP Function

This function returns the exponential value (to the base e) of a numeric value expression. EXP is a Trafodion SQL extension.

```
EXP (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the EXP function. See [Numeric Value Expressions](#).

The minimum input value must be between -744.4400719 and -744.4400720.

The maximum input value must be between 709.78271289338404 and 709.78271289338405.

7.48.1. Examples of EXP

- This function returns the value 3.49034295746184128E+000, or approximately 3.4903:

```
EXP (1.25)
```

- This function returns the value 2.0. The function EXP is the inverse of the function LOG:

```
EXP (LOG(2.0))
```

7.49. EXPLAIN Function

The EXPLAIN function is a table-valued stored function that generates a result table describing an access plan for a SELECT, INSERT, DELETE, or UPDATE statement. See [Result of the EXPLAIN Function](#).

The EXPLAIN function can be specified as a table reference (*table*) in the FROM clause of a SELECT statement if it is preceded by the keyword TABLE and surrounded by parentheses.

For information on the EXPLAIN statement, see [EXPLAIN Statement](#).

```
EXPLAIN (module,'statement-pattern')
```

- *module* is:

```
'module-name' | NULL
```

- '*module-name*'

Reserved for future use.

The module name is enclosed in single quotes and is case-sensitive. If a module name is uppercase, the value you specify within single quotes must be uppercase. For example: 'MYCAT.MYSCH.MYPROG'

- NULL

explains statements prepared in the session. '*statement-pattern*'

A statement pattern is enclosed in single quotes and is case-sensitive. The statement name must be in uppercase, unless you delimit the statement name in a PREPARE statement.

7.49.1. Considerations for EXPLAIN Function

Using a Statement Pattern

Using a statement pattern is analogous to using a LIKE pattern. You can use the LIKE pattern in the following ways:

```
SELECT * FROM table (EXPLAIN(NULL, 'S%'));
SELECT * FROM table (EXPLAIN(NULL, 'S1'));
SELECT * FROM table (EXPLAIN(NULL, '%1'));
```

However, you cannot use the LIKE pattern in this way:

```
SELECT * FROM table (EXPLAIN (NULL, '%'))
```

This statement returns the EXPLAIN result for all prepared statements whose names begin with the uppercase letter 'S':

```
SELECT * FROM table (EXPLAIN (NULL, 'S%'))
```

If the statement pattern does not find any matching statement names, no rows are returned as the result of the SELECT statement.

Obtaining an EXPLAIN Plan While Queries Are Running

Trafodion SQL provides the ability to capture an EXPLAIN plan for a query at any time while the query is running with the QID option. By default, this behavior is disabled for a Trafodion session.



Enable this feature before you start preparing and executing queries.

After this feature is enabled, use the following syntax in an EXPLAIN function to get the query execution plan of a running query:

```
SELECT * FROM table (EXPLAIN(NULL, 'QID=_qid_'))
```

- *qid* is a case-sensitive identifier, which represents the query ID. For example:

```
'QID=MXID0100101119421210365940005336900000085905admin00_2605_S1'
```

The EXPLAIN function or statement returns the plan that was generated when the query was prepared. EXPLAIN for QID retrieves all the information from the original plan of the executing query. The plan is available until the query finishes executing and is removed or deallocated.

Result of the EXPLAIN Function

The result table of the EXPLAIN function describes the access plans for SELECT, INSERT, DELETE, or UPDATE statements.

In this description of the result of the EXPLAIN function, an operator tree is a structure that represents operators used in an access plan as nodes, with at most one parent node for each node in the tree, and with only one root node.

A node of an operator tree is a point in the tree that represents an event (involving an operator) in a plan. Each node might have subordinate nodes — that is, each event might generate a subordinate event or events in the plan.

Column Name	Data Type	Description
MODULE_NAME	CHAR(60)	Reserved for future use.
STATEMENT_NAME	CHAR(60)	Statement name; truncated on the right if longer than 60 characters.
PLAN_ID	LARGEINT	Unique system-generated plan ID automatically assigned by Trafodion SQL; generated at compile time.
SEQ_NUM	INT	Sequence number of the current operator in the operator tree; indicates the sequence in which the operator tree is generated.
OPERATOR	CHAR(30)	Current operator type.
LEFT_CHILD_SEQ_NUM	INT	Sequence number for the first child operator of the current operator; null if node has no child operators.
RIGHT_CHILD_SEQ_NUM	INT	Sequence number for the second child operator of the current operator; null if node does not have a second child.
TNAME	CHAR(60)	For operators in scan group, full name of base table, truncated on the right if too long for column. If correlation name differs from table name, simple correlation name first and then table name in parentheses.
CARDINALITY	REAL	Estimated number of rows that will be returned by the current operator. Cardinality appears as ROWS/REQUEST in some forms of EXPLAIN output. For the right child of a nested join, multiply the cardinality by the number of requests to get the total number of rows produced by this operator.
OPERATOR_COST	REAL	Estimated cost associated with the current operator to execute the operator.
TOTAL_COST	REAL	Estimated cost associated with the current operator to execute the operator, including the cost of all subtrees in the operator tree.
DETAIL_COST	VARCHAR (200)	Cost vector of five items, described in the next table.
DESCRIPTION	VARCHAR (3000)	Additional information about the operator.

The DETAIL_COST column of the EXPLAIN function results contains these cost factors:

CPU_TIME	An estimate of the number of seconds of processor time it might take to execute the instructions for this operator. A value of 1.0 is 1 second.
IO_TIME	An estimate of the number of seconds of I/O time (seeks plus data transfer) to perform the I/O for this operator.
MSG_TIME	An estimate of the number of seconds it takes for the messaging for this operator. The estimate includes the time for the number of local and remote messages and the amount of data sent.
IDLETIME	An estimate of the number of seconds to wait for an event to happen. The estimate includes the amount of time to open a table or start an ESP process.
PROBES	The number of times the operator will be executed. Usually, this value is 1, but it can be greater when you have, for example, an inner scan of a nested-loop join.

7.49.2. Examples of EXPLAIN Function

- Display the specified columns in the result table of the EXPLAIN function for the prepared statement REGION:

```
>>SELECT seq_num, operator, operator_cost FROM table (EXPLAIN (null, 'REG'));

SEQ_NUM      OPERATOR          OPERATOR_COST
-----  -----
1  TRAFODION_SCAN      0.43691027
2  ROOT                0.0

--- 2 row(s) selected.

>>log;
```

The example displays only part of the result table of the EXPLAIN function. It first uses the EXPLAIN function to generate the table and then selects the desired columns.

7.50. EXTRACT Function

The EXTRACT function extracts a datetime field from a datetime or interval value expression. It returns an exact numeric value.

```
EXTRACT (datetime-field FROM extract-source)
```

- *datetime-field* is:

YEAR \| MONTH \| DAY \| HOUR \| MINUTE \| SECOND

- *extract-source* is:

datetime-expression \| interval-expression

See [Datetime Value Expressions](#) and [Interval Value Expressions](#).

7.50.1. Examples of EXTRACT

- Extract the year from a DATE value:

```
EXTRACT (YEAR FROM DATE '2007-09-28')
```

The result is 2007.

- Extract the year from an INTERVAL value:

```
EXTRACT (YEAR FROM INTERVAL '01-09' YEAR TO MONTH)
```

The result is 1.

7.50.2. HOUR Function

The HOUR function converts a TIME or TIMESTAMP expression into an INTEGER value in the range 0 through 23 that represents the corresponding hour of the day.

HOUR is a Trafodion SQL extension.

```
HOUR (datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type TIME or TIMESTAMP. See [Datetime Value Expressions](#).

7.50.3. Examples of HOUR

- Return an integer that represents the hour of the day from the ship timestamp column in the project table:

```
SELECT start_date, ship_timestamp, HOUR(ship_timestamp)
FROM persnl.project
WHERE projcode = 1000;
```

Start/Date	Time/Shipped	(EXPR)
2007-04-10	2007-04-21 08:15:00.000000	8

7.51. GROUP_CONCAT Function

This function returns a string result with the concatenated non-NULL values from a group. It returns NULL if there are no non-NULL values. The syntax is as follows:

```
GROUP_CONCAT([DISTINCT] expr [,expr ...]
            [ORDER BY {unsigned_integer | col_name | expr}
             [ASC | DESC] [,col_name ...]]
            [SEPARATOR str_val])
```

Get the concatenated values of expression combinations. To eliminate duplicate values, use the DISTINCT clause. To sort values in the result, use the ORDER BY clause. To sort in reverse order, add the DESC (descending) keyword to the name of the column you are sorting by in the ORDER BY clause. The default is ascending order; this may be specified explicitly using the ASC keyword. The default separator between values in a group is comma (,). To specify a separator explicitly, use SEPARATOR followed by the string literal value that should be inserted between group values. To eliminate the separator altogether, specify SEPARATOR ".

7.51.1. Examples of GROUP_CONCAT

The following example returns concatenated strings for column test_score for each student.

```
>> SELECT student_name,
      GROUP_CONCAT(DISTINCT test_score
                    ORDER BY test_score DESC SEPARATOR ' ')
      FROM student
      GROUP BY student_name;
STUDENT_NAME      (EXPR)
-----
scott            91 90 80 56
tom              91 77 43
```

7.52. INSERT Function

The INSERT function returns a character string where a specified number of characters within the character string has been deleted, beginning at a specified start position, and where another character string has been inserted at the start position. Every character, including multi-byte characters, is treated as one character.

INSERT is a Trafodion SQL extension.

```
INSERT (char-expr-1, start, length, char-expr-2)
```

- *char-expr-1, char-expr-2*

are SQL character value expressions (of data type CHAR or VARCHAR) that specify two strings of characters. The character string *char-expr-2* is inserted into the character string *char-expr-1*. See [Character Value Expressions](#).

- *start*

specifies the starting position *start* within *char-expr-1* at which to start deleting *length* number of characters. after the deletion, the character string *char-expr-2* is inserted into the character string *char-expr-1*, beginning at the start position specified by the number *start*. The number *start* must be a value greater than zero of exact numeric data type and with a scale of zero.

- *length*

specifies the number of characters to delete from *char-expr-1*. The number *length* must be a value greater than or equal to zero of exact numeric data type and with a scale of zero. *length* must be less than or equal to the length of *char-expr-1*.

7.52.1. Examples of INSERT

- Suppose that your JOB table includes an entry for a sales representative. Use the INSERT function to change SALESREP to SALES REP:

```
UPDATE persnl.job
SET jobdesc = INSERT (jobdesc, 6, 3, ' REP')
WHERE jobdesc = 'SALESREP';
```

Now check the row you updated:

```
SELECT jobdesc FROM persnl.job WHERE jobdesc = 'SALES REP';

Job Description
-----
SALES REP

--- 1 row(s) selected.
```

7.53. IS_IPV4 Function

For a given argument, if it is a valid IPV4 string, IS_IPV4() returns 1 else returns 0.

```
IS_IPV4( expression )
```

- *expression*

specifies an expression that determines the values to include in the validation of the IP address. The *expression* cannot contain an aggregate function or a subquery. If the input value is NULL, IS_IPV4 returns NULL. See [Expressions](#).

7.53.1. Examples of IS_IPV4

This function returns 1 for the first input argument, since it is a valid IPV4 string; 0 for the second input argument, since it is an invalid IPV4 string.

```
>>SELECT IS_IPV4('10.0.5.9'), IS_IPV4('10.0.5.256') from dual;  
  
(EXPR)      (EXPR)  
-----  -----  
1           0
```

7.54. IS_IPV6 Function

Returns 1 if the argument is a valid IPv6 address specified as a string, 0 otherwise. This function does not consider IPv4 addresses to be valid IPv6 addresses.

```
IS_IPV6( expression )
```

- *expression*

specifies an expression that determines the values to include in the validation of the IP address. The *expression* cannot contain an aggregate function or a subquery. If the input value is NULL, IS_IPV6 returns NULL. See [Expressions](#).

7.54.1. Examples of IS_IPV6

This function returns 0 for the second input argument, since it is a valid IPV6 string; 1 for the second input argument, since it is an invalid IPVr6 string.

```
>>SELECT IS_IPV6('10.0.5.9'), IS_IPV6('::1') from dual;  
(EXPR) (EXPR)  
----- -----  
1          0
```

```

+[[inet_aton_function]]
+== INET_ATON Function
+
+Given the dotted-quad representation of an IPv4 network address as a string,
+returns an integer that represents the numeric value of the address in network
+byte order (big endian). INET_ATON() returns NULL if it does not understand its
argument.
+
+```
+INET_ATON( expression )
+```
+
+* `expression_`_
++
+specifies an expression that determines the values to include in the
+conversion of the IP address. The _expression_ cannot contain an aggregate
+function or a subquery. If the input value is NULL, INET_ATON returns NULL.
+See <>expressions,Expressions>>.
+
+[[examples_of_inet_aton]]
+==== Examples of INET_ATON
+
+```
+>>SELECT INET_ATON('10.0.5.9') from dual;
+
+(EXPR)
-----
+167773449
+```
+<<<
+[[inet_ntoa_function]]
+== INET_NTOA Function
+
+Given a numeric IPv4 network address in network byte order, returns the
+dotted-quad string representation of the address as a nonbinary string in
+the connection character set. INET_NTOA() returns NULL if it does
+not understand its argument.
+
+```
+INET_NTOA( expression )
+```
+
+* `expression_`_
++
+specifies an expression that determines the values to include in the
+conversion of the number to IP address. The _expression_ cannot contain
+an aggregate function or a subquery. If the input value is NULL, INET_NTOA
+returns NULL.
+See <>expressions,Expressions>>.
+
+[[examples_of_inet_ntoa]]
+==== Examples of INET_NTOA

```

```

+
+this function will convert an integer into the dotted-quad string
+representation of the IP address.
+
+```
+>>SELECT INET_NTOA(167773449) from dual
+
+(EXPR)
+-----
+'10.0.5.9'
+```
+<<<

```

7.55. ISNULL Function

The ISNULL function returns the value of the first argument if it is not null, otherwise it returns the value of the second argument. Both expressions must be of comparable types.

ISNULL is a Trafodion SQL extension.

```
ISNULL(ck-expr, repl-value)
```

- *ck-expr*

an expression of any valid SQL data type.

- *repl-value*

an expression of any valid SQL data type, but must be a comparable type with that of *ck-expr*.

7.55.1. Examples of ISNULL

- This function returns a 0 instead of a null if value is null.

```
ISNULL(value,0)
```

- This function returns the date constant if date_col is null.

```
ISNULL(date_col, DATE '2006-01-01')
```

- This function returns 'Smith' if the string column last_name is null.

```
ISNULL(last_name, 'Smith')
```

7.56. JULIANTIMESTAMP Function

The JULIANTIMESTAMP function converts a datetime value into a 64-bit Julian timestamp value that represents the number of microseconds that have elapsed between 4713 B.C., January 1, 00:00, and the specified datetime value. JULIANTIMESTAMP returns a value of data type LARGEINT.

The function is evaluated once when the query starts execution and is not reevaluated (even if it is a long running query).

JULIANTIMESTAMP is a Trafodion SQL extension.

```
JULIANTIMESTAMP(datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a value of type DATE, TIME, or TIMESTAMP. If *datetime-expression* does not contain all the fields from YEAR through SECOND, Trafodion SQL extends the value before converting it to a Julian timestamp. Datetime fields to the left of the specified datetime value are set to current date fields. Datetime fields to the right of the specified datetime value are set to zero. See [Datetime Value Expressions](#).

7.56.1. Considerations for JULIANTIMESTAMP

The *datetime-expression* value must be a date or timestamp value from the beginning of year 0001 to the end of year 9999.

7.56.2. Examples of JULIANTIMESTAMP

The project table consists of five columns using the data types NUMERIC, VARCHAR, DATE, TIMESTAMP, and INTERVAL.

- Convert the TIMESTAMP value into a Julian timestamp representation:

```
SELECT ship_timestamp, JULIANTIMESTAMP (ship_timestamp)
FROM persnl.project
WHERE projcode = 1000;

SHIP_TIMESTAMP          (EXPR)
-----
2008-04-21 08:15:00.000000 212075525700000000
--- 1 row(s) selected.
```

- Convert the DATE value into a Julian timestamp representation:

```
SELECT start_date, JULIANTIMESTAMP (start_date)
FROM persnl.project
WHERE projcode = 1000;

START_DATE (EXPR)
-----
2008-04-10 212074545600000000

--- 1 row(s) selected.
```

7.57. LASTNOTNULL Function

The LASTNOTNULL function is a sequence function that returns the last non-null value of a column in an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

LASTNOTNULL is a Trafodion SQL extension.

```
LASTNOTNULL(column-expression)
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression. If only null values have been returned, LASTNOTNULL returns null.

7.57.1. Examples of LASTNOTNULL

- Return the last non-null value of a column:

```
SELECT LASTNOTNULL(I1) AS lastnotnull
FROM mining.seqfcn SEQUENCE BY ts;
```

```
lastnotnull
-----
 6215
 6215
 19058
 19058
 11966
```

```
--- 5 row(s) selected.
```

7.58. LCASE Function

The LCASE function down-shifts alphanumeric characters. For non-alphanumeric characters, LCASE returns the same character. LCASE can appear anywhere in a query where a value can be used, such as in a select list, an ON clause, a WHERE clause, a HAVING clause, a LIKE predicate, an expression, or as qualifying a new value in an UPDATE or INSERT statement. The result returned by the LCASE function is equal to the result returned by the [LOWER Function](#).

LCASE returns a string of fixed-length or variable-length character data, depending on the data type of the input string.

LCASE is a Trafodion SQL extension.

```
LCASE (character-expression)
```

- *character-expression*

is an SQL character value expression that specifies a string of characters to down-shift. See [Character Value Expressions](#).

7.58.1. Examples of LCASE

- Suppose that your CUSTOMER table includes an entry for Hotel Oregon. Select the column CUSTNAME and return in uppercase and lowercase letters by using the UCASE and LCASE functions:

```
SELECT custname ,UCASE(custname) ,LCASE(custname) FROM sales.customer;
(Expr)          (Expr)          (Expr)
-----
...            ...
Hotel Oregon    HOTEL OREGON    hotel oregon
--- 17 row(s) selected.
```

See [UCASE Function](#).

7.58.2. LEFT Function

The LEFT function returns the leftmost specified number of characters from a character expression. Every character, including multi-byte characters, is treated as one character.

LEFT is a Trafodion SQL extension.

```
LEFT (character-expr, count)
```

- *character-expr*

specifies the source string from which to return the leftmost specified number of characters. The source string is an SQL character value expression. The operand is the result of evaluating *character-expr*. See [Character Value Expressions](#).

- *count*

specifies the number of characters to return from *character-expr*. The number *count* must be a value of exact numeric data type greater than or equal to 0 with a scale of zero.

7.58.3. Examples of LEFT

- Return '_robert':

```
left('robert john smith', 6)
```

- Use the LEFT function to append the company name to the job descriptions:

```
UPDATE persnl.job SET jobdesc = LEFT (jobdesc, 11) || ' COMNET';

SELECT jobdesc FROM persnl.job;

Job Description
-----
MANAGER COMNET
PRODUCTION COMNET
ASSEMBLER COMNET
SALESREP COMNET
SYSTEM ANAL COMNET
ENGINEER COMNET
PROGRAMMER COMNET
ACCOUNTANT COMNET
ADMINISTRAT COMNET
SECRETARY COMNET

--- 10 row(s) selected.
```

7.59. LOCATE Function

The LOCATE function searches for a given substring in a character string. If the substring is found, Trafodion SQL returns the character position of the substring within the string. Every character, including multi-byte characters, is treated as one character. The result returned by the LOCATE function is equal to the result returned by the [Position Function](#).

LOCATE is a Trafodion SQL extension.

```
LOCATE(substring-expression,source-expression)
```

- *substring-expression*

is an SQL character value expression that specifies the substring to search for in *source-expression*. The *substring-expression* cannot be NULL. See [Character Value Expressions](#).

- *source-expression*

is an SQL character value expression that specifies the source string. the *source-expression* cannot be null. See [Character Value Expressions](#).

Trafodion SQL returns the result as a 2-byte signed integer with a scale of zero. If *substring-expression* is not found in *source-expression* , Trafodion SQL returns 0.

7.59.1. Considerations for LOCATE

Result of LOCATE

- If the length of *source-expression* is zero and the length of *substring-expression* is greater than zero, Trafodion SQL returns 0.
- If the length of *substring-expression* is zero, Trafodion SQL returns 1.
- If the length of *substring-expression* is greater than the length of *source-expression*, Trafodion SQL returns 0.
- If *source-expression* is a null value, Trafodion SQL returns a null value.

Using UCASE

To ignore case in the search, use the UCASE function (or the LCASE function) for both the *substring-expression* and the *source-expression*.

7.59.2. Examples of LOCATE

- Return the value 8 for the position of the substring 'John' within the string:

```
LOCATE ('John', 'Robert John Smith')
```

- Suppose that the EMPLOYEE table has an EMPNAME column that contains both the first and last names. This SELECT statement returns all records in table EMPLOYEE that contain the substring 'SMITH', regardless of whether the column value is in uppercase or lowercase characters:

```
SELECT * FROM persnl.employee  
WHERE LOCATE ('SMITH', UCASE(empname)) > 0 ;
```

7.60. LOG Function

The LOG function returns the natural logarithm of a numeric value expression. LOG is a Trafodion SQL extension.

```
LOG (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the LOG function. The value of the argument must be greater than zero. See [Numeric Value Expressions](#).

7.60.1. Examples of LOG

- This function returns the value 6.93147180559945344e-001, or approximately 0.69315:

```
LOG (2.0)
```

7.60.2. LOG10 Function

The LOG10 function returns the base 10 logarithm of a numeric value expression.

LOG10 is a Trafodion SQL extension.

```
LOG10 (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the LOG10 function. The value of the argument must be greater than zero. See [Numeric Value Expressions](#).

7.60.3. Examples of LOG10

- This function returns the value 1.39794000867203776E+000, or approximately 1.3979:

```
LOG10 ( 25 )
```

7.61. LOWER Function

The LOWER function down-shifts alphanumeric characters. For non-alphanumeric characters, LOWER returns the same character. LOWER can appear anywhere in a query where a value can be used, such as in a select list, an ON clause, a WHERE clause, a HAVING clause, a LIKE predicate, an expression, or as qualifying a new value in an UPDATE or INSERT statement. The result returned by the LOWER function is equal to the result returned by the [LCASE Function](#).

LOWER returns a string of fixed-length or variable-length character data, depending on the data type of the input string.

```
LOWER (character-expression)
```

- *character-expression*

is an SQL character value expression that specifies a string of characters to down-shift. See [Character Value Expressions](#).

7.61.1. Considerations for LOWER

For a UTF8 character expression, the LOWER function down-shifts all the uppercase or title case characters in a given string to lowercase and returns a character string with the same data type and character set as the argument.

A lower case character is a character that has the "alphabetic" property in Unicode Standard 2 whose Unicode name includes *lower*. An uppercase character is a character that has the "alphabetic" property in the Unicode Standard 2 and whose Unicode name includes *upper*. A title case character is a character that has the Unicode "alphabetic" property and whose Unicode name includes *title*.

7.61.2. Examples of LOWER

- Suppose that your CUSTOMER table includes an entry for Hotel Oregon. Select the column CUSTNAME and return the result in uppercase and lowercase letters by using the UPPER and LOWER functions:

```
SELECT custname,UPPER(custname),LOWER(custname) FROM sales.customer;  
  
(EXPR)          (EXPR)          (EXPR)  
-----  -----  -----  
...           ...           ...  
Hotel Oregon    HOTEL OREGON   hotel oregon  
  
--- 17 row(s) selected.
```

See [UPPER Function](#).

7.61.3. LPAD Function

The LPAD function pads the left side of a string with the specified string. Every character in the string, including multi-byte characters, is treated as one character.

LPAD is a Trafodion SQL extension.

```
LPAD (str, len [,padstr])
```

- *str*

can be an expression. See [Character Value Expressions](#).

- *len*

identifies the desired number of characters to be returned and can be an expression but must be an integral value. If *len* is equal to the length of the string, no change is made. If *len* is smaller than the string size, the string is truncated.

- *pad-character*

can be an expression and may be a string.

7.61.4. Examples of LPAD

- This function returns ' kite':

```
LPAD('kite', 7)
```

- This function returns 'ki':

```
LPAD('kite', 2)
```

- This function returns '0000kite':

```
LPAD('kite', 8, '0')
```

- This function returns 'go fly a kite':

```
LPAD('go fly a kite', 13, 'z')
```

- This function returns 'John,John, go fly a kite':

```
LPAD('go fly a kite', 23, 'John,')
```

7.62. LTRIM Function

The LTRIM function removes leading spaces from a character string. If you must remove any leading character other than space, use the TRIM function and specify the value of the character. See the [TRIM Function](#).

LTRIM is a Trafodion SQL extension.

```
LTRIM (character-expression)
```

- *character-expression*

is an SQL character value expression and specifies the string from which to trim leading spaces. See [Character Value Expressions](#).

7.62.1. Considerations for LTRIM

Result of LTRIM

The result is always of type VARCHAR, with maximum length equal to the fixed length or maximum variable length of *character-expression*.

7.62.2. Examples of LTRIM

- Return 'Robert':

```
LTRIM (' Robert ')
```

See [TRIM Function](#) and [RTRIM Function](#).

7.63. MAX/MAXIMUM Function

MAX is an aggregate function that returns the maximum value within a set of values. MAXIMUM is the equivalent of MAX wherever the function name MAX appears within a statement. The data type of the result is the same as the data type of the argument.

```
MAX | MAXIMUM ([ALL | DISTINCT] expression)
```

- ALL | DISTINCT

specifies whether duplicate values are included in the computation of the maximum of the *expression*. The default option is ALL, which causes duplicate values to be included. If you specify DISTINCT, duplicate values are eliminated before the MAX/MAXIMUM function is applied.

- *expression*

specifies an expression that determines the values to include in the computation of the maximum. The *expression* cannot contain an aggregate function or a subquery. The DISTINCT clause specifies that the MAX/MAXIMUM function operates on distinct values from the one-column table derived from the evaluation of *expression*. All nulls are eliminated before the function is applied to the set of values. If the result table is empty, MAX/MAXIMUM returns NULL. See [Expressions](#).

7.63.1. Considerations for MAX/MAXIMUM

7.63.2. Operands of the Expression

The expression includes columns from the rows of the SELECT result table but cannot include an aggregate function.

These expressions are valid:

```
MAX (SALARY)
MAX (SALARY * 1.1)
MAX (PARTCOST * QTY_ORDERED)
```

7.63.3. Examples of MAX/MAXIMUM

- Display the maximum value in the SALARY column:

```
SELECT MAX (salary) FROM persnl.employee;  
(EXPR)  
-----  
175500.00  
--- 1 row(s) selected.
```

7.64. MD5 Function

Calculates an MD5 128-bit checksum for the string. The value is returned as a string of 32 hexadecimal digits, or NULL if the argument was NULL.

```
MD5( _expression_)
```

- *expression*

specifies an expression that determines the values to include in the computation of the MD5. The *expression* cannot contain an aggregate function or a subquery. If the input value is NULL, MD5 returns NULL. See [Expressions](#).

7.64.1. Examples of MD5

The return value is a nonbinary string in the connection character set.

```
>>SELECT MD5('testing') from dual;  
(EXPR)  
-----  
'ae2b1fca515949e5d54fb22b8ed95575'
```

7.65. MIN Function

MIN is an aggregate function that returns the minimum value within a set of values. The data type of the result is the same as the data type of the argument.

```
MIN ([ALL | DISTINCT] _expression_)
```

- ALL | DISTINCT

specifies whether duplicate values are included in the computation of the minimum of the *expression*. The default option is ALL, which causes duplicate values to be included. If you specify DISTINCT, duplicate values are eliminated before the MIN function is applied.

- *expression*

specifies an expression that determines the values to include in the computation of the minimum. The *expression* cannot contain an aggregate function or a subquery. The DISTINCT clause specifies that the MIN function operates on distinct values from the one-column table derived from the evaluation of *expression*. All nulls are eliminated before the function is applied to the set of values. If the result table is empty, MIN returns NULL. See [Expressions](#).

7.65.1. Considerations for MIN

Operands of the Expression

The expression includes columns from the rows of the SELECT result table — but cannot include an aggregate function. These expressions are valid:

```
MIN (SALARY)
MIN (SALARY * 1.1)
MIN (PARTCOST * QTY_ORDERED)
```

7.65.2. Examples of MIN

- Display the minimum value in the SALARY column:

```
SELECT MIN (salary) FROM persnl.employee;  
  
(EXPR)  
-----  
17000.00  
  
--- 1 row(s) selected.
```

7.66. MINUTE Function

The MINUTE function converts a TIME or TIMESTAMP expression into an INTEGER value, in the range 0 through 59, that represents the corresponding minute of the hour.

MINUTE is a Trafodion SQL extension.

```
MINUTE (datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type TIME or TIMESTAMP. See [Datetime Value Expressions](#).

7.66.1. Examples of minute

- Return an integer that represents the minute of the hour from the ship timestamp column in the project table:

```
SELECT start_date, ship_timestamp, MINUTE(ship_timestamp)
FROM persnl.project
WHERE projcode = 1000;

Start/Date Time/Shipped          (EXPR)
-----
2008-04-10 2008-04-21 08:15:00.000000      15
```

7.67. MOD Function

The MOD function returns the remainder (modulus) of an integer value expression divided by an integer value expression.

MOD is a Trafodion SQL extension.

```
MOD (integer-expression-1, integer-expression-2)
```

- *integer-expression-1*

is an SQL numeric value expression of data type SMALLINT, INTEGER, or LARGEINT that specifies the value for the dividend argument of the MOD function.

- *integer-expression-2*

is an SQL numeric value expression of data type SMALLINT, INTEGER, or LARGEINT that specifies the value for the divisor argument of the MOD function. The divisor argument cannot be zero. See [Numeric Value Expressions](#).

7.67.1. Examples of MOD

- This function returns the value 2 as the remainder or modulus:

```
MOD(11,3)
```

7.68. MONTH Function

The MONTH function converts a DATE or TIMESTAMP expression into an INTEGER value in the range 1 through 12 that represents the corresponding month of the year.

MONTH is a Trafodion SQL extension.

```
MONTH (datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

7.68.1. Examples of MONTH

- Return an integer that represents the month of the year from the start date column in the project table:

```
SELECT start_date, ship_timestamp, MONTH(start_date) FROM persnl.project  
WHERE projcode = 1000;
```

Start/Date	Time/Shipped	(EXPR)
2008-04-10	2008-04-21 08:15:00.000000	4

7.69. MONTHNAME Function

The MONTHNAME function converts a DATE or TIMESTAMP expression into a character literal that is the name of the month of the year (January, February, and so on).

MONTHNAME is a Trafodion SQL extension.

```
MONTHNAME (datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

7.69.1. Considerations for MONTHNAME

The MONTHNAME function returns the name of the month in ISO8859-1.

7.69.2. Examples of MONTHNAME

- Return a character literal that is the month of the year from the start date column in the project table:

```
SELECT start_date, ship_timestamp, MONTHNAME(start_date)
FROM persnl.project
WHERE projcode = 1000;

Start/Date Time/Shipped          (EXPR)
-----
2008-04-10 2008-04-21 08:15:00.000000 April
```

7.70. MOVINGAVG Function

The MOVINGAVG function is a sequence function that returns the average of non-null values of a column in the current window of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

MOVINGAVG is a Trafodion SQL extension.

```
MOVINGAVG(column-expression, integer-expression [, max-rows])
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

- *integer-expression*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the current window.

The current window is defined as the current row and the previous (*integer-expression* - 1) rows.

- *max-rows*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the maximum number of rows in the current window.

Note these considerations for the window size:

- The actual value for the window size is the minimum of *integer-expression* and *max-rows*.
- If these conditions are met, MOVINGAVG returns the same result as RUNNINGAVG:
 - The *integer-expression* is out of range, and *max-rows* is not specified. This condition includes the case in which both *integer-expression* and *max-rows* are larger than the result table.
 - The minimum of *integer-expression* and *max-rows* is out of range. In this case, *integer-expression* could be within range, but *max-rows* might be the minimum value of the two and be out of range (for example, a negative number).
- The number of rows is out of range if it is larger than the size of the result table, negative, or NULL.

7.70.1. Examples of MOVINGAVG

- Return the average of non-null values of a column in the current window of three rows:

```
CREATE TABLE db.mining.seqfcn (I1 INTEGER, ts TIMESTAMP);

SELECT MOVINGAVG (I1,3) AS MOVINGAVG3
FROM mining.seqfcn SEQUENCE BY ts;

I1          TS
6215        TIMESTAMP '1950-03-05 08:32:09'
28174       TIMESTAMP '1951-02-15 14:35:49'
null         TIMESTAMP '1955-05-18 08:40:10'
4597         TIMESTAMP '1960-09-19 14:40:39'
11966       TIMESTAMP '1964-05-01 16:41:02'

MOVINGAVG3
-----
6215
17194
17194
16385
8281

--- 5 row(s) selected.
```

7.71. MOVINGCOUNT Function

The MOVINGCOUNT function is a sequence function that returns the number of non-null values of a column in the current window of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

MOVINGCOUNT is a Trafodion SQL extension.

```
MOVINGCOUNT (column-expression, integer-expression [, max-rows])
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

- *integer-expression*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the current window.

The current window is defined as the current row and the previous (*integer-expression* - 1) rows.

- *max-rows*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the maximum number of rows in the current window.

Note these considerations for the window size:

- The actual value for the window size is the minimum of *integer-expression* and *max-rows*.
- If these conditions are met, MOVINGCOUNT returns the same result as RUNNINGCOUNT:
 - The *integer-expression* is out of range, and *max-rows* is not specified. This condition includes the case in which both *integer-expression* and *max-rows* are larger than the result table.
 - The minimum of *integer-expression* and *max-rows* is out of range. In this case, *integer-expression* could be within range, but *max-rows* might be the minimum value of the two and be out of range (for example, a negative number).
- The number of rows is out of range if it is larger than the size of the result table, negative, or NULL.

7.71.1. Considerations for MOVINGCOUNT

The MOVINGCOUNT sequence function is defined differently from the COUNT aggregate function. If you specify DISTINCT for the COUNT aggregate function, duplicate values are eliminated before COUNT is applied. You cannot specify DISTINCT for the MOVINGCOUNT sequence function; duplicate values are counted.

7.71.2. Examples of MOVINGCOUNT

- Return the number of non-null values of a column in the current window of three rows:

```
SELECT MOVINGCOUNT (I1,3) AS MOVINGCOUNT3
FROM mining.seqfcn SEQUENCE BY ts;
```

```
MOVINGCOUNT3
```

```
-----  
1  
2  
2  
2  
2
```

```
--- 5 row(s) selected.
```

7.72. MOVINGMAX Function

The MOVINGMAX function is a sequence function that returns the maximum of non-null values of a column in the current window of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

MOVINGMAX is a Trafodion SQL extension.

```
MOVINGMAX (column-expression, integer-expression [, max-rows])
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

- *integer-expression*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the current window.

The current window is defined as the current row and the previous (*integer-expression* - 1) rows.

- *max-rows*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the maximum number of rows in the current window.

Note these considerations for the window size:

- The actual value for the window size is the minimum of *integer-expression* and *max-rows*.
- If these conditions are met, MOVINGMAX returns the same result as RUNNINGMAX:
 - The *integer-expression* is out of range, and *max-rows* is not specified. This condition includes the case in which both *integer-expression* and *max-rows* are larger than the result table.
 - The minimum of *integer-expression* and *max-rows* is out of range. In this case, *integer-expression* could be within range, but *max-rows* might be the minimum value of the two and be out of range (for example, a negative number).
- The number of rows is out of range if it is larger than the size of the result table, negative, or NULL.

7.72.1. Examples of MOVINGMAX

- Return the maximum of non-null values of a column in the current window of three rows:

```
SELECT MOVINGMAX (I1,3) AS MOVINGMAX3
FROM mining.seqfcn SEQUENCE BY ts;
```

```
MOVINGMAX3
```

```
-----  
6215  
28174  
28174  
28174  
11966
```

```
--- 5 row(s) selected.
```

7.73. MOVINGMIN Function

The MOVINGMIN function is a sequence function that returns the minimum of non-null values of a column in the current window of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

MOVINGMIN is a Trafodion SQL extension.

```
MOVINGMIN (column-expression, integer-expression [, max-rows])
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

- *integer-expression*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the current window.

The current window is defined as the current row and the previous (*integer-expression* - 1) rows.

- *max-rows*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the maximum number of rows in the current window.

Note these considerations for the window size:

- The actual value for the window size is the minimum of *integer-expression* and *max-rows*.
- If these conditions are met, MOVINGMIN returns the same result as RUNNINGMIN:
 - The *integer-expression* is out of range, and *max-rows* is not specified. This condition includes the case in which both *integer-expression* and *max-rows* are larger than the result table.
 - The minimum of *integer-expression* and *max-rows* is out of range. In this case, *integer-expression* could be within range, but *max-rows* might be the minimum value of the two and be out of range (for example, a negative number).
- The number of rows is out of range if it is larger than the size of the result table, negative, or NULL.

7.73.1. Examples of MOVINGMIN

- Return the minimum of non-null values of a column in the current window of three rows:

```
SELECT MOVINGMIN (I1,3) AS MOVINGMIN3
FROM mining.seqfcn SEQUENCE BY ts;
```

```
MOVINGMIN3
```

```
-----  
6215  
6215  
6215  
4597  
4597
```

```
--- 5 row(s) selected.
```

7.74. MOVINGSTDDEV Function

The MOVINGSTDDEV function is a sequence function that returns the standard deviation of non-null values of a column in the current window of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

MOVINGSTDDEV is a Trafodion SQL extension.

```
MOVINGSTDDEV (column-expression, integer-expression [, max-rows])
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

- *integer-expression*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the current window.

The current window is defined as the current row and the previous (*integer-expression* - 1) rows.

- *max-rows*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the maximum number of rows in the current window.

Note these considerations for the window size:

- The actual value for the window size is the minimum of *integer-expression* and *max-rows*.
- If these conditions are met, MOVINGSTDDEV returns the same result as RUNNINGSTDDEV:
 - The *integer-expression* is out of range, and *max-rows* is not specified. This condition includes the case in which both *integer-expression* and *max-rows* are larger than the result table.
 - The minimum of *integer-expression* and *max-rows* is out of range. In this case, *integer-expression* could be within range, but *max-rows* might be the minimum value of the two and be out of range (for example, a negative number).
- The number of rows is out of range if it is larger than the size of the result table, negative, or NULL.

7.74.1. Examples of MOVINGSTDDEV

- Return the standard deviation of non-null values of a column in the current window of three rows:

```
SELECT MOVINGSTDDEV (I1,3) AS MOVINGSTDDEV3
FROM mining.seqfcn SEQUENCE BY ts;

MOVINGSTDDEV3
-----
0.0000000000000000E+000
1.55273578080753976E+004
1.48020166531456112E+004
1.51150124820766640E+004
6.03627542446499008E+003

--- 5 row(s) selected.
```

- You can use the CAST function for display purposes. For example:

```
SELECT CAST(MOVINGSTDDEV (I1,3) AS DEC (18,3))
FROM mining.seqfcn SEQUENCE BY ts;

(EXPR)
-----
.000
15527.357
14802.016
15115.012
6036.275

--- 5 row(s) selected.
```

7.75. MOVINGSUM Function

The MOVINGSUM function is a sequence function that returns the sum of non-null values of a column in the current window of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

MOVINGSUM is a Trafodion SQL extension.

```
MOVINGSUM (column-expression, integer-expression [, max-rows])
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

- *integer-expression*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the current window.

The current window is defined as the current row and the previous (*integer-expression* - 1) rows.

- *max-rows*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the maximum number of rows in the current window.

Note these considerations for the window size:

- The actual value for the window size is the minimum of *integer-expression* and *max-rows*.
- If these conditions are met, MOVINGSUM returns the same result as RUNNINGSUM:
 - The *integer-expression* is out of range, and *max-rows* is not specified. This condition includes the case in which both *integer-expression* and *max-rows* are larger than the result table.
 - The minimum of *integer-expression* and *max-rows* is out of range. In this case, *integer-expression* could be within range, but *max-rows* might be the minimum value of the two and be out of range (for example, a negative number).
- The number of rows is out of range if it is larger than the size of the result table, negative, or NULL.

7.75.1. Examples of MOVINGSUM

- Return the sum of non-null values of a column in the current window of three rows:

```
SELECT MOVINGSUM (I1,3) AS MOVINGSUM3
FROM mining.seqfcn SEQUENCE BY ts;
```

```
MOVINGSUM3
```

```
-----
6215
34389
34389
32771
16563
```

```
--- 5 row(s) selected.
```

7.76. MOVINGVARIANCE Function

The MOVINGVARIANCE function is a sequence function that returns the variance of non-null values of a column in the current window of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

MOVINGVARIANCE is a Trafodion SQL extension.

```
MOVINGVARIANCE (column-expression, integer-expression [, max-rows])
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

- *integer-expression*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the current window.

The current window is defined as the current row and the previous (*integer-expression* - 1) rows.

- *max-rows*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the maximum number of rows in the current window.

Note these considerations for the window size:

- The actual value for the window size is the minimum of *integer-expression* and *max-rows*.
- If these conditions are met, MOVINGVARIANCE returns the same result as RUNNINGVARIANCE:
 - The *integer-expression* is out of range, and *max-rows* is not specified. This condition includes the case in which both *integer-expression* and *max-rows* are larger than the result table.
 - The minimum of *integer-expression* and *max-rows* is out of range. In this case, *integer-expression* could be within range, but *max-rows* might be the minimum value of the two and be out of range (for example, a negative number).
- The number of rows is out of range if it is larger than the size of the result table, negative, or NULL.

7.76.1. Examples of MOVINGVARIANCE

- Return the variance of non-null values of a column in the current window of three rows:

```
SELECT MOVINGVARIANCE (I1,3) AS MOVINGVARIANCE3
FROM mining.seqfcn SEQUENCE BY ts;

MOVINGVARIANCE3
-----
0.0000000000000000E+000
2.41098840499999960E+008
2.19099696999999968E+008
2.2846360233333304E+008
3.64366210000000016E+007

--- 5 row(s) selected.
```

- You can use the CAST function for display purposes. For example:

```
SELECT CAST(MOVINGVARIANCE (I1,3) AS DEC (18,3))
FROM mining.seqfcn SEQUENCE BY ts;

(EXPR)
-----
.000
241098840.500
219099697.000
228463602.333
36436621.000

--- 5 row(s) selected.
```

7.76.2. NULLIF Function

The NULLIF function compares the value of two expressions. Both expressions must be of comparable types. The return value is NULL when the two expressions are equal. Otherwise, the return value is the value of the first expression.

```
NULLIF(expr1, expr2)
```

- *expr1*

an expression to be compared.

- *expr2*

an expression to be compared.

The `NULLIF(expr1, expr2)` is equivalent to:

```
CASE
    WHEN expr1 = expr2 THEN NULL
    ELSE expr1
END
```

NULLIF returns a NULL if both arguments are equal. The return value is the value of the first argument when the two expressions are not equal.

7.76.3. Examples of NULLIF

- This function returns a null if the *value* is equal to 7. The return value is the value of the first argument when that value is not 7.

```
NULLIF(value,7)
```

7.77. NULLIFZERO Function

The NULLIFZERO function returns the value of the expression if that value is not zero. It returns NULL if the value of the expression is zero.

```
NULLIFZERO (expression)
```

- *expression*

specifies a value expression. It must be a numeric data type.

7.77.1. Examples of NULLIFZERO

- This function returns the value of the column named salary for each row where the column's value is not zero. It returns a NULL for each row where the column's value is zero.

```
SELECT NULLIFZERO(salary) FROM employee_tab;
```

- This function returns a value of 1 for each row of the table:

```
SELECT NULLIFZERO(1) FROM employee_tab;
```

- This function returns a value of NULL for each row of the table:

```
SELECT NULLIFZERO(0) FROM employee_tab;
```

7.78. NVL Function

The NVL function determines if the selected column has a null value and then returns the new-operand value; otherwise the operand value is returned.

```
NVL (operand, new-operand)
```

- *operand*

specifies a value expression.

- *new-operand*

specifies a value expression. *operand* and *new-operand* must be comparable data types.

If *operand* is a null value, NVL returns *new-operand*. If *operand* is not a null value, NVL returns *operand*.

The *operand* and *new-operand* can be a column name, subquery, Trafodion SQL string functions, math functions, or constant values.

7.78.1. Examples of NVL

- This function returns a value of z:

```
SELECT NVL(CAST(NULL AS CHAR(1)), 'z') FROM (VALUES(1)) x(a);
(EXPR)
-----
"z"
--- 1 row(s) selected.
```

- This function returns a value of 1:

```
SELECT NVL(1, 2) FROM (VALUES(0)) x(a)
(EXPR)
-----
1
--- 1 row(s) selected.
```

- This function returns a value of 9999999 for the null value in the column named a1:

```
SELECT NVL(a1, 9999999) from t1;  
  
(EXPR)  
-----  
123  
34  
9999999  
  
--- 3 row(s) selected.  
  
select * from t1;  
  
A1  
-----  
123  
34  
?  
  
--- 3 row(s) selected.
```

7.79. OCTET_LENGTH Function

The OCTET_LENGTH function returns the length of a character string in bytes.

```
OCTET_LENGTH (string-value-expression)
```

- *string-value-expression*

specifies the string value expression for which to return the length in bytes. Trafodion SQL returns the result as a 2-byte signed integer with a scale of zero. If *string-value-expression* is null, Trafodion SQL returns a length of zero. See [Character Value Expressions](#).

7.79.1. Considerations for OCTET_LENGTH

CHAR and VARCHAR Operands

For a column declared as fixed CHAR, Trafodion SQL returns the length of that column as the maximum number of storage bytes. For a VARCHAR column, Trafodion SQL returns the length of the string stored in that column as the actual number of storage bytes.

Similarity to CHAR_LENGTH Function

The OCTET_LENGTH and CHAR_LENGTH functions are similar. The OCTET_LENGTH function returns the number of bytes, rather than the number of characters, in the string. This distinction is important for multi-byte implementations. For an example of selecting a double-byte column, see [Example of OCTET_LENGTH](#).

Examples of OCTET_LENGTH

- If a character string is stored as two bytes for each character, this function returns the value 12. Otherwise, the function returns 6:

```
OCTET_LENGTH ( 'Robert' )
```

7.79.2. OFFSET Function

The OFFSET function is a sequence function that retrieves columns from previous rows of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [[sequence_by clause](#)].`_offset_is_a_trafodion_sql_extension.`

```
OFFSET ( column-expression , number-rows [ , max-rows ] )
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

- *number-rows*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the offset as the number of rows from the current row. If the number of rows exceeds *max-rows*, OFFSET returns `OFFSET(column-expression,max-rows)`. If the number of rows is out of range and *max-rows* is not specified or is out of range, OFFSET returns null. The number of rows is out of range if it is larger than the size of the result table, negative, or NULL.

- *max-rows*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the maximum number of rows of the offset.

7.79.3. Examples of OFFSET

- Retrieve the I1 column offset by three rows:

```
SELECT OFFSET(I1,3) AS offset3
FROM mining.seqfcn SEQUENCE BY ts;

offset3
-----
?
?
?
6215
28174

--- 5 row(s) selected.
```

The first three rows retrieved display null because the offset from the current row does not fall within the result table.

7.80. PI Function

The PI function returns the constant value of pi as a floating-point value.

PI is a Trafodion SQL extension.

```
PI()
```

7.80.1. Examples of PI

- This constant function returns the value 3.1415926000000000E+000:

```
PI()
```

7.81. POSITION Function

The POSITION function searches for a given substring in a character string. If the substring is found, Trafodion SQL returns the character position of the substring within the string. Every character, including multi-byte characters, is treated as one character. The result returned by the POSITION function is equal to the result returned by the [LOCATE Function](#).

```
POSITION (substring-expression IN source-expression)
```

- *substring-expression*

is an SQL character value expression that specifies the substring to search for in *source-expression*. The *substring-expression* cannot be NULL. See [Character Value Expressions](#).

- *source-expression*

is an SQL character value expression that specifies the source string. the *source-expression* cannot be null. See [Character Value Expressions](#).

Trafodion SQL returns the result as a 2-byte signed integer with a scale of zero. If *substring-expression* is not found in *source-expression*, Trafodion SQL returns zero.

7.81.1. Considerations for POSITION

Result of POSITION

If the length of *source-expression* is zero and the length of *substring-expression* is greater than zero, Trafodion SQL returns 0. If the length of *substring-expression* is zero, Trafodion SQL returns 1.

If the length of *substring-expression* is greater than the length of *source-expression*, Trafodion SQL returns zero. If *source-expression* is a null value, Trafodion SQL returns a null value.

Using the UPSHIFT Function

To ignore case in the search, use the UPSHIFT function (or the LOWER function) for both the *substring-expression* and the *source-expression*.

7.81.2. Examples of POSITION

- This function returns the value 8 for the position of the substring 'John' within the string:

```
POSITION ('John' IN 'Robert John Smith')
```

- Suppose that the EMPLOYEE table has an EMPNAME column that contains both the first and last names. Return all records in table EMPLOYEE that contain the substring 'Smith' regardless of whether the column value is in uppercase or lowercase characters:

```
SELECT * FROM persnl.employee  
WHERE POSITION ('SMITH' IN UPSHIFT(empname)) > 0 ;
```

7.82. POWER Function

The POWER function returns the value of a numeric value expression raised to the power of an integer value expression. You can also use the exponential operator `**`.

POWER is a Trafodion SQL extension.

```
POWER (numeric-expression-1, numeric-expression-2)
```

- *numeric-expression-1, numeric-expression-2*

are SQL numeric value expressions that specify the values for the base and exponent arguments of the POWER function. See [Numeric Value Expressions](#).

If base *numeric-expression-1_is_zero*, the exponent *numeric-expression-2* must be greater than zero, and the result is zero. If the exponent is zero, the base cannot be 0, and the result is 1. If the base is negative, the exponent must be a value with an exact numeric data type and a scale of zero.

7.82.1. Examples of POWER

- Return the value 15.625:

```
POWER ( 2.5 , 3 )
```

- Return the value 27. The function POWER raised to the power of 2 is the inverse of the function SQRT:

```
POWER ( SQRT( 27 ) , 2 )
```

7.83. QUARTER Function

The QUARTER function converts a DATE or TIMESTAMP expression into an INTEGER value in the range 1 through 4 that represents the corresponding quarter of the year. Quarter 1 represents January 1 through March 31, and so on.

QUARTER is a Trafodion SQL extension.

```
QUARTER (datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

7.83.1. Examples of QUARTER

- Return an integer that represents the quarter of the year from the START_DATE column in the PROJECT table:

```
SELECT start_date, ship_timestamp, QUARTER(start_date)
FROM persnl.project
WHERE projcode = 1000;

Start/Date Time/Shipped          (EXPR)
-----
2008-04-10 2008-04-21 08:15:00.000000      2
```

7.84. RADIANS Function

The RADIANS function converts a numeric value expression (expressed in degrees) to the number of radians.

RADIANS is a Trafodion SQL extension.

```
RADIANS (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the RADIANS function. See [Numeric Value Expressions](#).

7.84.1. Examples of RADIANS

- Return the value 7.853981500000000E-001, or approximately 0.78540 in degrees:

```
RADIANS (45)
```

- Return the value 45 in degrees. The function DEGREES is the inverse of the function RADIANS.

```
DEGREES (RADIANS (45))
```

7.85. RANK/RUNNINGRANK Function

The RANK/RUNNINGRANK function is a sequence function that returns the rank of the given value of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. RANK is an alternative syntax for RANK/RUNNINGRANK.

RANK/RUNNINGRANK is a Trafodion extension.

```
RUNNINGRANK(expression) | RANK(expression)
```

- *expression*

specifies the expression on which to perform the rank.

RANK/RUNNINGRANK returns the rank of the expression within the intermediate result table. The definition of rank is as follows:

```
RANK = 1 for the first value of the intermediate result table.  
= the previous value of RANK if the previous value of expression is  
the same as the current value of expression.  
= RUNNINGCOUNT(*) otherwise.
```

In other words, RANK starts at 1. Values that are equal have the same rank. The value of RANK advances to the relative position of the row in the intermediate result when the value changes.

7.85.1. Considerations for RANK/RUNNINGRANK

Sequence Order Dependency

The RUNNINGRANK function is meaningful only when the given expression is the leading column of the SEQUENCE BY clause. This is because the RUNNINGRANK function assumes that the values of expression are in order and that like values are contiguous. If an ascending order is specified for expression in the SEQUENCE BY clause, then the RUNNINGRANK function assigns a rank of 1 to the lowest value of expression. If a descending order is specified for expression in the SEQUENCE BY clause, then the RUNNINGRANK function assigns a rank of 1 to the highest value of expression.

NULL Values

For the purposes of RUNNINGRANK, NULL values are considered to be equal.

7.85.2. Examples of RANK/RUNNINGRANK

- Suppose that seqfcn has been created as:

```
CREATE TABLE cat.sch.seqfcn (i1 INTEGER, i2 INTEGER);
```

The table SEQFCN has columns *i1* and *i2* with data:

i1	i2
1	100
3	200
4	100
2	200
5	300
10	null

- Return the rank of *i1*:

```
SELECT i1, RUNNINGRANK(i1) AS rank
FROM cat.sch.seqfcn SEQUENCE BY i1;
```

i1	rank
1	1
2	2
3	3
4	4
5	5
6	6
8	7
10	8

--- 8 row(s) selected.

- Return the rank of *i1* descending:

```
SELECT i1, RUNNINGRANK (i1) AS rank
FROM cat.sch.seqfcn SEQUENCE BY i1 DESC;
```

i1	rank
10	1
8	2
6	3
5	4
4	5
3	6
2	7
1	8

```
--- 8 row(s) selected.
```

- Return the rank of *i2*, using the alternative RANK syntax:

```
SELECT i2, RANK (i2) AS rank
FROM cat.sch.seqfcn SEQUENCE BY i2;
```

i2	rank
100	1
100	1
200	3
200	3
200	3
300	6
?	7
?	7

```
--- 8 row(s) selected.
```

Notice that the two NULL values received the same rank.

- Return the rank of *i2* descending, using the alternative RANK syntax:

```
SELECT i2, RANK (i2) AS rank
FROM cat.sch.seqfcn SEQUENCE BY i2 DESC;
```

i2	rank
?	1
?	1
300	3
200	4
200	4
200	4
100	7
100	7

--- 8 row(s) selected.

- Return the rank of *i2* descending, excluding NULL values:

```
SELECT i2, RANK (i2) AS rank
FROM cat.sch.seqfcn WHERE i2 IS NOT NULL SEQUENCE BY i2 DESC;
```

i2	rank
300	1
200	2
200	2
200	2
100	5
100	5

--- 6 row(s) selected.

7.86. REPEAT Function

The REPEAT function returns a character string composed of the evaluation of a character expression repeated a specified number of times.

REPEAT is a Trafodion SQL extension.

```
REPEAT (character-expr, count)
```

- *character-expr*

specifies the source string from which to return the specified number of repeated strings. The source string is an SQL character value expression. The operand is the result of evaluating *character-expr*. See [Character Value Expressions](#).

- *count*

specifies the number of times the source string *character-expr* is to be repeated. The number *count* must be a value greater than or equal to zero of exact numeric data type and with a scale of zero.

7.86.1. Examples of REPEAT

- Return this quote from Act 5, Scene 3, of King Lear:

```
REPEAT ('Never,' , 5)
```

```
Never, Never, Never, Never,
```

7.87. REPLACE Function

The REPLACE function returns a character string where all occurrences of a specified character string in the original string are replaced with another character string. All three character value expressions must be comparable types. The return value is the VARCHAR type.

REPLACE is a Trafodion SQL extension.

```
REPLACE (char-expr-1, char-expr-2, char-expr-3)
```

- *char-expr-1, char-expr-2, char-expr-3*

are SQL character value expressions. The operands are the result of evaluating the character expressions. All occurrences of *char-expr-2* in *char-expr-1* are replaced by *char-expr-3*. See [Character Value Expressions](#).

7.87.1. Examples of REPLACE

- Use the REPLACE function to change job descriptions so that occurrences of the company name are updated:

```
SELECT jobdesc FROM persnl.job;
job_description
-----
MANAGER COMNET
PRODUCTION COMNET
ASSEMBLER COMNET
SALESREP COMNET
SYSTEM ANAL COMNET
...
--- 10 row(s) selected.

UPDATE persnl.job
SET jobdesc = REPLACE(jobdesc, 'COMNET', 'TDMNET');

Job Description
-----
MANAGER TDMNET
PRODUCTION TDMNET
ASSEMBLER TDMNET
SALESREP TDMNET
SYSTEM ANAL TDMNET
...
--- 10 row(s) selected.
```

7.88. RIGHT Function

The RIGHT function returns the rightmost specified number of characters from a character expression. Every character, including multi-byte characters, is treated as one character.

RIGHT is a Trafodion SQL extension.

```
RIGHT (character-expr, count)
```

- *character-expr*

specifies the source string from which to return the rightmost specified number of characters. The source string is an SQL character value expression. The operand is the result of evaluating *character-expr*. See [Character Value Expressions](#).

- *count*

specifies the number of characters to return from *character-expr*. The number count must be a value of exact numeric data type with a scale of zero.

7.88.1. Examples of RIGHT

- Return 'smith':

```
RIGHT('robert_john_smith', 5)
```

- Suppose that a six-character company literal has been concatenated as the first six characters to the job descriptions in the JOB table. Use the RIGHT function to remove the company literal from the job descriptions:

```
UPDATE persnl.job  
SET jobdesc = RIGHT (jobdesc, 12);
```

7.89. ROUND Function

The ROUND function returns the value of *numeric_expr* rounded to *num* places to the right of the decimal point.

ROUND is a Trafodion SQL extension.

```
ROUND(numeric-expr [ , num ] )
```

- *numeric-expr*

is an SQL numeric value expression.

- *num*

specifies the number of places to the right of the decimal point for rounding. If *num* is a negative number, all places to the right of the decimal point and *num* places to the left of the decimal point are zeroed. If *num* is not specified or is 0, then all places to the right of the decimal point are zeroed.

For any exact numeric value, the value *numeric_expr* is rounded away from 0 (for example, to $x+1$ when $x.5$ is positive and to $x-1$ when $x.5$ is negative). For the inexact numeric values (real, float, and double) the value *numeric_expr* is rounded toward the nearest even number.

7.89.1. Examples of ROUND

- This function returns the value of 123.46.

```
ROUND(123.4567, 2)
```

- This function returns the value of 123.

```
ROUND(123.4567, 0)
```

- This function returns the value of 120.

```
ROUND(123.4567, -1)
```

- This function returns the value of 0.

```
ROUND(999.0, -4)
```

- This function returns the value of 1000.

```
ROUND(999.0, -3)
```

- This function returns the value of 2.0E+000.

```
ROUND(1.5E+000, 0)
```

- This function returns the value of 2.0E+00.

```
ROUND(2.5E+000, 0)
```

- This function returns the value of 1.0E+00.

```
ROUND(1.4E+000, 0)
```

7.90. ROWS SINCE Function

The ROWS SINCE function is a sequence function that returns the number of rows counted since the specified condition was last true in the intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

Rows since is a Trafodion SQL extension.

```
ROWS_SINCE [INCLUSIVE] (condition [, max-rows])
```

- INCLUSIVE

specifies the current row is to be considered. If you specify INCLUSIVE, the condition is evaluated in the current row. Otherwise, the condition is evaluated beginning with the previous row. If you specify INCLUSIVE and the condition is true in the current row, ROWS SINCE returns 0.

- *condition*

specifies a condition to be considered for each row in the result table. Each column in *condition* must be a column that exists in the result table. If the condition has never been true for the result table, ROWS SINCE returns null.

- *max-rows*

is an SQL numeric value expression of signed data type SMALLINT or INTEGER that specifies the maximum number of rows from the current row to consider. If the condition has never been true for *max-rows* from the current row, or if *max-rows* is negative or null, ROWS SINCE returns null.

7.90.1. Considerations for ROWS SINCE

Counting the Rows

If you specify INCLUSIVE, the condition in each row of the result table is evaluated starting with the current row as row 0 (zero) (up to the maximum number of rows or the size of the result table). Otherwise, the condition is evaluated starting with the previous row as row 1.

If a row is reached where the condition is true, ROWS SINCE returns the number of rows counted so far. Otherwise, if the condition is never true within the result table being considered, ROWS SINCE returns null. Trafodion SQL then goes to the next row as the new current row.

7.90.2. Examples of ROWS SINCE

- Return the number of rows since the condition $i1 \text{ IS } NULL$ became true:

```
SELECT ROWS SINCE (i1 IS NULL) AS rows_since_null
FROM mining.seqfcn SEQUENCE BY ts;

rows_since_null
-----
?
?
1
2
1

--- 5 row(s) selected.
```

- Return the number of rows since the condition $i1 < i2$ became true:

```
SELECT ROWS SINCE (i1<i2), ROWS SINCE INCLUSIVE (i1<i2)
FROM mining.seqfcn SEQUENCE BY ts;

(EXPR)      (EXPR)
-----
?          0
1          1
2          0
1          1
2          0

--- 5 row(s) selected.
```

7.91. ROWS SINCE CHANGED Function

The ROWS SINCE CHANGED function is a sequence function that returns the number of rows counted since the specified set of values last changed in the intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

ROWS SINCE CHANGED is a Trafodion SQL extension.

```
ROWS SINCE CHANGED (column-expression-list)
```

- *column-expression-list*

is a comma-separated list that specifies a derived column list determined by the evaluation of the column expression list. ROWS SINCE CHANGED returns the number of rows counted since the values of *column-expression-list* changed.

7.91.1. Considerations for ROWS SINCE CHANGED

Counting the Rows

For the first row in the intermediate result table, the count is 1. For subsequent rows that have the same value for *column-expression-list* as the previous row, the count is 1 plus the count in the previous row. For subsequent rows that have a different value of *column-expression-list* than the previous row, the count is 1.

7.91.2. Examples of ROWS SINCE CHANGED

- Return the number of rows since the value *i1* last changed:

```
SELECT ROWS SINCE CHANGED (i1)
FROM mining.seqfcn SEQUENCE BY ts;
```

- Return the number of rows since the values *i1* and *ts* last changed:

```
SELECT ROWS SINCE CHANGED (i1, ts)
FROM mining.seqfcn SEQUENCE BY ts;
```

7.92. RPAD Function

The RPAD function pads the right side of a string with the specified string. Every character in the string, including multi-byte characters, is treated as one character.

RPAD is a Trafodion SQL extension.

```
RPAD (str, len [, padstr])
```

- *str*

can be an expression. See [Character Value Expressions](#).

- *len*

identifies the desired number of characters to be returned and can be an expression but must be an integral value. If *len* is equal to the length of the string, no change is made. If *len* is smaller than the string size, the string is truncated.

- *pad-character*

can be an expression and may be a string.

7.92.1. Examples of RPAD Function

- This function returns 'kite':

```
RPAD('kite', 7)
```

- This function returns 'ki':

```
RPAD('kite', 2)
```

- This function returns 'kite0000':

```
RPAD('kite', 8, '0')
```

- This function returns 'go fly a kite':

```
RPAD('go fly a kite', 13, 'z')
```

- This function returns 'go fly a kitez'

```
RPAD('go fly a kite', 14, 'z')
```

- This function returns 'kitegoflygoflygof':

```
RPAD('kite', 17, 'gofly' )
```

7.93. RTRIM Function

The RTRIM function removes trailing spaces from a character string. If you must remove any leading character other than space, use the TRIM function and specify the value of the character. See the [TRIM Function](#).

RTRIM is a Trafodion SQL extension.

```
RTRIM (character-expression)
```

- *character-expression*

is an SQL character value expression and specifies the string from which to trim trailing spaces.

See [Character Value Expressions](#).

7.93.1. Considerations for RTRIM

Result of RTRIM

The result is always of type VARCHAR, with maximum length equal to the fixed length or maximum variable length of *character-expression*.

7.93.2. Examples of RTRIM

- Return ' Robert':

```
RTRIM (' Robert ')
```

See [TRIM Function](#) and [LTRIM Function](#).

7.94. RUNNINGAVG Function

The RUNNINGAVG function is a sequence function that returns the average of non-null values of a column up to and including the current row of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

RUNNINGAVG is a Trafodion SQL extension.

```
RUNNINGAVG (_column-expression_)
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

RUNNINGAVG returns the average of non-null values of *column-expression* up to and including the current row.

7.94.1. Considerations for RUNNINGAVG

Equivalent Result

The result of RUNNINGAVG is equivalent to:

```
RUNNINGSUM(column-expr) / RUNNINGCOUNT(*)
```

7.94.2. Examples of RUNNINGAVG

- Return the average of non-null values of *i1* up to and including the current row:

```
SELECT RUNNINGAVG(i1) AS avg_i1
FROM mining.seqfcn SEQUENCE BY ts;

avg_i1
-----
       6215
      17194
     11463
      9746
     10190

--- 5 row(s) selected.
```

7.95. RUNNINGCOUNT Function

The RUNNINGCOUNT function is a sequence function that returns the number of rows up to and including the current row of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

RUNNINGCOUNT is a Trafodion SQL extension.

```
RUNNINGCOUNT { (*) | (column-expression) }
```

- *

as an argument causes RUNNINGCOUNT(*) to return the number of rows in the intermediate result table up to and including the current row.

- *column-expression*

specifies a derived column determined by the evaluation of the column expression. If *column-expression* is the argument, RUNNINGCOUNT returns the number of rows containing non-null values of *column-expression* in the intermediate result table up to and including the current row.

7.95.1. Considerations for RUNNINGCOUNT

No DISTINCT Clause

The RUNNINGCOUNT sequence function is defined differently from the COUNT aggregate function. If you specify DISTINCT for the COUNT aggregate function, duplicate values are eliminated before COUNT is applied. You cannot specify DISTINCT for the RUNNINGCOUNT sequence function; duplicate values are counted.

7.95.2. Examples of RUNNINGCOUNT

- Return the number of rows that include non-null values of *i1* up to and including the current row:

```
SELECT RUNNINGCOUNT (i1) AS count_i1
FROM mining.seqfcn SEQUENCE BY ts;
```

```
count_i1
-----
1
2
2
3
4
```

```
--- 5 row(s) selected.
```

7.96. RUNNINGMAX Function

The RUNNINGMAX function is a sequence function that returns the maximum of values of a column up to and including the current row of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

RUNNINGMAX is a Trafodion SQL extension.

```
RUNNINGMAX (column-expression)
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

RUNNINGMAX returns the maximum of values of *column-expression* up to and including the current row.

7.96.1. Examples of RUNNINGMAX

- Return the maximum of values of *i1* up to and including the current row:

```
SELECT RUNNINGMAX(i1) AS max_i1
FROM mining.seqfcn SEQUENCE BY ts;
```

```
max_i1
-----
6215
28174
28174
28174
28174
```

```
--- 5 row(s) selected.
```

7.97. RUNNINGMIN Function

The RUNNINGMIN function is a sequence function that returns the minimum of values of a column up to and including the current row of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

RUNNINGMIN is a Trafodion SQL extension.

```
RUNNINGMIN (column-expression)
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

RUNNINGMIN returns the minimum of values of *column-expression* up to and including the current row.

7.97.1. Examples of RUNNINGMIN

- Return the minimum of values of *i1* up to and including the current row:

```
SELECT RUNNINGMIN(i1) AS min_i1
FROM mining.seqfcn SEQUENCE BY ts;
```

```
min_i1
-----
6215
6215
6215
4597
4597
```

```
--- 5 row(s) selected.
```

7.97.2. RUNNINGSTDDEV Function

The RUNNINGSTDDEV function is a sequence function that returns the standard deviation of non-null values of a column up to and including the current row of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

RUNNINGSTDDEV is a Trafodion SQL extension.

```
RUNNINGSTDDEV (_column-expression_)
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

RUNNINGSTDDEV returns the standard deviation of non-null values of *column-expression* up to and including the current row.

7.97.3. Considerations for RUNNINGSTDDEV

Equivalent Result

The result of RUNNINGSTDDEV is equivalent to:

```
SQRT(RUNNINGVARIANCE(column-expression))
```

7.97.4. Examples of RUNNINGSTDDEV

- Return the standard deviation of non-null values of *i1* up to and including the current row:

```
SELECT RUNNINGSTDDEV (i1) AS stddev_i1
FROM mining.seqfcn SEQUENCE BY ts;
```

STDDEV_I1

```
-----
0.000000000000000E+000
1.55273578080753976E+004
1.48020166531456112E+004
1.25639147428923072E+004
1.09258501408357232E+004
```

--- 5 row(s) selected.

- You can use the CAST function for display purposes. For example:

```
SELECT CAST(RUNNINGSTDDEV(i1) AS DEC(18,3))
FROM mining.seqfcn SEQUENCE BY ts;
```

(EXPR)

```
-----
.000
5527.357
14802.016
12563.914
10925.850
```

--- 5 row(s) selected.

7.98. RUNNINGSUM Function

The RUNNINGSUM function is a sequence function that returns the sum of non-null values of a column up to and including the current row of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

RUNNINGSUM is a Trafodion SQL extension.

```
RUNNINGSUM (column-expression)
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

RUNNINGSUM returns the sum of non-null values of *column-expression* up to and including the current row.

7.98.1. Examples of RUNNINGSUM

- Return the sum of non-null values of *i1* up to and including the current row:

```
SELECT RUNNINGSUM(i1) AS sum_i1
FROM mining.seqfcn SEQUENCE BY ts;
```

```
sum_i1
-----
6215
34389
34389
38986
50952
```

```
--- 5 row(s) selected.
```

7.99. RUNNINGVARIANCE Function

The RUNNINGVARIANCE function is a sequence function that returns the variance of non-null values of a column up to and including the current row of an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement. See [SEQUENCE BY Clause](#).

RUNNINGVARIANCE is a Trafodion SQL extension.

```
RUNNINGVARIANCE (column-expression)
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression.

RUNNINGVARIANCE returns the variance of non-null values of *column-expression* up to and including the current row.

7.99.1. Examples of RUNNINGVARIANCE

- Return the variance of non-null values of *i1* up to and including the current row:

```
SELECT RUNNINGVARIANCE(i1) AS variance_i1
FROM mining.seqfcn SEQUENCE BY TS;
```

```
variance_i1
-----
0.0000000000000000E+000
2.41098840499999960E+008
2.1909969999999968E+008
1.5785195366666640E+008
1.1937420129999980E+008

--- 5 row(s) selected.
```

- You can use the CAST function for display purposes. For example:

```
SELECT CAST(RUNNINGVARIANCE (i1) AS DEC (18,3))
FROM mining.seqfcn SEQUENCE BY ts;

(EXPR)
-----
.000
241098840.500
219099697.000
157851953.666
119374201.299

--- 5 row(s) selected.
```

7.100. SECOND Function

The SECOND function converts a TIME or TIMESTAMP expression into an INTEGER value in the range 0 through 59 that represents the corresponding second of the hour.

SECOND is a Trafodion SQL extension.

```
SECOND (datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type TIME or TIMESTAMP. See [Datetime Value Expressions](#).

7.100.1. Examples of SECOND

- Return a numeric value that represents the second of the hour from the *ship_timestamp* column:

```
SELECT start_date, ship_timestamp, SECOND(ship_timestamp)
FROM persnl.project
WHERE projcode = 1000;

Start/Date Time/Shipped          (EXPR)
-----
2008-04-10 2008-04-21 08:15:00.000000 .000000
```

7.101. SHA Function

Calculates an SHA-1 160-bit checksum for the string, as described in RFC 3174 (Secure Hash Algorithm). The value is returned as a string of 40 hexadecimal digits, or NULL if the argument was NULL.

7.101.1. examples of SHA

```
>>SELECT SHA1( 'abc' ) from dual;  
  
( EXPR )  
-----  
'a9993e364706816aba3e25717850c26c9cd0d89d'
```

7.102. SHA2 Function

Calculates the SHA-2 family of hash functions (SHA-224, SHA-256, SHA-384, and SHA-512). The first argument is the cleartext string to be hashed. The second argument indicates the desired bit length of the result, which must have a value of 224, 256, 384, 512. If either argument is NULL or the hash length is not one of the permitted values, the return value is NULL. Otherwise, the function result is a hash value containing the desired number of bits. See the notes at the beginning of this section about storing hash values efficiently.

7.102.1. examples of SHA2

```
>>SELECT SHA2( 'abc' , 224) from dual;  
(EXPR)  
-----  
'23097d223405d8228642a477bda255b32aadbce4bda0b3f7e36c9da7'
```

7.103. SIGN Function

The SIGN function returns an indicator of the sign of a numeric value expression. If the value is less than zero, the function returns -1 as the indicator. If the value is zero, the function returns 0. If the value is greater than zero, the function returns 1.

SIGN is a Trafodion SQL extension.

```
SIGN (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the SIGN function. See [Numeric Value Expressions](#).

7.103.1. Examples of SIGN

- Return the value -1:

```
SIGN(-20 + 12)
```

- Return the value 0:

```
SIGN(-20 + 20)
```

- Return the value 1:

```
SIGN(-20 + 22)
```

7.104. SIN Function

The SIN function returns the SINE of a numeric value expression, where the expression is an angle expressed in radians.

SIN is a Trafodion SQL extension.

```
SIN (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the SIN function. See [Numeric Value Expressions](#).

7.104.1. Examples of SIN

- This function returns the value 3.42052233254419840E-001, or approximately 0.3420, the sine of 0.3491 (which is 20 degrees):

```
SIN (0.3491)
```

7.105. SINH Function

The SINH function returns the hyperbolic sine of a numeric value expression, where the expression is an angle expressed in radians.

SINH is a Trafodion SQL extension.

```
SINH (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the SINH function. See [Numeric Value Expressions](#).

7.105.1. Examples of SINH

- This function returns the value 1.60191908030082560E+000, or approximately 1.6019, the hyperbolic sine of 1.25:

```
SINH (1.25)
```

7.105.2. SPACE Function

The SPACE function returns a character string consisting of a specified number of spaces, each of which is 0x20 or 0x0020, depending on the chosen character set.

SPACE is a Trafodion SQL extension.

```
SPACE (length [, char-set-name])
```

- *length*

specifies the number of characters to be returned. The number *count* must be a value greater than or equal to zero of exact numeric data type and with a scale of zero. *length* cannot exceed 32768 for the ISO8859-1 or UTF8 character sets.

- *char-set-name*

can be ISO88591 or UTF8. If you do not specify this second argument, the default is the default character set.

The returned character string will be of data type VARCHAR associated with the character set specified by *char-set-name*.

7.105.3. Examples of SPACE

- Return three spaces:

```
SPACE(3)
```

7.106. SQRT Function

The SQRT function returns the square root of a numeric value expression. SQRT is a Trafodion SQL extension.

```
SQRT ( numeric-expression )
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the SQRT function. The value of the argument must not be a negative number. See [Numeric Value Expressions](#).

7.106.1. Examples of SQRT

- This function returns the value 5.19615242270663232e+000, or approximately 5.196:

```
SQRT( 27 )
```

7.107. STDDEV Function

STDDEV is an aggregate function that returns the standard deviation of a set of numbers. STDDEV is a Trafodion SQL extension.

```
STDDEV ([ALL | DISTINCT] expression [, weight])
```

- ALL | DISTINCT

specifies whether duplicate values are included in the computation of the STDDEV of the *expression*. The default option is ALL, which causes duplicate values to be included. If you specify DISTINCT, duplicate values are eliminated before the STDDEV function is applied. If DISTINCT is specified, you cannot specify *weight*.

- *expression*

specifies a numeric value expression that determines the values for which to compute the standard deviation. The *expression* cannot contain an aggregate function or a subquery. The DISTINCT clause specifies that the STDDEV function operates on distinct values from the one-column table derived from the evaluation of *expression*.

- *weight*

specifies a numeric value expression that determines the weights of the values for which to compute the standard deviation. *weight* cannot contain an aggregate function or a subquery. *weight* is defined on the same table as *expression*. The one-column table derived from the evaluation of *expression* and the one-column table derived from the evaluation of *weight* must have the same cardinality.

7.107.1. Considerations for STDDEV

Definition of STDDEV

The standard deviation of a value expression is defined to be the square root of the variance of the expression. See [VARIANCE Function](#).

Because the definition of variance has $N-1$ in the denominator of the expression (if *weight* is not specified), Trafodion SQL returns a system-defined default setting of zero (and no error) if the number of rows in the table, or a group of the table, is equal to 1.

Data Type of the Result

The data type of the result is always DOUBLE PRECISION.

Operands of the Expression

The expression includes columns from the rows of the SELECT result table but cannot include an aggregate function.

These are valid:

```
STDDEV (SALARY) STDDEV (SALARY * 1.1)  
STDDEV (PARTCOST * QTY_ORDERED)
```

Nulls

STDDEV is evaluated after eliminating all nulls from the set. If the result table is empty, STDDEV returns NULL.

FLOAT(54) and DOUBLE PRECISION Data

Avoid using large FLOAT(54) or DOUBLE PRECISION values as arguments to STDDEV. If $\text{SUM}(x * x)$ exceeds the value of $1.15792089237316192e77$ during the computation of $\text{STDDEV}(x)$, a numeric overflow occurs.

7.107.2. Examples of STDDEV

- Compute the standard deviation of the salary of the current employees:

```
SELECT STDDEV(salary) AS StdDev_Salary FROM persnl.employee;  
  
STDDEV_SALARY  
-----  
3.5717406250000000E+004  
  
--- 1 row(s) selected.
```

- Compute the standard deviation of the cost of parts in the current inventory:

```
SELECT STDDEV (price * qty_available) FROM sales.parts;  
  
(EXPR)  
-----  
7.1389949999999808E+006  
  
--- 1 row(s) selected.
```

7.108. SUBSTRING/SUBSTR Function

The SUBSTRING function extracts a substring out of a given character expression. It returns a character string of data type VARCHAR, with a maximum length equal to the smaller of these two:

- The fixed length of the input string (for CHAR-type strings) or the maximum variable length (for VARCHAR-type strings)
- The value of the length argument (when a constant is specified) or 32708 (when a non-constant is specified)

SUBSTR is equivalent to SUBSTRING.

```
SUBSTRING (character-expr FROM start-position [FOR length])
```

or:

```
SUBSTRING (character-expr, start-position [, length])
```

- *character-expr*

specifies the source string from which to extract the substring. The source string is an SQL character value expression.

The operand is the result of evaluating *character-expr*. See [Character Value Expressions](#).

- *start-position*

specifies the starting position *start-position* within *character-expr* at which to start extracting the substring. *start-position* must be a value with an exact numeric data type and a scale of zero.

- *length*

specifies the number of characters to extract from *character-expr*. Keep in mind that every character, including multi-byte characters, counts as one character. *length* is the length of the extracted substring and must be a value greater than or equal to zero of exact numeric data type and with a scale of zero. The *length* field is optional, so if you do not specify the substring *length*, all characters starting at *start-position* and continuing until the end of the character expression are returned.

The *length* field is optional. If you do not specify it, all characters starting at *start-position* and continuing until the end of the *character-expr* are returned.

7.108.1. Alternative Forms

- The SUBSTRING function treats SUBSTRING(*string* FOR *int*) equivalent to SUBSTRING(*string* FROM 1 FOR *int*).

The Trafodion database software already supports the ANSI standard form as:

```
SUBSTRING(string FROM int [ FOR int ])
```

- The SUBSTRING function treats SUBSTRING (*string*, *Fromint*) equivalent to SUBSTRING(*string* FROM *Fromint*). The Trafodion database software already supports SUBSTRING (*string*, *Fromint*, *Forint*) as equivalent to the ANSI standard form:

```
SUBSTRING(string FROM Fromint FOR Forint)
```

7.108.2. Considerations for SUBSTRING/SUBSTR

Requirements for the Expression, Length, and Start Position

- The data types of the substring length and the start position must be numeric with a scale of zero. Otherwise, an error is returned.
- If the sum of the start position and the substring length is greater than the length of the character expression, the substring from the start position to the end of the string is returned.
- If the start position is greater than the length of the character expression, an empty string ("") is returned.
- The resulting substring is always of type VARCHAR. If the source character string is an up-shifted CHAR or VARCHAR string, the result is an up-shifted VARCHAR type.

7.108.3. Examples of SUBSTRING/SUBSTR

- Extract 'Ro':

```
SUBSTRING('Robert John Smith' FROM 0 FOR 3)
SUBSTR('Robert John Smith' FROM 0 FOR 3)
```

- Extract 'John':

```
SUBSTRING ('Robert John Smith' FROM 8 FOR 4)
SUBSTR ('Robert John Smith' FROM 8 FOR 4)
```

- Extract 'John Smith':

```
SUBSTRING ('Robert John Smith' FROM 8)
SUBSTR ('Robert John Smith' FROM 8)
```

- Extract 'Robert John Smith':

```
SUBSTRING ('Robert John Smith' FROM 1 FOR 17)
SUBSTR ('Robert John Smith' FROM 1 FOR 17)
```

- Extract 'John Smith':

```
SUBSTRING ('Robert John Smith' FROM 8 FOR 15)
SUBSTR ('Robert John Smith' FROM 8 FOR 15)
```

- Extract 'Ro':

```
SUBSTRING ('Robert John Smith' FROM -2 FOR 5)
SUBSTR ('Robert John Smith' FROM -2 FOR 5)
```

- Extract an empty string "":

```
SUBSTRING ('Robert John Smith' FROM 8 FOR 0)
SUBSTR ('Robert John Smith' FROM 8 FOR 0)
```

7.109. SUM Function

SUM is an aggregate function that returns the sum of a set of numbers.

```
SUM ([ALL | DISTINCT] expression)
```

- ALL | DISTINCT

specifies whether duplicate values are included in the computation of the SUM of the *expression*. The default option is ALL, which causes duplicate values to be included. If you specify DISTINCT, duplicate values are eliminated before the SUM function is applied.

- *expression*

specifies a numeric or interval value expression that determines the values to sum. The *expression* cannot contain an aggregate function or a subquery. The DISTINCT clause specifies that the SUM function operates on distinct values from the one-column table derived from the evaluation of *expression*. All nulls are eliminated before the function is applied to the set of values. If the result table is empty, SUM returns NULL. See [Expressions](#).

7.109.1. Considerations for SUM

Data Type and Scale of the Result

The data type of the result depends on the data type of the argument. If the argument is an exact numeric type, the result is LARGEINT. If the argument is an approximate numeric type, the result is DOUBLE PRECISION. If the argument is INTERVAL data type, the result is INTERVAL with the same precision as the argument. The scale of the result is the same as the scale of the argument. If the argument has no scale, the result is truncated.

Operands of the Expression

The expression includes columns from the rows of the SELECT result table — but cannot include an aggregate function. The valid expressions are:

```
SUM (SALARY)
SUM (SALARY * 1.1)
SUM (PARTCOST * QTY_ORDERED)
```

7.109.2. Examples of SUM

- Compute the total value of parts in the current inventory:

```
SELECT SUM (price * qty_available) FROM sales.parts;  
(EXPR)  
-----  
117683505.96  
--- 1 row(s) selected.
```

7.110. TAN Function

The TAN function returns the tangent of a numeric value expression, where the expression is an angle expressed in radians.

TAN is a Trafodion SQL extension.

```
TAN (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the TAN function. See [Numeric Value Expressions](#).

7.110.1. Examples of TAN

- This function returns the value 3.64008908293626880E-001, or approximately 0.3640, the tangent of 0.3491 (which is 20 degrees):

```
TAN (0.3491)
```

7.110.2. TANH Function

The TANH function returns the hyperbolic tangent of a numeric value expression, where the expression is an angle expressed in radians.

TANH is a Trafodion SQL extension.

```
TANH (numeric-expression)
```

- *numeric-expression*

is an SQL numeric value expression that specifies the value for the argument of the TANH function. See [Numeric Value Expressions](#).

7.110.3. Examples of TANH

- This function returns the value 8.48283639957512960E-001 or approximately 0.8483, the hyperbolic tangent of 1.25:

```
TANH (1.25)
```

7.111. THIS Function

The THIS function is a sequence function that is used in the ROWS SINCE function to distinguish between the value of the column in the current row and the value of the column in previous rows (in an intermediate result table ordered by a SEQUENCE BY clause in a SELECT statement). See [ROWS SINCE Function](#).

THIS is a Trafodion SQL extension.

```
THIS (column-expression)
```

- *column-expression*

specifies a derived column determined by the evaluation of the column expression. If the value of the expression is null, THIS returns null.

7.111.1. Considerations for THIS

Counting the Rows

You can use the THIS function only within the ROWS SINCE function. For each row, the ROWS SINCE condition is evaluated in two steps:

1. The expression for THIS is evaluated for the current row. This value becomes a constant.
2. The condition is evaluated for the result table, using a combination of the THIS constant and the data for each row in the result table, starting with the previous row as row 1 (up to the maximum number of rows or the size of the result table).

If a row is reached where the condition is true, ROWS SINCE returns the number of rows counted so far. Otherwise, if the condition is never true within the result table being considered, ROWS SINCE returns null. Trafodion SQL then goes to the next row as the new current row and the THIS constant is reevaluated.

7.111.2. Examples of THIS

- Return the number of rows since the condition *i1* less than a previous row became true:

```
SELECT ROWS SINCE (THIS(i1) < i1) AS rows_since_this
FROM mining.seqfcn SEQUENCE BY ts;

rows_since_this
-----
?
?
1
1
?

--- 5 row(s) selected.
```

7.112. TIMESTAMPADD Function

The `TIMESTAMPADD` function adds the interval of time specified by *interval-ind* and *num_expr* to *datetime_expr*. If the specified interval is in years, months, or quarters and the resulting date is not a valid date, the day will be rounded down to the last day of the result month. The type of the *datetime_expr* is returned except when the *interval-ind* contains any time component, in which case a `TIMESTAMP` is returned.

`TIMESTAMPADD` is a Trafodion SQL extension.

```
TIMESTAMPADD (interval-ind, num-expr, datetime-expr)
```

- *interval-ind*

is `SQL_TSI_YEAR`, `SQL_TSI_MONTH`, `SQL_TSI_DAY`, `SQL_TSI_HOUR`, `SQL_TSI_MINUTE`, `SQL_TSI_SECOND`, `SQL_TSI_QUARTER`, or `SQL_TSI_WEEK`

- *num_expr*

is an SQL exact numeric value expression that specifies how many *interval-ind* units of time are to be added to *datetime_expr*. If *num_expr* has a fractional portion, it is ignored. If *num_expr* is negative, the return value precedes *datetime_expr* by the specified amount of time.

- *datetime_expr*

is an expression that evaluates to a datetime value of type DATE or `TIMESTAMP`. The type of the *datetime_expr* is returned except when the *interval-ind* contains any time component, in which case a `TIMESTAMP` is returned.

7.112.1. Examples of TIMESTAMPADD

- This function adds seven days to the date specified in *start-date*:

```
TIMESTAMPADD (SQL_TSI_DAY, 7, start-date)
```

- This function returns the value DATE '2008-03-06':

```
TIMESTAMPADD (SQL_TSI_WEEK, 1, DATE '2008-02-28')
```

- This function returns the value DATE '1999-02-28':

```
TIMESTAMPADD (SQL_TSI_YEAR, -1, DATE '2000-02-29')
```

- This function returns the value TIMESTAMP '2003-02-28 13:27:35':

```
TIMESTAMPADD (SQL_TSI_MONTH, -12, TIMESTAMP '2004-02-29 13:27:35')
```

- This function returns the value TIMESTAMP '2004-02-28 13:27:35':

```
TIMESTAMPADD (SQL_TSI_MONTH, 12, TIMESTAMP '2003-02-28 13:27:35')
```

- This function returns the value DATE '2008-06-30':

```
TIMESTAMPADD (SQL_TSI_QUARTER, -2, DATE '2008-12-31')
```

- This function returns the value TIMESTAMP '2008-06-30 23:59:55':

```
TIMESTAMPADD (SQL_TSI_SECOND, -5, DATE '2008-07-01')
```

7.113. TIMESTAMPDIFF Function

The `TIMESTAMPDIFF` function returns the integer value for the number of *interval-ind* units of time between *startdate* and *enddate*. If *enddate* precedes *startdate*, the return value is negative or zero.

```
TIMESTAMPDIFF (interval-ind, startdate, enddate)
```

- *interval-ind*

is `SQL_TSI_YEAR`, `SQL_TSI_MONTH`, `SQL_TSI_DAY`, `SQL_TSI_HOUR`, `SQL_TSI_MINUTE`, `SQL_TSI_SECOND`, `SQL_TSI_QUARTER`, or `SQL_TSI_WEEK`

- *startdate* and *enddate*

are each of type DATE or TIMESTAMP

The method of counting crossed boundaries such as days, minutes, and seconds makes the result given by `TIMESTAMPDIFF` consistent across all data types. The `TIMESTAMPDIFF` function makes these boundary assumptions:

- A year begins at the start of January 1.
- A new quarter begins on January 1, April 1, July 1, and October 1.
- A week begins at the start of Sunday.
- A day begins at midnight.

The result is a signed integer value equal to the number of *interval-ind* boundaries crossed between the first and second date. For example, the number of weeks between Sunday, January 4 and Sunday, January 1 is 1. The number of months between March 31 and April 1 would be 1 because the month boundary is crossed from March to April.

The `TIMESTAMPDIFF` function generates an error if the result is out of range for integer values. For seconds, the maximum number is equivalent to approximately 68 years. The `TIMESTAMPDIFF` function generates an error if a difference in weeks is requested and one of the two dates precedes January 7 of the year 0001.

7.113.1. Examples of TIMESTAMPDIFF

- This function returns the value 1 because a 1-second boundary is crossed even though the two timestamps differ by only one microsecond:

```
TIMESTAMPDIFF
(
    SQL_TSI_SECOND
    , TIMESTAMP '2006-09-12 11:59:58.999999'
    , TIMESTAMP '2006-09-12 11:59:59.000000'
)
```

- This function returns the value 0 because no 1-second boundaries are crossed:

```
TIMESTAMPDIFF
( SQL_TSI_YEAR
, TIMESTAMP '2006-12-31 23:59:59.000000'
, TIMESTAMP '2006-12-31 23:59:59.999999'
)
```

- This function returns the value 1 because a year boundary is crossed:

```
TIMESTAMPDIFF
( SQL_TSI_YEAR
, TIMESTAMP '2006-12-31 23:59:59.999999'
, TIMESTAMP '2007-01-01 00:00:00.000000;
)
```

- This function returns the value 1 because a WEEK boundary is crossed:

```
TIMESTAMPDIFF (SQL_TSI_WEEK, DATE '2006-01-01', DATE '2006-01-09')
```

- This function returns the value of -29:

```
TIMESTAMPDIFF (SQL_TSI_DAY, DATE '2004-03-01', DATE '2004-02-01')
```

7.114. TO_CHAR Function

The TO_CHAR function converts a datetime value to a character value. The optional second argument describes the format of the character value.

```
TO_CHAR(character-expression [,format-string])
```

- *character-expression*

is an expression that gives a datetime value.

- *format-string*

is one of the following character string literals:

- 'YYYY-MM-DD'
- 'MM/DD/YYYY'
- 'DD.MM.YYYY'
- 'YYYY-MM'
- 'MM/DD/YYYY'
- 'YYYY/MM/DD'
- 'YYYYMMDD'
- 'YY/MM/DD'
- 'MM/DD/YY'
- 'MM-DD-YYYY'
- 'YYYYMM'
- 'DD-MM-YYYY'
- 'DD-MON-YYYY'
- 'DDMONYYYY'
- 'HH:MI:SS'
- 'HH24:MI:SS'
- 'YYYYMMDDHH24MISS'

- 'DD.MM.YYYY:HH24.MI.SS'
- 'YYYY-MM-DD HH24:MI:SS'
- 'YYYYMMDD:HH24:MI:SS'
- 'MMDDYYYY HH24:MI:SS'
- 'MM/DD/YYYY HH24:MI:SS'
- 'DD-MON-YYYY HH:MI:SS'
- 'MONTH DD, YYYY, HH:MI'
- 'DD.MM.YYYY HH24.MI.SS'

Here, YYYY refers to a 4-digit year. YY refers to a two-digit year. MM refers to a two-digit month. MON refers to a three-letter abbreviation for month ('JAN', 'FEB', 'MAR', 'APR', 'MAY', 'JUN', 'JUL', 'AUG', 'SEP', 'OCT', 'NOV' or 'DEC'). MONTH refers to the month spelled out. In the output value, the month abbreviation or month will appear in upper case.

HH and HH24 refer to a 2-digit hour field. MI refers to a two-digit minutes field. SS refers to a 2-digit seconds field.

If the *format-string* argument is omitted, 'YYYY-MM-DD' is used as the default for date and timestamp values, and 'HH:MI:SS' is used for time values.

7.114.1. Considerations for TO_CHAR

If the *format-string* contains only hour, minute or seconds fields, the input data type must be time or timestamp.

If the *format-string* contains only year, month or day fields, the input data type must be date or timestamp.

If the *format-string* contains all fields, and the input data type is date, the hour, minute and second fields in the result will be filled with zeroes.

7.114.2. Examples of TO_CHAR

- This function returns the character value '01MAR2016':

```
TO_CHAR (DATE '2016-03-01', 'DDMONYYYY')
```

- This function returns the character value '01.03.2016 00:00:00':

```
TO_CHAR (DATE '2016-03-01', 'DD.MM.YYYY HH24.MI.SS')
```

- This function returns the character value '12:05:10':

```
TO_CHAR (TIME '12:05:10')
```

- This function returns the character value '20160301120510':

```
TO_CHAR (TIMESTAMP '2016-03-01 12:05:10', 'YYYYMMDDHH24MISS')
```

7.115. TO_DATE Function

The TO_DATE function converts a character value to a date. The optional second argument describes the format of the character value.

```
TO_DATE(character-expression [,format-string])
```

- *character-expression*

is an expression that gives a character value.

- *format-string*

is one of the following character string literals:

- 'YYYY-MM-DD'
- 'MM/DD/YYYY'
- 'DD.MM.YYYY'
- 'YYYY-MM'
- 'MM/DD/YYYY'
- 'YYYY/MM/DD'
- 'YYYYMMDD'
- 'YY/MM/DD'
- 'MM/DD/YY'
- 'MM-DD-YYYY'
- 'YYYYMM'
- 'DD-MM-YYYY'
- 'DD-MON-YYYY'
- 'DDMONYYYY'
- 'YYYYMMDDHH24MISS'
- 'DD.MM.YYYY:HH24.MI.SS'
- 'YYYY-MM-DD HH24:MI:SS'

- 'YYYYMMDD:HH24:MI:SS'
- 'MMDDYYYY HH24:MI:SS'
- 'MM/DD/YYYY HH24:MI:SS'
- 'DD-MON-YYYY HH:MI:SS'
- 'MONTH DD, YYYY, HH:MI'
- 'DD.MM.YYYY HH24.MI.SS'

Here, YYYY refers to a 4-digit year. YY refers to a two-digit year. MM refers to a two-digit month. MON refers to a three-letter abbreviation for month ('JAN', 'FEB', 'MAR', 'APR', 'MAY', 'JUN', 'JUL', 'AUG', 'SEP', 'OCT', 'NOV' or 'DEC'). MONTH refers to the month spelled out. The month in either MON or MONTH form may be given in lower case, upper case or any mixture.

HH and HH24 refer to a 2-digit hour field. MI refers to a two-digit minutes field. SS refers to a 2-digit seconds field.

If the *format-string* argument is omitted, 'YYYY-MM-DD' is used as the default.

7.115.1. Considerations for TO_DATE

If the *format-string* contains hour, minute or seconds fields, the output data type is timestamp. Otherwise, the output data type is date.

7.115.2. Examples of TO_DATE

- This function returns the date value '2016-12-07':

```
TO_DATE ( '2016-12-07' )
```

- This function returns the date value '2016-07-12':

```
TO_DATE ( '12-07-2016' , 'DD-MM-YYYY' )
```

- This function returns the date value '2016-12-07':

```
TO_DATE ( '07DEC2016' , 'DDMONYYYY' )
```

- This function returns the timestamp value '2016-12-07 17:05:01.000000':

```
TO_DATE ('07.12.2016:17.05.01', 'DD.MM.YYYY:HH24.MI.SS')
```

7.116. TO_TIME Function

The TO_TIME function converts a character value to a time. The second argument describes the format of the character value.

```
TO_TIME(character-expression ,format-string)
```

- *character-expression*

is an expression that gives a character value.

- *format-string*

is one of the following character string literals:

- 'HH:MI:SS'
- 'HH24:MI:SS'

Here, HH and HH24 refer to a 2-digit hour field. MI refers to a two-digit minutes field. SS refers to a 2-digit seconds field.

7.116.1. Examples of TO_TIME

- This function returns the time value '17:05:01':

```
TO_TIME ('17:05:01' , 'HH24:MI:SS')
```

7.117. TO_TIMESTAMP Function

The TO_TIMESTAMP function converts a character value to a timestamp.

```
TO_TIMESTAMP(character-expression)
```

- *character-expression*

is an expression that gives a character value. The expression is assumed to have the format YYYY-MM-DD HH:MI:SS[.FFFFFF], where YYYY is a 4-digit year, MM is a 2-digit month, DD is a 2-digit day, HH is a 2-digit hours field, MI is a 2-digit minutes field, SS is a two-digit seconds field and FFFFFF is an optional microseconds field.

7.117.1. Example of TO_TIMESTAMP

- This function returns the timestamp value '2016-12-07 10:01:00':

```
TO_TIMESTAMP ('2016-12-07 10:01:00')
```

7.118. TRANSLATE Function

The TRANSLATE function translates a character string from a source character set to a target character set. The TRANSLATE function changes both the character string data type and the character set encoding of the string.

```
TRANSLATE(character-value-expression USING translation-name)
```

- *character-value-expression*

is a character string.

- *translation-name*

is one of these translation names:

Translation Name	Source Character Set	Target Character Set	Comments
ISO88591TOUTF8	ISO88591	UTF8	Translates ISO8859-1 characters to UTF8 characters. No data loss is possible.
UTF8TOISO88591	UTF8	ISO88591	Translates UTF8 characters to ISO88591 characters. Trafodion SQL will display an error if it encounters a Unicode character that cannot be converted to the target character set.

translation-name identifies the translation, source and target character set. When you translate to the UTF8 character set, no data loss is possible. However, when Trafodion SQL translates a *character-value-expression* from UTF8, it may be that certain characters cannot be converted to the target character set. Trafodion SQL reports an error in this case.

Trafodion SQL returns a variable-length character string with character repertoire equal to the character repertoire of the target character set of the translation and the maximum length equal to the fixed length or maximum variable length of the source *character-value-expression*.

If you enter an illegal *translation-name*, Trafodion SQL returns an error.

If the character set for *character-value-expression* is different from the source character set as specified in the *translation-name*, Trafodion SQL returns an error.

7.119. TRIM Function

The TRIM function removes leading and trailing characters from a character string. Every character, including multi-byte characters, is treated as one character.

```
TRIM ([[trim-type]] [trim-char] FROM] trim-source)
```

- *trim-type* is:

```
LEADING | TRAILING | BOTH
```

- *trim-type*

specifies whether characters are to be trimmed from the leading end (LEADING), trailing end (TRAILING), or both ends (BOTH) of *trim-source*. If you omit *trim-type*, the default is BOTH.

- *trim_char*

is an SQL character value expression and specifies the character to be trimmed from *trim-source*. *trim_char* has a maximum length of 1. If you omit *trim_char*, SQL trims blanks (' ') from *trim-source*.

- *trim-source*

is an SQL character value expression and specifies the string from which to trim characters. See [Character Value Expressions](#).

7.119.1. Considerations for TRIM

Result of TRIM

The result is always of type VARCHAR, with maximum length equal to the fixed length or maximum variable length of *trim-source*. If the source character string is an up-shifts CHAR or VARCHAR string, the result is an up-shifts VARCHAR type.

7.119.2. Examples of TRIM

- Return 'Robert':

```
TRIM(' Robert ')
```

- The EMPLOYEE table defines FIRST_NAME as CHAR(15) and LAST_NAME as CHAR(20). This expression uses the TRIM function to return the value 'Robert Smith' without extra blanks:

```
TRIM(first_name) || ' ' || TRIM (last_name)
```

7.120. UCASE Function

The UCASE function up-shifts alphanumeric characters. For non-alphanumeric characters, UCASE returns the same character. UCASE can appear anywhere in a query where a value can be used, such as in a select list, an ON clause, a WHERE clause, a HAVING clause, a LIKE predicate, an expression, or as qualifying a new value in an UPDATE or INSERT statement. The result returned by the UCASE function is equal to the result returned by the [UPPER Function](#) or [UPSHIFT Function](#).

UCASE returns a string of fixed-length or variable-length character data, depending on the data type of the input string.

UCASE is a Trafodion SQL extension.

```
UCASE ( character-expression )
```

- *character-expression*

is an SQL character value expression that specifies a string of characters to upshift. See [Character Value Expressions](#).

7.120.1. Considerations for UCASE

For a UTF8 character_expression, the UCASE function up-shifts all lowercase or title case characters to uppercase and returns a character string. If the argument is of type CHAR(*n*) or VARCHAR(*n*), the result is of type VARCHAR(min(3_n_, 2048)), where the maximum length of VARCHAR is the minimum of 3_n_ or 2048, whichever is smaller.

A lowercase character is a character that has the "alphabetic" property in Unicode Standard 2 and whose Unicode name includes lower. An uppercase character is a character that has the "alphabetic" property and whose Unicode name includes upper. A title case character is a character that has the Unicode "alphabetic" property and whose Unicode name includes *title*.

7.120.2. Examples of UCASE

- Suppose that your CUSTOMER table includes an entry for Hotel Oregon. Select the column CUSTNAME and return in uppercase and lowercase letters by using the UCASE and LCASE functions:

```
SELECT custname,UCASE(custname),LCASE(custname) FROM sales.customer;  
  
(EXPR)          (EXPR)          (EXPR)  
-----  
...           ...           ...  
Hotel Oregon    HOTEL OREGON    hotel oregon  
  
--- 17 row(s) selected.
```

See [LCASE Function](#).

7.120.3. UPPER Function

The UPPER function up-shifts alphanumeric characters. For non-alphanumeric characters, UCASE returns the same character. UPPER can appear anywhere in a query where a value can be used, such as in a select list, an ON clause, a WHERE clause, a HAVING clause, a LIKE predicate, an expression, or as qualifying a new value in an UPDATE or INSERT statement. The result returned by the UPPER function is equal to the result returned by the [UPSHIFT Function](#) or [UCASE Function](#).

UPPER returns a string of fixed-length or variable-length character data, depending on the data type of the input string.

```
UPPER (character-expression)
```

- *character-expression*

is an SQL character value expression that specifies a string of characters to upshift. See [Character Value Expressions](#).

7.120.4. Examples of UPPER

- Suppose that your CUSTOMER table includes an entry for Hotel Oregon. Select the column CUSTNAME and return in uppercase and lowercase letters by using the UPPER and LOWER functions:

```
SELECT custname,UPPER(custname),LOWER(custname) FROM sales.customer;
          (EXPR)           (EXPR)           (EXPR)
-----  -----
...           ...           ...
Hotel Oregon      HOTEL OREGON      hotel oregon
--- 17 row(s) selected.
```

See [LOWER Function](#).

For examples of when to use the UPPER function, see [UPSHIFT Function](#).

7.120.5. UPSHIFT Function

The UPSHIFT function up-shifts alphanumeric characters. For non-alphanumeric characters, UCASE returns the same character. UPSHIFT can appear anywhere in a query where a value can be used, such as in a select list, an ON clause, a WHERE clause, a HAVING clause, a LIKE predicate, an expression, or as qualifying a new value in an UPDATE or INSERT statement. The result returned by the UPSHIFT function is equal to the result returned by the [UPPER Function](#) or [UCASE Function](#).

UPSHIFT returns a string of fixed-length or variable-length character data, depending on the data type of the input string.

UPSHIFT is a Trafodion SQL extension.

```
UPSHIFT (character-expression)
```

- *character-expression*

is an SQL character value expression that specifies a string of characters to upshift. See [Character Value Expressions](#).

7.120.6. Examples of UPSHIFT

- Suppose that your CUSTOMER table includes an entry for Hotel Oregon. Select the column CUSTNAME and return a result in uppercase and lowercase letters by using the UPSHIFT, UPPER, and LOWER functions:

```
SELECT UPSHIFT(custname), UPPER(custname), UCASE(custname)
FROM sales.customer;

(Expr)          (Expr)          (Expr)
-----
...             ...
HOTEL OREGON    HOTEL OREGON    HOTEL OREGON
...
--- 17 row(s) selected.
```

- Perform a case-insensitive search for the DataSpeed customer:

```
SELECT *
FROM sales.customer
WHERE UPSHIFT (custname) = 'DATASPEED';

CUSTNAME      STREET          CITY      ...
-----  -----  -----
DataSpeed    300 SAN GABRIEL WAY  NEW YORK  ...
                                         ...

--- 1 row(s) selected.
```

In the table, the name can be in lowercase, uppercase, or mixed case letters.

- Suppose that your database includes two department tables: DEPT1 and DEPT2. Return all rows from the two tables in which the department names have the same value regardless of case:

```
SELECT *
FROM persnl.dept1 D1, persnl.dept2 D2
WHERE UPSHIFT(D1.deptname) = UPSHIFT(D2.deptname);
```

7.121. USER Function

The `USER` function returns either the database user name associated with the specified user ID number or the database user name of the current user who invoked the function. The current user

is the authenticated user who started the session. That database user name is used for authorization of SQL statements in the current session.

```
USER [ (user-id) ]
```

- *user-id*

is the 32-bit number associated with a database user name.

The `USER` function is similar to the [AUTHNAME Function](#) and the [CURRENT USER Function](#).

7.121.1. Considerations for USER

- This function can be specified only in the top level of a `SELECT` statement.
- The value returned is string data type `VARCHAR(128)` and is in ISO8859-1 encoding.

7.121.2. Examples of USER

- This example shows the database user name of the current user who is logged in to the session:

```
SELECT USER FROM (values(1)) x(a);  
(EXPR)  
-----  
TSHAW  
--- 1 row(s) selected.
```

- This example shows the database user name associated with the user ID number, 33333:

```
SELECT USER (33333) FROM (values(1)) x(a);  
(EXPR)  
-----  
DB ROOT  
--- 1 row(s) selected.
```

7.122. VARIANCE Function

VARIANCE is an aggregate function that returns the statistical variance of a set of numbers. VARIANCE is a Trafodion SQL extension.

```
VARIANCE ([ALL | DISTINCT] expression [, weight])
```

- ALL | DISTINCT

specifies whether duplicate values are included in the computation of the VARIANCE of the *expression*. The default option is ALL, which causes duplicate values to be included. If you specify DISTINCT, duplicate values are eliminated before the VARIANCE function is applied. If DISTINCT is specified, you cannot specify *weight*.

- *expression*

specifies a numeric value expression that determines the values for which to compute the variance. *expression* cannot contain an aggregate function or a subquery. The DISTINCT clause specifies that the VARIANCE function operates on distinct values from the one-column table derived from the evaluation of *expression*.

- *weight*

specifies a numeric value expression that determines the weights of the values for which to compute the variance. *weight* cannot contain an aggregate function or a subquery. *weight* is defined on the same table as *expression*. The one-column table derived from the evaluation of *expression* and the one-column table derived from the evaluation of *weight* must have the same cardinality.

7.122.1. Considerations for VARIANCE

Definition of VARIANCE

Suppose that v_i are the values in the one-column table derived from the evaluation of *expression*. N is the cardinality of this one-column table that is the result of applying the *expression* to each row of the source table and eliminating rows that are null.

If *weight* is specified, w_i are the values derived from the evaluation of *weight*. N is the cardinality of the two-column table that is the result of applying the *expression* and *weight* to each row of the source table and eliminating rows that have nulls in either column.

Definition When Weight Is Not Specified

If *weight* is not specified, the statistical variance of the values in the one-column result table is defined as:

where v_i is the i-th value of *expression*, v is the average value expressed in the common data type, and N is the cardinality of the result table.

Because the definition of variance has $N-1$ in the denominator of the expression (when weight is not specified), Trafodion SQL returns a default value of zero (and no error) if the number of rows in the table, or a group of the table, is equal to 1.

Definition When Weight Is Specified

If *weight* is specified, the statistical variance of the values in the two-column result table is defined as:

where v_i is the i-th value of *expression*, w_i is the i-th value of *weight*, vw is the weighted average value expressed in the common data type, and N is the cardinality of the result table.

Weighted Average

The weighted average vw of v_i and w_i is defined as:

where v_i is the i-th value of *expression*, w_i is the i-th value of *weight*, and N is the cardinality of the result table.

Data Type of the Result

The data type of the result is always DOUBLE PRECISION.

Operands of the Expression

The expression includes columns from the rows of the SELECT result table — but cannot include an aggregate function.

These expressions are valid:

```
VARIANCE (SALARY) VARIANCE (SALARY * 1.1)
VARIANCE (PARTCOST * QTY_ORDERED)
```

Nulls

VARIANCE is evaluated after eliminating all nulls from the set. If the result table is empty, VARIANCE returns NULL.

FLOAT(54) and DOUBLE PRECISION Data

Avoid using large FLOAT(54) or DOUBLE PRECISION values as arguments to VARIANCE. If $\text{SUM}(x * x)$ exceeds the value of $1.15792089237316192\text{e}77$ during the computation of $\text{VARIANCE}(x)$, then a numeric overflow occurs.

7.122.2. Examples of VARIANCE

- Compute the variance of the salary of the current employees:

```
SELECT VARIANCE(salary) AS Variance_Salary FROM persnl.employee;

VARIANCE_SALARY
-----
1.27573263588496116E+009

--- 1 row(s) selected.
```

- Compute the variance of the cost of parts in the current inventory:

```
SELECT VARIANCE (price * qty_available) FROM sales.parts;

(EXPR)
-----
5.09652410092950336E+013

--- 1 row(s) selected.
```

7.123. WEEK Function

The WEEK function converts a DATE or TIMESTAMP expression into an INTEGER value in the range 1 through 54 that represents the corresponding week of the year. If the year begins on a Sunday, the value 1 will be returned for any datetime that occurs in the first 7 days of the year. Otherwise, the value 1 will be returned for any datetime that occurs in the partial week before the start of the first Sunday of the year. The value 53 is returned for datetimes that occur in the last full or partial week of the year except for leap years that start on Saturday where December 31 is in the 54th full or partial week.

WEEK is a Trafodion SQL extension.

```
WEEK (datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

7.123.1. Examples of WEEK

- Return an integer that represents the week of the year from the START_DATE column in the PROJECT table:

```
SELECT start_date, ship_timestamp, WEEK(start_date)
FROM persnl.project
WHERE projcode = 1000;

Start/Date Time/Shipped          ( EXPR )
-----
2008-04-10 2008-04-21 08:15:00.000000 | 15
```

7.124. YEAR Function

The YEAR function converts a DATE or TIMESTAMP expression into an INTEGER value that represents the year.

YEAR is a Trafodion SQL extension.

```
YEAR (datetime-expression)
```

- *datetime-expression*

is an expression that evaluates to a datetime value of type DATE or TIMESTAMP. See [Datetime Value Expressions](#).

7.124.1. Examples of YEAR

- Return an integer that represents the year from the start date column in the project table:

```
SELECT start_date, ship_timestamp, YEAR(start_date)
FROM persnl.project
WHERE projcode = 1000;
```

Start/Date	Time/Shipped	(EXPR)
2008-04-10	2008-04-21 08:15:00.000000	2008

7.125. ZEROIFNULL Function

The ZEROIFNULL function returns a value of zero if the expression is NULL. Otherwise, it returns the value of the expression.

```
ZEROIFNULL (expression)
```

- *expression*

specifies a value expression. It must be a numeric data type.

7.125.1. Examples of ZEROIFNULL

- ZEROIFNULL returns the value of the column named salary whenever the column value is not NULL and it returns 0 whenever the column value is NULL.

```
ZEROIFNULL (salary)
```

Chapter 8. OLAP Functions

On-line Analytical Process (OLAP) functions provide the capability to partition source data into groups of rows, order the rows in each group and compute aggregates within a window frame for a row.

Typically, an OLAP function in SQL is expressed in two components <FUNCTION> and <OVER>: <FUNCTION> specifies the function and the arguments, and <OVER> specifies the partitioning, the ordering and the window frames. <OVER> is sometimes called the window. OLAP functions are used to perform analytic tasks against data sets stored in or computed from a set of tables, such as moving average and ranks.

This section describes the syntax and semantics of the OLAP window functions. The OLAP window functions are ANSI compliant.

Trafodion OLAP functions have very similar semantics as Trafodion sequence functions which are SQL extensions and have to be used together with a SEQUENCE BY clause. For more information, see [Sequence Functions](#).

8.1. Considerations for Window Functions

These considerations apply to all window functions.

- *inline-window-specification*

The window defined by the *inline-window-specification* consists of the rows specified by the *window-frame-clause*, bounded by the current partition. If no PARTITION BY clause is specified, the partition is defined to be all the rows of the intermediate result. If a PARTITION BY clause is specified, the partition is the set of rows which have the same values for the expressions specified in the PARTITION clause.

- *window-frame-clause*

DISTINCT is not supported for window functions.

Use of a FOLLOWING term is not supported. Using a FOLLOWING term results in an error.

If no *window-frame-clause* is specified, "ROWS BETWEEN UNBOUNDED PRECEDING AND UNBOUNDED FOLLOWING" is assumed. This clause is not supported because it involves a FOLLOWING term and will result in an error.

"ROWS CURRENT ROW" is equivalent to "ROWS BETWEEN CURRENT ROW AND CURRENT ROW".

"ROWS preceding-row" is equivalent to "ROWS BETWEEN preceding-row AND CURRENT ROW".

8.1.1. Nulls

All nulls are eliminated before the function is applied to the set of values. If the window contains all NULL values, the result of the window function is NULL.

If the specified window for a particular row consists of rows that are all before the first row of the partition (no rows in the window), the result of the window function is NULL.

8.2. ORDER BY Clause Supports Expressions For OLAP Functions

The ORDER BY clause of the OLAP functions now supports expressions. However, use of multiple OLAP functions with different expressions in the same query is not supported. The following examples show how expressions may be used in the ORDER BY clause.

```
SELECT
  -1 * annualsalary neg_total
 , RANK() OVER (ORDER BY -1 * annualsalary) olap_rank
FROM employee;
```

Using an aggregate in the ORDER BY clause:

```
SELECT
  num
 , RANK() OVER (ORDER BY SUM(annualsalary)) olap_rank
FROM employee
GROUP BY num;
```

Using multiple functions with the same expression in the ORDER BY clause:

```
SELECT
  num
 , workgroupnum
 , RANK() OVER (ORDER BY SUM (annualsalary)*num) olap_rank
 , DENSE_RANK() OVER (ORDER BY SUM (annualsalary)*num) olap_drank
 , ROW_NUMBER() OVER (ORDER BY SUM (annualsalary)*num) olap_mum
FROM employee
GROUP BY num, workgroupnum, annualsalary;
```

Using more functions with the same expression in the ORDER BY clause:

```
SELECT
  num
 , workgroupnum
 , annualsalary
 , SUM(AnnualSalary) OVER (ORDER BY SUM(annualsalary)*num ROWS UNBOUNDED PRECEDING)
 , AVG(AnnualSalary) OVER (ORDER BY SUM(annualsalary)*num ROWS UNBOUNDED PRECEDING)
 , MIN(AnnualSalary) OVER (ORDER BY SUM(annualsalary)*num ROWS UNBOUNDED PRECEDING)
 , MAX(AnnualSalary) OVER (ORDER BY SUM(annualsalary)*num ROWS UNBOUNDED PRECEDING)
 , VARIANCE(AnnualSalary) OVER (ORDER BY SUM(annualsalary)*num ROWS UNBOUNDED PRECEDING)
 , STDDEV(AnnualSalary) OVER (ORDER BY SUM(annualsalary)*num ROWS UNBOUNDED PRECEDING)
 , COUNT(AnnualSalary) OVER (ORDER BY SUM(annualsalary)*num ROWS UNBOUNDED PRECEDING)
FROM employee
GROUP BY num, workgroupnum, annualsalary;
```

8.3. Limitations for Window Functions

Trafodion supports many ANSI compliant OLAP window functions. These functions include AVG, COUNT, DENSE_RANK, FIRST_VALUE, LAG, LAST_VALUE, LEAD, MAX, MIN, RANK, ROW_NUMBER, STDDEV, SUM, and VARIANCE. However, Trafodion imposes certain limitations on all window functions.

- The ANSI *window-clause* is not supported by Trafodion. Only the *inline-window-specification* is supported. An attempt to use an ANSI *window-clause* will result in a syntax error.



A window clause provides a mechanism to define and to refer to a window in a SQL query, as illustrated in the following example.

```
SELECT EmployeeID, Surname, Salary, State,
       AVG( Salary ) OVER Salary_Window
  FROM Employees
 WINDOW Salary_Window AS ( PARTITION BY State )
 ORDER BY State, Surname;
```

- The *window-frame-clause* cannot contain a FOLLOWING term, either explicitly or implicitly. Because the default window frame clause contains an implicit FOLLOWING ("ROWS BETWEEN UNBOUNDED PRECEDING AND UNBOUNDED FOLLOWING"), the default is not supported. So, practically, the *window-frame-clause* is not optional. An attempt to use a FOLLOWING term, either explicitly or implicitly will result in the "4343" error message.
- The window frame units can only be ROWS. RANGE is not supported by Trafodion. An attempt to use RANGE will result in a syntax error.

The difference between the two is that the frame with ROWS unit includes all rows regardless of the values in the ORDER BY clause. The frame with RANGE unit will include rows that are identical in value in the ORDER BY clause.

- The ANSI *window-frame-exclusion-specification* is not supported by Trafodion. An attempt to use a *window-frame-exclusion-specification* will result in a syntax error.

The *window-frame-exclusion-specification* can exclude rows, such as the current one, the current group, or current ties, from the window is not supported. This specification is not widely implementation by other vendors.

- Multiple *inline-window-specifications* in a single SELECT clause are not supported. For each window function within a SELECT clause, the ORDER BY clause and PARTITION BY specifications must be identical. The window frame can vary within a SELECT clause. An attempt to use multiple *inline-window-specifications* in a single SELECT clause will result in the "4340" error message.

- The ANSI *null-ordering-specification* within the ORDER BY clause is not supported by Trafodion. Null values will always be sorted as if they are greater than all non-null values. This is slightly different than a null ordering of NULLS LAST. An attempt to use a *null-ordering-specification* will result in a syntax error.
- The ANSI *filter-clause* is not supported for window functions by Trafodion. The *filter-clause* applies to all aggregate functions (grouped and windowed) and that the *filter-clause* is not currently supported for grouped aggregate functions. An attempt to use a *filter-clause* will result in a syntax error.
- The DISTINCT value for the *set-qualifier-clause* within a window function is not supported. Only the ALL value is supported for the *set-qualifier-clause* within a window function. An attempt to use DISTINCT in a window function will result in the "4341" error message.

8.4. AVG Window Function

AVG is a window function that returns the average of non-null values of the given expression for the current window specified by the *inline-window specification*.

```
AVG ([ALL] expression) OVER (inline-window-specification)
```

- *inline-window-specification* is:

```
[PARTITION BY expression [, expression]...]
[ORDER BY expression [ASC[ENDING] | DESC[ENDING]]
     [, expression [ASC[ENDING] | DESC[ENDING]]]...]...
[window-frame-clause]
```

- *window-frame-clause* is:

```
ROWS CURRENT ROW
| ROWS preceding-row
| ROWS BETWEEN preceding-row AND preceding-row
| ROWS BETWEEN preceding-row AND CURRENT ROW
| ROWS BETWEEN preceding-row AND following-row
| ROWS BETWEEN CURRENT ROW AND CURRENT ROW
| ROWS BETWEEN CURRENT ROW AND following-row
| ROWS BETWEEN following-row AND following-row
```

- *preceding-row* is:

```
UNBOUNDED PRECEDING
| unsigned-integer PRECEDING
```

- *following-row* is:

```
UNBOUNDED FOLLOWING
| unsigned-integer FOLLOWING
```

- ALL

specifies whether duplicate values are included in the computation of the AVG of the *expression*. The default option is ALL, which causes duplicate values to be included.

- *expression*

specifies a numeric or interval value *expression* that determines the values to average. See [Numeric Value Expressions](#) and [Interval Value Expressions](#).

- *inline-window-specification*

specifies _the _window _over _which _the _avg _is _computed. The *inline-window-specification* can contain an optional partition by clause, an optional ORDER BY clause and an optional window frame clause. The PARTITION BY clause specifies how the intermediate result is partitioned and the ORDER BY clause specifies how the rows are ordered within each partition.

- *window-frame-clause*

specifies the window within the partition over which the AVG is computed.

8.4.1. Examples of AVG Window Function

- Return the running average value of the SALARY column:

```
SELECT
    empnum
    , AVG(salary) OVER (ORDER BY empnum ROWS UNBOUNDED PRECEDING)
FROM persnl.employee;
```

- Return the running average value of the SALARY column within each department:

```
SELECT
    deptnum
    , empnum
    , AVG(salary) OVER (PARTITION BY deptnum ORDER BY empnum ROWS UNBOUNDED PRECEDING)
FROM persnl.employee;
```

- Return the moving average of salary within each department over a window of the last 4 rows:

```
SELECT
    deptnum
    , empnum
    , AVG(SALARY) OVER (PARTITION BY deptnum ORDER BY empnum ROWS 3 PRECEDING)
FROM persnl.employee;
```

8.5. COUNT Window Function

COUNT is a window function that returns the count of the non null values of the given expression for the current window specified by the inline-window-specification.

```
COUNT {(*) | ([ALL] expression) } OVER inline-window-specification
```

- *inline-window-specification* is:

```
[PARTITION BY expression [, expression]...]
[ORDER BY expression [ASC[ENDING] | DESC[ENDING]]
[,expression [ASC[ENDING] | DESC[ENDING]]]...]
[window-frame-clause]
```

- *window-frame-clause* is:

```
ROW CURRENT ROW
| ROW preceding-row
| ROW BETWEEN preceding-row AND preceding-row
| ROW BETWEEN preceding-row AND CURRENT ROW
| ROW BETWEEN preceding-row AND following-row
| ROW BETWEEN CURRENT ROW AND CURRENT ROW
| ROW BETWEEN CURRENT ROW AND following-row
| ROW BETWEEN following-row AND following-row
```

- *preceding-row* is:

```
UNBOUNDED PRECEDING
| unsigned-integer PRECEDING
```

- *following-row* is:

```
UNBOUNDED FOLLOWING
| unsigned-integer FOLLOWING
```

- ALL

specifies whether duplicate values are included in the computation of the COUNT of the *expression*. The default option is ALL, which causes duplicate values to be included.

- *expression*

specifies a value *expression* that is to be counted. See [Expressions](#).

- *inline-window-specification*

specifies the window over which the COUNT is computed. The *inline-window-specification* can contain an optional PARTITION BY clause, an optional ORDER BY clause and an optional window frame clause. The PARTITION BY clause specifies how the intermediate result is partitioned and the ORDER BY clause specifies how the rows are ordered within each partition.

- *window-frame-clause*

specifies the window within the partition over which the COUNT is computed.

8.5.1. Examples of COUNT Window Function

- Return the running count of the SALARY column:

```
SELECT
    empnum
    , COUNT(salary) OVER (ORDER BY empnum ROWS UNBOUNDED PRECEDING)
FROM persnl.employee;
```

- Return the running count of the SALARY column within each department:

```
SELECT
    deptnum
    , empnum
    , COUNT(salary) OVER (PARTITION BY deptnum ORDER BY empnum ROWS UNBOUNDED PRECEDING)
FROM persnl.employee;
```

- Return the moving count of salary within each department over a window of the last 4 rows:

```
SELECT
    deptnum
    , empnum
    , COUNT(salary) OVER (PARTITION BY deptnum ORDER BY empnum ROWS 3 PRECEDING)
FROM persnl.employee;
```

- Return the running count of employees within each department:

```
SELECT
    deptnum
    , empnum
    , COUNT(*) OVER (PARTITION BY deptnum ORDER BY empnum ROWS UNBOUNDED PRECEDING)
FROM persnl.employee;
```

8.6. DENSE_RANK Window Function

DENSE_RANK is a window function that returns the ranking of each row of the current partition specified by the inline-window-specification. The ranking is relative to the ordering specified in the inline-window-specification. The return value of DENSE_RANK starts at 1 for the first row of the window. Values of the given expression that are equal have the same rank. The value of DENSE_RANK advances 1 when the value of the given expression changes.

```
DENSE_RANK() OVER (inline-window-specification)
```

- *inline-window-specification* is:

```
[PARTITION BY expression [, expression]...]
[ORDER BY expression [ASC[ENDING] | DESC[ENDING]]
 [,expression [ASC[ENDING] | DESC[ENDING]]]...]
```

- *inline-window-specification*

specifies the window over which the DENSE_RANK is computed. The *inline-window-specification* can contain an optional PARTITION BY clause and an optional ORDER BY clause. The PARTITION BY clause specifies how the intermediate result is partitioned and the ORDER BY clause specifies how the rows are ordered within each partition.

8.6.1. Examples of DENSE_RANK Window Function

- Return the dense rank for each employee based on employee number:

```
SELECT
  DENSE_RANK() OVER (ORDER BY empnum)
  ,
  *
FROM persnl.employee;
```

- Return the dense rank for each employee within each department based on salary:

```
SELECT
  DENSE_RANK() OVER (PARTITION BY deptnum ORDER BY salary)
  ,
  *
FROM persnl.employee;
```

8.7. FIRST_VALUE Window Function

The FIRST_VLAUE window function returns the first value from a sorted partition.

```
FIRST_VALUE (expression)
```

- *expression*

Specifies a scalar expression or a column whose value from the first row in the partition is to be returned.



Trafodion only supports the function to return first value including null, and it is the default behavior.

8.7.1. Examples of FIRST_VALUE Window Function

Each row returned by the following query contains the employee name, the department number, the salary and the pay difference over the lowest salary in the department.

```
SELECT ename, deptno, sal,
       sal - FIRST_VALUE( sal ) OVER ( PARTITION BY deptno
                                         ORDER BY sal ) diff
  FROM emp
 ORDER BY deptno, sal;
```

8.8. LAG Window Function

The LAG window function can be used to access the previous rows from the same result set without using self-joins. The LAG function takes the same three parameters as the LEAD function with the exception that *offset* specifies the offset to access a row that comes before the current row. The return type of LAG is that of *expression*.

`LAG (expression, offset, default-value)`

- *expression*

Specifies a scalar expression or a column whose value from the previous row is to be returned. If the previous row does not exist in the current group, *expression* returns NULL.

- *offset*

Specifies an expression that can be evaluated to a positive integer indicating the offset before the current row. For example, a value of 1 accesses the previous row and a value of 3 accesses the third row before the current row.

- *default-value*

Specifies the value if the value returned by *expression* is NULL.

8.8.1. Examples of LAG Window Function

The LAG function in the following query returns the plan code of a previous plan and 'N/A' for the first plan.

```
SELECT CustomerCode, PlanCode AS CurrentPlanCode,
       LAG(PlanCode, 1, 'NA')
       OVER (PARTITION BY CustomerCode ORDER BY StartDate ASC) AS LastPlan
FROM CustomerPlan;
```

8.9. LAST_VALUE Window Function

The LAST_VALUE window function is similar to the FIRST_VALUE function with the exception that the value from the last row in a sorted partition is returned.

8.10. LEAD Window Function

The LEAD window function can be used to access the subsequent rows (or columns from the subsequence rows) from the current rows, without using self-joins. The return type of LEAD is that of *expression*.

`LEAD (expression, offset, default-value)`

- *expression*

Specifies a scalar expression or a column whose value from the subsequent row is to be returned. If the subsequent row does not exist in the current group, *expression* returns NULL.

- *offset*

Specifies an expression that can be evaluated to a positive integer indicating the offset after the current row. For example, a value of 1 accesses the next row and a value of 3 accesses the third row from the current row.

- *default-value*

Specifies the value if the value returned by *expression* is NULL.

8.10.1. Examples of LEAD Window Function

The LEAD function in the following query returns the start date of next plan and DATEADD function subtracts one day from that date as the end date of the current plan.

```
SELECT *,
DATEADD(DAY, -1, LEAD(StartDate, 1, '01-Jan-2100')
OVER (PARTITION BY CustomerCode ORDER BY StartDate ASC)) AS EndDate
FROM CustomerPlan
```

8.11. MAX Window Function

MAX is a window function that returns the maximum value of all non null values of the given expression for the current window specified by the inline-window-specification.

```
MAX ([ALL] expression) OVER (inline-window-specification)
```

- *inline-window-specification* is:

```
[PARTITION BY expression [, expression]...]
[ORDER BY expression [ASC[ENDING] | DESC[ENDING]]
    [,expression [ASC[ENDING] | DESC[ENDING]]]...]
[window-frame-clause]
```

- *window-frame-clause* is:

```
ROWS CURRENT ROW
| ROWS preceding-row
| ROWS BETWEEN preceding-row AND preceding-row
| ROWS BETWEEN preceding-row AND CURRENT ROW
| ROWS BETWEEN preceding-row AND following-row
| ROWS BETWEEN CURRENT ROW AND CURRENT ROW
| ROWS BETWEEN CURRENT ROW AND following-row
| ROWS BETWEEN following-row AND following-row
```

- *preceding-row* is:

```
UNBOUNDED PRECEDING
| unsigned-integer PRECEDING
```

- *following-row* is:

```
UNBOUNDED FOLLOWING
| unsigned-integer FOLLOWING
```

- ALL

specifies whether duplicate values are included in the computation of the MAX of the *expression*. The default option is ALL, which causes duplicate values to be included.

- *expression*

specifies an expression that determines the values over which the MAX is computed. See [Expressions](#).

- *inline-window-specification*

specifies the window over which the MAX is computed. The *inline-window-specification* can contain an optional PARTITION BY clause, an optional ORDER BY clause and an optional window frame clause. The PARTITION BY clause specifies how the intermediate result is partitioned and the ORDER BY clause specifies how the rows are ordered within each partition.

- *window-frame-clause*

specifies the window within the partition over which the MAX is computed.

8.11.1. Examples of MAX Window Function

- Return the running maximum of the SALARY column:

```
SELECT
    empnum
    , MAX(salary) OVER (ORDER BY empnum ROWS UNBOUNDED PRECEDING)
FROM persnl.employee;
```

- Return the running maximum of the SALARY column within each department:

```
SELECT
    deptnum
    , empnum, MAX(salary) OVER (PARTITION BY deptnum ORDER BY empnum ROWS UNBOUNDED
PRECEDING)
FROM persnl.employee;
```

- Return the moving maximum of salary within each department over a window of the last 4 rows:

```
SELECT
    deptnum
    , empnum
    , MAX(salary) OVER (PARTITION BY deptnum ORDER BY empnum ROWS 3 PRECEDING)
FROM persnl.employee;
```

8.12. MIN Window Function

MIN is a window function that returns the minimum value of all non null values of the given expression for the current window specified by the inline-window-specification.

```
MIN ([ALL] expression) OVER (inline-window-specification)
```

- *inline-window-specification* is:

```
[PARTITION BY expression [, expression]...]
[ORDER BY expression [ASC[ENDING] | DESC[ENDING]]
    [,expression [ASC[ENDING] | DESC[ENDING]]]...]
[window-frame-clause]
```

- *window-frame-clause* is:

```
ROWS CURRENT ROW
| ROWS preceding-row
| ROWS BETWEEN preceding-row AND preceding-row
| ROWS BETWEEN preceding-row AND CURRENT ROW
| ROWS BETWEEN preceding-row AND following-row
| ROWS BETWEEN CURRENT ROW AND CURRENT ROW
| ROWS BETWEEN CURRENT ROW AND following-row
| ROWS BETWEEN following-row AND following-row
```

- *preceding-row* is:

```
UNBOUNDED PRECEDING
| unsigned-integer PRECEDING
```

- *following-row* is:

```
UNBOUNDED FOLLOWING
| unsigned-integer FOLLOWING
```

- `ALL`

specifies whether duplicate values are included in the computation of the MIN of the *expression*. The default option is ALL, which causes duplicate values to be included.

- *expression*

specifies an expression that determines the values over which the MIN is computed. See [Expressions](#).

- *inline-window-specification*

specifies the window over which the MIN is computed. The *inline-window-specification* can contain an optional PARTITION BY clause, an optional ORDER BY clause and an optional window frame clause. The PARTITION BY clause specifies how the intermediate result is partitioned and the ORDER BY clause specifies how the rows are ordered within each partition.

- *window-frame-clause*

specifies the window within the partition over which the MIN is computed.

8.12.1. Examples of MIN Window Function

- Return the running minimum of the SALARY column:

```
SELECT
    empnum
    , MIN(salary) OVER (ORDER BY empnum ROWS UNBOUNDED PRECEDING)
FROM persnl.employee;
```

- Return the running minimum of the SALARY column within each department:

```
SELECT
    deptnum
    , empnum
    , MIN(salary) OVER (PARTITION BY deptnum ORDER BY empnum ROWS UNBOUNDED PRECEDING)
FROM persnl.employee;
```

- Return the moving minimum of salary within each department over a window of the last 4 rows:

```
SELECT
    deptnum
    , empnum
    , MIN(salary) OVER (PARTITION BY deptnum ORDER BY empnum ROWS 3 PRECEDING)
FROM persnl.employee;
```

8.13. RANK Window Function

RANK is a window function that returns the ranking of each row of the current partition specified by the inline-window-specification. The ranking is relative to the ordering specified in the *inline-window-specification*. The return value of RANK starts at 1 for the first row of the window. Values that are equal have the same rank. The value of RANK advances to the relative position of the row in the window when the value changes.

```
RANK() OVER (inline-window-specification)
```

- *inline-window-specification* is:

```
[PARTITION BY expression [, expression]...]
[ORDER BY expression [ASC[ENDING] | DESC[ENDING]]
 [,expression [ASC[ENDING] | DESC[ENDING]]]...]
```

- *inline-window-specification*

specifies the window over which the RANK is computed. The *inline-window-specification* can contain an optional PARTITION BY clause and an optional ORDER BY clause. The PARTITION BY clause specifies how the intermediate result is partitioned and the ORDER BY clause specifies how the rows are ordered within each partition.

8.13.1. Examples of RANK Window Function

- Return the rank for each employee based on employee number:

```
SELECT
  RANK() OVER (ORDER BY empnum)
  ,
  *
FROM persnl.employee;
```

- Return the rank for each employee within each department based on salary:

```
SELECT
  RANK() OVER (PARTITION BY deptnum ORDER BY salary)
  ,
  *
FROM persnl.employee;
```

8.13.2. ROW_NUMBER Window Function

ROW_NUMBER is a window function that returns the row number of each row of the current window specified by the inline-window-specification.

```
ROW_NUMBER () OVER (inline-window-specification)
```

- *inline-window-specification* is:

```
[PARTITION BY expression [, expression]...]
[ORDER BY expression [ASC[ENDING] | DESC[ENDING]]
 [,expression [ASC[ENDING] | DESC[ENDING]]]...]
```

- *inline-window-specification*

specifies the window over which the ROW_NUMBER is computed. The *inline-window-specification* can contain an optional PARTITION BY clause and an optional ORDER BY clause. The PARTITION BY clause specifies how the intermediate result is partitioned and the ORDER BY clause specifies how the rows are ordered within each partition.

- *window-frame-clause*

specifies the window within the partition over which the ROW_NUMBER is computed.

8.13.3. Examples of ROW_NUMBER Window Function

- Return the row number for each row of the employee table:

```
SELECT
    ROW_NUMBER () OVER(ORDER BY empnum)
    ,
    *
FROM persnl.employee;
```

- Return the row number for each row within each department:

```
SELECT
    ROW_NUMBER () OVER(PARTITION BY deptnum ORDER BY empnum)
    ,
    *
FROM persnl.employee;
```

8.13.4. STDDEV Window Function

STDDEV is a window function that returns the standard deviation of non null values of the given expression for the current window specified by the inline-window-specification.

```
STDDEV ([ALL] expression) OVER (inline-window-specification)
```

- *inline-window-specification* is:

```
[PARTITION BY expression [, expression]...]
[ORDER BY expression [ASC[ENDING] | DESC[ENDING]]
     [,expression [ASC[ENDING] | DESC[ENDING]]]...]
[ window-frame-clause ]
```

- *window-frame-clause* is:

```
ROWS CURRENT ROW
| ROWS preceding-row
| ROWS BETWEEN preceding-row AND preceding-row
| ROWS BETWEEN preceding-row AND CURRENT ROW
| ROWS BETWEEN preceding-row AND following-row
| ROWS BETWEEN CURRENT ROW AND CURRENT ROW
| ROWS BETWEEN CURRENT ROW AND following-row
| ROWS BETWEEN following-row AND following-row
```

- *preceding-row* is:

```
UNBOUNDED PRECEDING
| unsigned-integer PRECEDING
```

- *following-row* is:

```
UNBOUNDED FOLLOWING
| unsigned-integer FOLLOWING
```

- ALL

specifies whether duplicate values are included in the computation of the STDDEV of the *expression*. The default option is ALL, which causes duplicate values to be included.

- *expression*

specifies a numeric or interval value *expression* that determines the values over which STDDEV is computed.

- *inline-window-specification*

specifies the window over which the STDDEV is computed. The *inline-window-specification* can contain an optional PARTITION BY clause, an optional ORDER BY clause and an optional window frame clause. The PARTITION BY clause specifies how the intermediate result is partitioned and the ORDER BY clause specifies how the rows are ordered within each partition.

- *window-frame-clause*

specifies the window within the partition over which the STDDEV is computed.

8.13.5. Examples of STDDEV

- Return the standard deviation of the salary for each row of the employee table:

```
SELECT
    STDDEV(salary) OVER(ORDER BY empnum ROWS UNBOUNDED PRECEDING)
    ,
    *
FROM persnl.employee;
```

- Return the standard deviation for each row within each department:

```
SELECT
    STDDEV() OVER(PARTITION BY deptnum ORDER BY empnum ROWS UNBOUNDED PRECEDING)
    ,
    *
FROM persnl.employee;
```

8.14. SUM Window Function

SUM is a window function that returns the sum of non null values of the given expression for the current window specified by the inline-window-specification.

```
SUM ([ALL] expression) OVER (inline-window-specification)
```

- *inline-window-specification* is:

```
[PARTITION BY expression [, expression]...]
[ORDER BY expression [ASC[ENDING] | DESC[ENDING]]
    [,expression [ASC[ENDING] | DESC[ENDING]]]...]
[window-frame-clause]
```

- *window-frame-clause* is:

```
ROWS CURRENT ROW
| ROWS preceding-row
| ROWS BETWEEN preceding-row AND preceding-row
| ROWS BETWEEN preceding-row AND CURRENT ROW
| ROWS BETWEEN preceding-row AND following-row
| ROWS BETWEEN CURRENT ROW AND CURRENT ROW
| ROWS BETWEEN CURRENT ROW AND following-row
| ROWS BETWEEN following-row AND following-row
```

- *preceding-row* is:

```
UNBOUNDED PRECEDING
| unsigned-integer PRECEDING
```

- *following-row* is:

```
UNBOUNDED FOLLOWING
| unsigned-integer FOLLOWING
```

- **ALL**

specifies whether duplicate values are included in the computation of the SUM of the *expression*. The default option is ALL, which causes duplicate values to be included.

- *expression*

specifies a numeric or interval value expression that determines the values to sum. See [Expressions](#).

- *inline-window-specification*

specifies the window over which the SUM is computed. The *inline-window-specification* can contain an optional PARTITION BY clause, an optional ORDER BY clause and an optional window frame clause. The PARTITION BY clause specifies how the intermediate result is partitioned and the ORDER BY clause specifies how the rows are ordered within each partition.

- *window-frame-clause*

specifies the window within the partition over which the SUM is computed.

8.14.1. Examples of SUM Window Function

- Return the running sum value of the SALARY column:

```
SELECT
    empnum
    , SUM (salary) OVER (ORDER BY empnum ROWS UNBOUNDED PRECEDING)
FROM persnl.employee;
```

- Return the running sum of the SALARY column within each department:

```
SELECT
    deptnum
    , empnum, SUM (salary) OVER (PARTITION BY deptnum ORDER BY empnum ROWS UNBOUNDED
PRECEDING)
FROM persnl.employee;
```

- Return the moving sum of the SALARY column within each department over a window of the last 4 rows:

```
SELECT
    deptnum
    , empnum
    , SUM (salary) OVER (PARTITION BY deptnum ORDER BY empnum ROWS 3 PRECEDING)
FROM persnl.employee;
```

8.15. VARIANCE Window Function

VARIANCE is a window function that returns the variance of non null values of the given expression for the current window specified by the inline-window-specification.

```
VARIANCE ([ALL] expression) OVER (inline-window-specification)
```

- *inline-window-specification* is:

```
[PARTITION BY expression [, expression]...]
[ORDER BY expression [ASC[ENDING] | DESC[ENDING]]
    [,expression [ASC[ENDING] | DESC[ENDING]]]...]
[window-frame-clause]
```

- *window-frame-clause* is:

```
ROWS CURRENT ROW
| ROWS preceding-row
| ROWS BETWEEN preceding-row AND preceding-row
| ROWS BETWEEN preceding-row AND CURRENT ROW
| ROWS BETWEEN preceding-row AND following-row
| ROWS BETWEEN CURRENT ROW AND CURRENT ROW
| ROWS BETWEEN CURRENT ROW AND following-row
| ROWS BETWEEN following-row AND following-row
```

- *preceding-row* is:

```
UNBOUNDED PRECEDING
| unsigned-integer PRECEDING
```

- *following-row* is:

```
UNBOUNDED FOLLOWING
| unsigned-integer FOLLOWING
```

- ALL

specifies whether duplicate values are included in the computation of the VARIANCE of the *expression*. The default option is ALL, which causes duplicate values to be included.

- *expression*

specifies a numeric or interval value expression that determines the values over which the variance is computed. See [Expressions](#).

- *inline-window-specification*

specifies the window over which the VARIANCE is computed. The *inline-window-specification* can contain an optional PARTITION BY clause, an optional ORDER BY clause and an optional window frame clause. The PARTITION BY clause specifies how the intermediate result is partitioned and the ORDER BY clause specifies how the rows are ordered within each partition.

- *window-frame-clause*

specifies the window within the partition over which the VARIANCE is computed.

8.15.1. Examples of VARIANCE Window Function

- Return the variance of the SALARY column:

```
SELECT
    empnum
    , VARIANCE (salary) OVER (ORDER BY empnum ROWS UNBOUNDED PRECEDING)
FROM persnl.employee;
```

- Return the variance of the SALARY column within each department:

```
SELECT
    deptnum
    , empnum
    , VARIANCE (salary) OVER (PARTITION BY deptnum ORDER BY empnum ROWS UNBOUNDED
    PRECEDING)
FROM persnl.employee;
```

Chapter 9. SQL Runtime Statistics

The Runtime Management System (RMS) shows the status of queries while they are running. RMS can service on-demand requests from the Trafodion Command Interface (TrafCI) to get statistics for a given query ID or for active queries in a given process. RMS also provides information about itself to determine the health of the RMS infrastructure.

RMS provides the summary statistics for each fragment instance and detailed statistics for each operator (TDB_ID) of a given active query. A query is considered active if either the compilation or execution is in progress. The variable_input column output is returned as a multiple value pair of the form *token=value*. For more information, see [Considerations For Obtaining Statistics For Each Fragment-Instance of an Active Query](#).

RMS is enabled and available all the time.

9.1. PERTABLE and OPERATOR Statistics

The SQL database engine determines which type of statistics collection is appropriate for the query. The RMS infrastructure provides the runtime metrics about a query while a query is executing. You can identify queries that are using excessive resources, suspend a query to determine its impact on resources, and cancel a query, when necessary. PERTABLE statistics count rows and report rows estimated in the operators in the disk processes and time spent in the ESP processes. Although PERTABLE statistics can deduce when all the rows have been read from the disks, it is impossible to correctly assess the current state of the query.

Complex queries such as joins, sorts, and group result sets are often too large to fit into memory, so intermediate results must overflow to scratch files. These operators are called Big Memory Operators (BMOs). Because of the BMOs, RMS provides OPERATOR statistics, which provide a richer set of statistics so that the current state of a query can be determined at any time.

With OPERATOR statistics, all SQL operators are instrumented and the following statistics are collected:

- Node time spent in the operator
- Actual number of rows flowing to the parent operator
- Estimated number of rows flowing to the parent operator (estimated by the optimizer)
- Virtual memory used in the BMO
- Amount of data overflowed to scratch files and read back to the query

For more information, see [Displaying SQL Runtime Statistics](#).

9.2. Adaptive Statistics Collection

The SQL database engine chooses the appropriate statistics collection type based on the type of query. By default, the SQL database engine statistics collection is OPERATOR statistics. You can view the statistics in different formats: PERTABLE, ACCUMULATED, PROGRESS, and DEFAULT. Statistics Collection is adaptive to ensure that sufficient statistics information is available without

causing any performance impact to the query's execution. For some queries, either no statistics or PERTABLE statistics are collected.

Query Type	Statistics Collection Type
OLT optimized queries	PERTABLE
Unique queries	PERTABLE
CQD	No statistics
SET commands	No statistics
EXPLAIN	No statistics
GET STATISTICS	No statistics
All other queries	DEFAULT

9.3. Retrieving SQL Runtime Statistics

9.3.1. Using the GET STATISTICS Command

The GET STATISTICS command shows statistical information for:

- A single query ID (QID)
- Active queries for a process ID (PID)
- RMS itself

A query is considered active if either compilation or execution is in progress. In the case of a SELECT statement, a query is in execution until the statement or result set is closed. Logically, a query is considered to be active when the compile end time is -1 and the compile start time is not -1, or when the execute end time is -1 and the execute start time is not -1.

9.3.2. Syntax of GET STATISTICS

```
GET STATISTICS FOR QID { query-id | CURRENT } [stats-view-type]
    | PID { process-name | [ nodeid, pid ] } [ ACTIVE n ][ stats-view-type ]
    | RMS node-num | ALL [ RESET ]

stats-view-type is:
ACCUMULATED | PERTABLE | PROGRESS | DEFAULT
```

- QID

Required keyword if requesting statistics for a specific query.

- *query-id*

is the query ID. You must put the *query-id* in double quotes if the user name in the query ID contains lower case letters or if the user name contains a period.



The *query-id* is a unique identifier for the SQL statement generated when the query is compiled (prepared). The *query-id* is visible for queries executed through certain TrafCI commands.

- CURRENT

provides statistics for the most recently prepared or executed statement in the same session where you run the GET STATISTICS FOR QID CURRENT command. You must issue the GET STATISTICS FOR QID CURRENT command immediately after the PREPARE or EXECUTE statement.

- **PID**

Required keyword if requesting statistics for an active query in a given process.

- *process-name*

is the name of the process ID (PID) in the format: \$Z_nnn_. The process name can be for the master (MXOSRVR) or executor server process (ESP). If the process name corresponds to the ESP, the ACTIVE *n* query is just the _n_th query in that ESP and might not be the currently active query in the ESP.

- **ACTIVE *n***

describes which of the active queries for which RMS returns statistics. ACTIVE 1 is the default. ACTIVE 1 returns statistics for the first active query. ACTIVE 2 returns statistics for the second active query.

- *stats-view-type*

sets the statistics view type to a different format. Statistics are collected at the operator level by default. For exceptions, see [Adaptive Statistics Collection](#).

- **ACCUMULATED**

causes the statistics to be displayed in an aggregated summary across all tables in the query.

- **PERTABLE**

displays statistics for each table in the query. This is the default *stats-view-type* although statistics are collected at the operator level. If the collection occurs at a lower level due to Adaptive Statistics, the default is the lowered collection level. For more information, see [Adaptive Statistics Collection](#).

- **progress**

displays rows of information corresponding to each of the big memory operators (BMO) operators involved in the query, in addition to pertable *stats-view-type*. For more information about BMOs, see [Pertable and Operator Statistics](#).

- **PROGRESS**

displays rows of information corresponding to each of the big memory operators (BMO) operators involved in the query, in addition to pertable *stats-view-type*. For more information about BMOs, see [Pertable and Operator Statistics](#).

- **default**

displays statistics in the same way as it is collected.

- RMS

required keyword if requesting statistics about RMS itself.

- *node-num*

returns the statistics about the RMS infrastructure for a given node.

- ALL

returns the statistics about the RMS infrastructure for every node in the cluster.

- RESET

resets the cumulative RMS statistics counters.

9.3.3. Examples of GET STATISTICS

These examples show the runtime statistics that various get statistics commands return. for more information about the runtime statistics and RMS counters, see [Displaying SQL Runtime Statistics](#).

- This GET STATISTICS command returns PERTABLE statistics for the most recently executed statement in the same session:

```
SQL> GET STATISTICS FOR QID CURRENT;

Qid
MXID1100801837021216821167247667200000000030000_59_SQL_CUR_6
Compile Start Time      2011/03/30 07:29:15.332216
Compile End Time        2011/03/30 07:29:15.339467
Compile Elapsed Time   0:00:00.007251
Execute Start Time     2011/03/30 07:29:15.383077
Execute End Time       2011/03/30 07:29:15.470222
Execute Elapsed Time   0:00:00.087145
State                  CLOSE
Rows Affected          0
SQL Error Code         100
Stats Error Code       0
Query Type             SQL_SELECT_NON_UNIQUE Estimated Accessed Rows 0
Estimated Used Rows    0
Parent Qid              NONE
Child Qid              NONE
Number of SQL Processes 1
Number of Cpus           1
Execution Priority      -1
Transaction Id          -1
Source String            SELECT
```

```
CUR_SERVICE , PLAN , TEXT , CUR_SCHEMA , RULE_NAME , APPL_NAME , SESSION_NAME , DSN_NAME , ROLE_NAME  
, DEFAULT_SCHEMA_ACCESS_ONLY  
FROM(VALUES(CAST('HP_DEFAULT_SERVICE' as VARCHAR(50)),CAST(0 AS INT),CAST(0 AS  
INT),CAST('NEO.USR' as  
VARCHAR(260)),CAST('' as VARCHAR(  
SQL Source Length      548  
Rows Returned          1  
First Row Returned Time 2011/03/30 07:29:15.469778  
Last Error before AQR   0  
Number of AQR retries   0  
Delay before AQR        0  
No. of times reclaimed  0  
Stats Collection Type   OPERATOR_STATS  
SQL Process Busy Time   0  
UDR Process Busy Time   0  
SQL Space Allocated     32 KB  
SQL Space Used          3 KB  
SQL Heap Allocated      7 KB  
SQL Heap Used           1 KB  
EID Space Allocated     0 KB  
EID Space Used          0 KB  
EID Heap Allocated      0 KB  
EID Heap Used           0 KB  
Processes Created        0  
Process Create Time      0  
Request Message Count    0  
Request Message Bytes    0  
Reply Message Count      0  
Reply Message Bytes      0  
Scr. Overflow Mode       DISK  
Scr File Count           0  
Scr. Buffer Blk Size     0  
Scr. Buffer Blks Read    0  
Scr. Buffer Blks Written 0  
Scr. Read Count          0  
Scr. Write Count          0  
  
--- SQL operation complete.
```

- This GET STATISTICS command returns PERTABLE statistics for the specified query ID (note that this command should be issued in the same session):

```

SQL> GET STATISTICS FOR QID
+> "MXID110080051792121681875280726720000000030000_48_SQL_CUR_2"
+> ;

Qid
MXID110080051792121681875280726720000000030000_48_SQL_CUR_2
Compile Start Time      2011/03/30 00:53:21.382211
Compile End Time        2011/03/30 00:53:22.980201
Compile Elapsed Time    0:00:01.597990
Execute Start Time     2011/03/30 00:53:23.079979
Execute End Time       -1
Execute Elapsed Time   7:16:13.494563
State                  OPEN
Rows Affected          -1
SQL Error Code         0
Stats Error Code       0
Query Type             SQL_SELECT_NON_UNIQUE
Estimated Accessed Rows 2,487,984
Estimated Used Rows    2,487,984
Parent Qid              NONE
Child Qid              NONE
Number of SQL Processes 129
Number of Cpus           9
Execution Priority      -1
Transaction Id          34359956800
Source String            select count(*) from
MANAGEABILITY.INSTANCE_REPOSITORY.EVENTS_TEXT K,
MANAGEABILITY.INSTANCE_REPOSITORY.EVENTS_TEXT J,
MANAGEABILITY.INSTANCE_REPOSITORY.EVENTS_TEXT H,
MANAGEABILITY.INSTANCE_REPOSITORY.EVENTS_TEXT G
SQL Source Length        220
Rows Returned           0
First Row Returned Time -1
Last Error before AQR   0
Number of AQR retries   0
Delay before AQR         0
No. of times reclaimed  0
Stats Collection Type    OPERATOR_STATS
SQL Process Busy Time   830,910,830,000
UDR Process Busy Time   0
SQL Space Allocated     179,049          KB
SQL Space Used           171,746          KB
SQL Heap Allocated       1,140,503         KB
SQL Heap Used            1,138,033         KB
EID Space Allocated      46,080          KB
EID Space Used           42,816          KB
EID Heap Allocated       18,624          KB
EID Heap Used             192          KB
Processes Created        32

```

Process Create Time	799,702
Request Message Count	202,214
Request Message Bytes	27,091,104
Reply Message Count	197,563
Reply Message Bytes	1,008,451,688
Scr. Overflow Mode	DISK
Scr. File Count	0
Scr. Buffer Blk Size	0
Scr. Buffer Blks Read	0
Scr. Buffer Blks Written	0
Scr. Read Count	0
Scr. Write Count	0

Table Name

Disk Process	Open	Open	Records Accessed	Records Used	Disk	Message	Message	Lock	Lock
Estimated/Actual	Estimated/Actual	Estimated/Actual	I/Os	Count	Bytes	Escl	wait		
Busy Time	Count	Time							
MANAGEABILITY.INSTANCE_REPOSITORY.EVENTS_TEXT(H)									
621,996			621,996						
621,998			621,998	0	441	10,666,384	0	0	0
303,955	32	15,967							
MANAGEABILITY.INSTANCE_REPOSITORY.EVENTS_TEXT(J) 621,996 621,996									
621,996			621,996						
621,998			621,998	0	439	10,666,384	0	0	0
289,949	32	19,680							
MANAGEABILITY.INSTANCE_REPOSITORY.EVENTS_TEXT(K) 621,996 621,996									
621,996			621,996						
621,998			621,998	0	439	10,666,384	0	0	0
301,956	32	14,419							
MANAGEABILITY.INSTANCE_REPOSITORY.EVENTS_TEXT(G)									
0			621,996						
0			0	0	192	4,548,048	0	0	0
0	32	40,019							

--- SQL operation complete.

- This GET STATISTICS command returns ACCUMULATED statistics for the most recently executed statement in the same session:

```
SQL> GET STATISTICS FOR QID CURRENT ACCUMULATED;

Qid
MXID1100802517321216821277534304000000000340000_957_SQL_CUR_6
Compile Start Time      2011/03/30 08:05:07.646667
Compile End Time        2011/03/30 08:05:07.647622
Compile Elapsed Time   0:00:00.000955
Execute Start Time     2011/03/30 08:05:07.652710
Execute End Time       2011/03/30 08:05:07.740461
Execute Elapsed Time   0:00:00.087751
State                  CLOSE
Rows Affected          0
SQL Error Code         100
Stats Error Code       0
Query Type             SQL_SELECT_NON_UNIQUE
Estimated Accessed Rows 0
Estimated Used Rows    0
Parent Qid              NONE
Child Qid              NONE
Number of SQL Processes 0
Number of Cpus          0
Execution Priority     -1
Transaction Id          -1
Source String           SELECT
CUR_SERVICE,PLAN,TEXT,CUR_SCHEMA,RULE_NAME,APPL_NAME,SESSION_NAME,DSN_NAME,ROLE_NAME
,DEFAULT_SCHEMA_ACCESS_ONLY
FROM(VALUES(CAST('HP_DEFAULT_SERVICE' as VARCHAR(50)),CAST(0 AS INT),CAST(0 AS
INT),CAST('NEO.SCH' as
VARCHAR(260)),CAST('' as VARCHAR(
SQL Source Length        548
Rows Returned            1
First Row Returned Time  2011/03/30 08:05:07.739827
Last Error before AQR    0
Number of AQR retries    0
Delay before AQR          0
No. of times reclaimed   0
Stats Collection Type     OPERATOR_STATS
Accessed Rows              0
Used Rows                  0
Message Count              0
Message Bytes              0
Stats Bytes                0
Disk IOs                   0
Lock Waits                 0
Lock Escalations            0
Disk Process Busy Time    0
SQL Process Busy Time     0
UDR Process Busy Time     0
SQL Space Allocated        32
                                         KB
```

SQL Space Used	3	KB
SQL Heap Allocated	7	KB
SQL Heap Used	1	KB
EID Space Allocated	0	KB
EID Space Used	0	KB
EID Heap Allocated	0	KB
EID Heap Used	0	KB
Opens	0	
Open Time	0	
Processes Created	0	
Process Create Time	0	
Request Message Count	0	
Request Message Bytes	0	
Reply Message Count	0	
Reply Message Bytes	0	
Scr. Overflow Mode	UNKNOWN	
Scr. File Count	0	
Scr. Buffer Blk Size	0	
Scr. Buffer Blks Read	0	
Scr. Buffer Blks Written	0	
Scr. Read Count	0	
Scr. Write Count	0	

--- SQL operation complete.

- These GET STATISTICS commands return PERTABLE statistics for the first active query in the specified process ID:

```
SQL> GET STATISTICS FOR PID 0,27195;
SQL> GET STATISTICS FOR PID $Z000F3R;
```

9.4. Displaying SQL Runtime Statistics

By default, GET STATISTICS displays table-wise statistics (PERTABLE). If you want to view the statistics in a different format, use the appropriate view option of the GET STATISTICS command.

RMS provides abbreviated statistics information for prepared statements and full runtime statistics for executed statements.

The following table shows the RMS counters that are returned by GET STATISTICS, tokens from the STATISTICS table-valued function that relate to the RMS counters, and descriptions of the counters and tokens.

Counter Name	Tokens in STATISTICS Table-Valued Function	Description
Qid	Qid	A unique ID generated for each query. Each time a SQL statement is prepared, a new query ID is generated.
Compile Start Time	CompStartTime	Time when the query compilation started or time when PREPARE for this query started.
Compile End Time	CompEndTime	Time when the query compilation ended or time when PREPARE for this query ended.
Compile Elapsed Time	CompElapsedTime	Amount of actual time to prepare the query.
Execute Start Time	ExeStartTime	Time when query execution started.
Execute End Time	ExeEndTime	Time when query execution ended. When a query is executing, Execute End Time is -1.
Execute Elapsed Time	ExeElapsedTime	Amount of actual time used by the SQL executor to execute the query.
State	State	Internally used.
Rows Affected	RowsAffected	Represents the number of rows affected by the INSERT, UPDATE, or DELETE (IUD) SQL statements. Value of -1 for SELECT statements or non-IUD SQL statements.
SQL Error Code	SQLErrorCode	Top-level error code returned by the query, indicating whether the query completed with warnings, errors, or successfully. A positive number indicates a warning. A negative number indicates an error. The value returned may not be accurate up to the point GET STATISTICS was executed.
Stats Error Code	StatsErrorCode	Error code returned to the statistics collector while obtaining statistics from RMS. If an error code, counter values may be incorrect. Reissue the GET STATISTICS command.

Counter Name	Tokens in STATISTICS Table-Valued Function	Description
Query Type	Estimated Accessed Rows	Type of DML statement and enum value: - SQL_SELECT_UNIQUE=1 - SQL_SELECT_NON_UNIQUE=2 - SQL_INSERT_UNIQUE=3 - SQL_INSERT_NON_UNIQUE=4 - SQL_UPDATE_UNIQUE=5 - SQL_UPDATE_NON_UNIQUE=6 - SQL_DELETE_UNIQUE=7 - SQL_DELETE_NON_UNIQUE=8 - SQL_CONTROL=9 - SQL_SET_TRANSACTION=10 - SQL_SET_CATALOG=11 - SQL_SET_SCHEMA=12 - SQL_CALL_NO_RESULT_SETS=13 - SQL_CALL_WITH_RESULT_SETS=14 - SQL_SP_RESULT_SET=15 - SQL_INSERT_ROWSET_SIDETREE=16 - SQL_CAT_UTIL=17 - SQL_EXE_UTIL=18 - SQL_OTHER=1 - SQL_UNKNOWN=0
QueryType	EstRowsAccessed	Compiler's estimated number of rows accessed by the executor in TSE.
Estimated Used Rows	EstRowsUsed	Compiler's estimated number of rows returned by the executor in TSE after applying the predicates.
Parent Qid	parentQid	A unique ID for the parent query. If there is no parent query ID associated with the query, RMS returns NONE. For more information, see Using the Parent Query ID .
Child Qid	childQid	A unique ID for the child query. If there is no child query, then there will be no child query ID and RMS returns NONE. For more information, see Child Query ID .
Number of SQL Processes	numSqlProcs	Represents the number of SQL processes (excluding TSE processes) involved in executing the query.
Number of CPUs	numCpus	Represents the number of nodes that SQL is processing the query.
Transaction ID	transId	Represents the transaction ID of the transaction involved in executing the query. When no transaction exists, the Transaction ID is -1.
Source String	sqlSrc	Contains the first 254 bytes of source string.
SQL Source Length	sqlSrcLen	The actual length of the SQL source string.
Rows Returned	rowsReturned	Represents the number of rows returned from the root operator at the master executor process.
First Row Returned Time	firstRowReturnTime	Represents the actual time that the first row is returned by the master root operator.
Last Error Before AQR	LastErrorBeforeAQR	The error code that triggered Automatic Query Retry (AQR) for the most recent retry. If the value is not 0, this is the error code that triggered the most recent AQR.
Number of AQR retries	AQRNumRetries	The number of retries for the current query until now.
Delay before AQR	DelayBeforeAQR	Delay in seconds that SQL waited before initiating AQR.

Counter Name	Tokens in STATISTICS Table-Valued Function	Description
No. of times reclaimed	reclaimSpaceCnt	When a process is under virtual memory pressure, the execution space occupied by the queries executed much earlier will be reclaimed to free up space for the upcoming queries. This counter represents how many times this particular query is reclaimed.
	statsRowType	statsRowType can be one of the following: - SQLSTATS_DESC_OPER_STATS=0 - SQLSTATS_DESC_ROOT_OPER_STATS=1 - SQLSTATS_DESC_PERTABLE_STATS=11 - SQLSTATS_DESC_UDR_STATS=13 - SQLSTATS_DESC_MASTER_STATS=15 - SQLSTATS_DESC_RMS_STATS=16 - SQLSTATS_DESC_BMO_STATS=17
Stats Collection Type	StatsType	Collection type, which is OPERATOR_STATS by default. StatsType can be one of the following: - SQLCLI_NO_STATS=0 - SQLCLI_ACCUMULATED_STATS=2 - SQLCLI_PERTABLE_STATS=3 - SQLCLI_OPERATOR_STATS=5
Accessed Rows (Rows Accessed)	AccessedRows	Actual number of rows accessed by the executor in TSE.
Used Rows (Rows Used)	UsedRows	Number of rows returned by TSE after applying the predicates. In a push down plan, TSE may not return all the used rows.
Message Count	NumMessages	Count of the number of messages sent to TSE.
Message Bytes	MessageBytes	Count of the message bytes exchanged with TSE.
Stats Bytes	StatsBytes	Number of bytes returned for statistics counters from TSE.
Disk IOs	DiskIOs	Number of physical disk reads for accessing the tables.
Lock Waits	LockWaits	Number of times this statement had to wait on a conflicting lock.
Lock Escalations	Escalations	Number of times row locks escalated to a file lock during the execution of this statement.
Disk Process Busy Time	ProcessBusyTime	An approximation of the total node time in microseconds spent by TSE for executing the query.
SQL Process Busy Time	CpuTime	An approximation of the total node time in microseconds spent in the master and ESPs involved in the query.
UDR Process Busy Time (same as UDR CPU Time)	udrCpuTime	An approximation of the total node time in microseconds spent in the UDR server process.
UDR Server ID	UDRServerId	MXUDR process ID.
Recent Request Timestamp		Actual timestamp of the recent request sent to MXUDR.
Recent Reply Timestamp		Actual timestamp of the recent request received by MXUDR.
SQL Space Allocated ¹	SpaceTotal ¹	The amount of "space" type of memory in KB allocated in the master and ESPs involved in the query.
SQL Space Used ¹	SpaceUsed ¹	Amount of "space" type of memory in KB used in master and ESPs involved in the query.
SQL Heap Allocated ²	HeapTotal ²	Amount of "heap" type of memory in KB allocated in master and ESPs involved in the query.

Counter Name	Tokens in STATISTICS Table-Valued Function	Description
SQL Heap Used ²	HeapUsed ²	Amount of "heap" type of memory in KB used in master and ESPs involved in the query.
EID Space Allocated ¹	Dp2SpaceTotal	Amount of "space" type of memory in KB allocated in the executor in TSEs involved in the query.
EID Space Used ¹	Dp2SpaceUsed	Amount of "space" type of memory in KB used in the executor in TSEs involved in the query.
EID Heap Allocated ²	Dp2HeapTotal	Amount of "heap" memory in KB allocated in the executor in TSEs involved in the query.
EID Heap Used ²	Dp2HeapUsed	Amount of "heap" memory in KB used in the executor in TSEs involved in the query.
Opens	Opens	Number of OPEN calls performed by the SQL executor on behalf of this statement.
Open Time	OpenTime	Time (in microseconds) this process spent doing opens on behalf of this statement.
Processes Created	Newprocess	The number of processes (ESPs and MXCMPs) created by the master executor for this statement.
Process Create Time	NewprocessTime	The elapsed time taken to create these processes.
Table Name	AnsiName	Name of a table in the query.
Request Message Count	reqMsgCnt	Number of messages initiated from the master to ESPs or from the ESP to ESPs.
Request Message Bytes	regMsgBytes	Number of message bytes that are sent from the master to ESPs or from the ESP to ESPs as part of the request messages.
Reply Message Count	replyMsgCnt	Number of reply messages from the ESPs for the message requests.
Reply Message Bytes	replyMsgBytes	Number of bytes sent as part of the reply messages.
Scr. Overflow Mode	scrOverFlowMode	Represents the scratch overflow mode. Modes are DISK_TYPE or SSD_TYPE.
Scr. File Count	scrFileCount	Number of scratch files created to execute the query. Default file size is 2 GB.
Scr. Buffer Blk Size	scrBufferBlockSize	Size of buffer block that is used to read from/write to the scratch file.
Scr. Buffer Blks Read	scrBufferRead	Number of scratch buffer blocks read from the scratch file.
Scr. Buffer Blks Written	scrBufferWritten	Number of scratch buffer blocks written to the scratch file. Exact size of scratch file can be obtained by multiplying Scr. Buffer Blk Size by this counter.
Scr. Read Count	scrReadCount	Number of file-system calls involved in reading buffer blocks from scratch files. One call reads multiple buffer blocks at once.
Scr. Write Count	scrWriteCount	Number of file-system calls involved in writing buffer blocks to scratch files. One call writes multiple buffer blocks at once.
BMO Heap Used	bmoHeapUsed	Amount of "heap" type of memory in KB used in the BMO operator(s). The BMO operators are HASH_JOIN (and all varieties of HASH_JOIN), HASH_GROUPBY (and all varieties of HASH_GROUPBY), and SORT (and all varieties of SORT).

Counter Name	Tokens in STATISTICS Table-Valued Function	Description
BMO Heap Total	bmoHeapTotal	Amount of "heap" type of memory in KB allocated in the BMO operator(s).
BMO Heap High Watermark	bmoHeapWM	Maximum amount of memory used in the BMO operator.
BMO Space Buffer Size	bmoSpaceBufferSize	Size in KB for space buffers allocated for the type of memory.
BMO Space Buffer Count	bmoSpaceBufferCount	Count of space buffers allocated for the type of memory.
Records Accessed (Estimated / Actual)		Actual number of rows accessed by the executor in TSE.
Records Used (Estimated / Actual)		Number of rows returned by TSE after applying the predicates. In a push-down plan, TSE may not return all the used rows.
ID		TDB ID of the operator at the time of execution of the query.
LCID		Left child operator ID.
RCID		Right child operator ID.
PaID		Parent operator ID (TDB-ID).
ExID		Explain plan operator ID.
Frag		Fragment ID to which this operator belongs.
Dispatches		Number of times the operator is scheduled in SQL executor.
Oper CPU Time	OperCpuTime	Approximation of the node time spent by the operator to execute the query.
Est. Records Used		Approximation of the number of tuples that would flow up to the parent operator.
Act. Records Used		Actual number of tuples that flowed up to the parent operator.
	ProcessId	Name of the process ID (PID) in the format: \$Znnn. The process name can be for the master (MXOSRVR) or executor server process (ESP).

1. Space is memory allocated from a pool owned by the executor. The executor operators requesting the memory are not expected to return the memory until the statement is deallocated.
2. Heap memory is used for temporary allocations. Operators may return heap memory before the statement is deallocated. This allows the memory to be reused as needed.

9.4.1. Examples of Displaying SQL Runtime Statistics



Some of the output has been reformatted for better document readability.

Statistics of a Prepared Statement

- This example shows the output of the currently prepared statement:

```
SQL> GET STATISTICS FOR QID CURRENT;

Qid                      MXID1100000649721215837305997952000000001930000_4200_Q1
Compile Start Time        2010/12/06 10:55:40.931000
Compile End Time          2010/12/06 10:55:42.131845
Compile Elapsed Time     0:00:01.200845
ExecuteStart Time         -1
Execute End Time          -1
Execute Elapsed Time     0:00:00.000000
State                     CLOSE
Rows Affected             -1
SQL Error Code            0
Stats Error Code          0
Query Type                SQL_SELECT_NON_UNIQUE
Estimated Accessed Rows   100,010
Estimated Used Rows       100,010
Parent Qid                 NONE
Child Qid                  NONE
Number of SQL Processes    0
Number of Cpus              0
Execution Priority         -1
Transaction Id             -1
Source String               select * from t100k where b in (select b from t10)
SQL Source Length          50
Rows Returned              0
First Row Returned Time    -1
Last Error before AQR      0
Number of AQR retries      0
Delay before AQR            0
No. of times reclaimed     0
Stats Collection Type      OPERATOR_STATS
--- SQL operation complete.
```

9.4.2. PERTABLE Statistics of an Executing Statement

- This example shows the PERTABLE statistics of an executing statement:

```
SQL> GET STATISTICS FOR QID CURRENT;

Qid                                MXID1100000649721215837305997952000000001930000_4200_Q1
Compile Start Time                  2010/12/06 10:55:40.931000
Compile End Time                   2010/12/06 10:55:42.131845
Compile Elapsed Time                0:00:01.200845
Execute Start Time                 2010/12/06 10:56:16.254686
Execute End Time                   2010/12/06 10:56:18.434873
Execute Elapsed Time                0:00:02.180187
State                               CLOSE
Rows Affected                      0
SQL Error Code                     100
Stats Error Code                   0
Query Type                          SQL_SELECT_NON_UNIQUE
Estimated Accessed Rows            100,010
Estimated Used Rows                100,010
Parent Qid                          NONE
Child Qid                           NONE
Number of SQL Processes            7
Number of Cpus                      1
Execution Priority                 -1
Transaction Id                     18121
Source String                       select * from t100k where b in (select b from t10)
SQL Source Length                  50
Rows Returned                      100
First Row Returned Time            2010/12/06 10:56:18.150977
Last Error before AQR              0
Number of AQR retries              0
Delay before AQR                   0
No. of times reclaimed            0
Stats Collection Type              OPERATOR_STATS
SQL Process Busy Time              600,000
UDR Process Busy Time              0
SQL Space Allocated                1,576          KB
SQL Space Used                     1,450          KB
SQL Heap Allocated                 199           KB
SQL Heap Used                      30            KB
EID Space Allocated                704           KB
EID Space Used                     549           KB
EID Heap Allocated                 582           KB
EID Heap Used                      6             KB
Processes Created                  4
Process Create Time                 750,762
Request Message Count              701
Request Message Bytes              135,088
Reply Message Count                 667
Reply Message Bytes                3,427,664
Scr. Overflow Mode                 DISK
```

```

Scr File Count      0
Scr. Buffer Blk Size  0
Scr. Buffer Blks Read   0
Scr. Buffer Blks Written 0

```

Table Name

Disk Process	Records Accessed Open	Records Used Open	Disk	Message Count	Message Bytes	Lock Escl	Lock wait
Estimated/Actual Busy Time	Estimated/Actual Count	Time	I/Os				
NEO.SCTEST.T10							
	10	10	0	2	5,280	0	0
2,000	32	15,967					
NEO.SCTEST.T100K							
	100,000	100,000	0	110	3,235,720	0	0
351,941	4	48,747					

--- SQL operation complete.

9.4.3. ACCUMULATED Statistics of an Executing Statement

- This example shows the ACCUMULATED statistics of an executing statement:

```
SQL> GET STATISTICS FOR QID CURRENT ACCUMULATED;

Qid                                MXID1100000649721215837305997952000000001930000_4200_Q1
Compile Start Time                  2010/12/06 10:55:40.931000
Compile End Time                   2010/12/06 10:55:42.131845
Compile Elapsed Time                0:00:01.200845
Execute Start Time                 2010/12/06 10:56:16.254686
Execute End Time                   2010/12/06 10:56:18.434873
Execute Elapsed Time                0:00:02.180187
State                               CLOSE
Rows Affected                      0
SQL Error Code                     100
Stats Error Code                   0
Query Type                          SQL_SELECT_NON_UNIQUE
Estimated Accessed Rows            100,010
Estimated Used Rows                100,010
Parent Qid                          NONE
Child Qid                           NONE
Number of SQL Processes            7
Number of Cpus                      1
Execution Priority                 -1
Transaction Id                     18121
Source String                       select * from t100k where b in (select b from t10)
SQL Source Length                  50
Rows Returned                      100
First Row Returned Time           2010/12/06 10:56:18.150977
Last Error before AQR              0
Number of AQR retries              0
Delay before AQR                   0
No. of times reclaimed            0
Stats Collection Type              OPERATOR_STATS
Accessed Rows                      100,010
Used Rows                           100,010
Message Count                       112
Message Bytes                      3,241,000
Stats Bytes                         2,904
Disk IOs                            0
Lock Waits                          0
Lock Escalations                   0
Disk Process Busy Time             353,941
SQL Process Busy Time              600,000
UDR Process Busy Time              0
SQL Space Allocated                1,576          KB
SQL Space Used                     1,450          KB
SQL Heap Allocated                 199           KB
SQL Heap Used                      30            KB
EID Space Allocated                704           KB
EID Space Used                     549           KB
```

EID Heap Allocated	582	KB
EID Heap Used	6	KB
Opens	4	
Open Time	48,747	
Processes Created	4	
Process Create Time	750,762	
Request Message Count	701	
Request Message Bytes	135,088	
Reply Message Count	667	
Reply Message Bytes	3,427,664	
Scr. Overflow Mode	DISK	
Scr. File Count	0	
Scr. Buffer Blk Size	0	
Scr. Buffer Blks Read	0	
Scr. Buffer Blks Written	0	
--- SQL operation complete.		

9.4.4. PROGRESS Statistics of an Executing Statement

- This example shows the PROGRESS statistics of an executing statement:

```
SQL> GET STATISTICS FOR QID CURRENT PROGRESS;

Qid                                MXID1100000649721215837305997952000000001930000_4200_Q1
Compile Start Time                  2010/12/06 10:55:40.931000
Compile End Time                   2010/12/06 10:55:42.131845
Compile Elapsed Time                0:00:01.200845
Execute Start Time                 2010/12/06 10:56:16.254686
Execute End Time                   2010/12/06 10:56:18.434873
Execute Elapsed Time                0:00:02.180187
State                               CLOSE
Rows Affected                      0
SQL Error Code                     100
Stats Error Code                   0
Query Type                          SQL_SELECT_NON_UNIQUE
Estimated Accessed Rows            100,010
Estimated Used Rows                100,010
Parent Qid                          NONE
Child Qid                           NONE
Number of SQL Processes            7
Number of Cpus                      1
Execution Priority                 -1
Transaction Id                     18121
Source String                       select * from t100k where b in (select b from t10)
SQL Source Length                  50
Rows Returned                      100
First Row Returned Time           2010/12/06 10:56:18.150977
Last Error before AQR              0
Number of AQR retries              0
Delay before AQR                   0
No. of times reclaimed            0
Stats Collection Type              OPERATOR_STATS
SQL Process Busy Time              600,000
SQL Space Allocated                1,576          KB
SQL Space Used                     1,450          KB
SQL Heap Allocated                 199           KB
SQL Heap Used                      30            KB
EID Space Allocated                704           KB
EID Space Used                     549           KB
EID Heap Allocated                 582           KB
EID Heap Used                      6             KB
Processes Created                  4
Process Create Time                750,762
Request Message Count              701
Request Message Bytes              135,088
Reply Message Count                667
Reply Message Bytes                3,427,664
Table Name
  Records Accessed                Records Used   Disk      Message      Message      Lock      Lock

```

Disk	Process	Open Estimated/Actual	Open Estimated/Actual	I/Os	Count	Bytes	Escl	wait
Busy	Time	Count	Time					
NEO.SCTEST.T10								
		10		10				
		10		10	0	2	5,280	0
2,000		0	0					
NEO.SCTEST.T100K								
		100,000		100,000				
		100,000		100,000	0	110	3,235,720	0
351,941		4	48,747					
Id	TDB	Mode	Phase	Phase	BMO	BMO	BMO	BMO
Buffer		Cpu			BMO	BMO	BMO	File
Name		Phase		Start	Heap	Heap	Space	Scratch
Size/Read/Written			Time		Time	Used	Total	
16	EX_HASHJ	DISK		0	0	56	0	BufSz
60,000							-1	BufCnt
							0	0

9.4.5. DEFAULT Statistics of an Executing Statement

- This example shows the DEFAULT statistics of an executing statement:

```
SQL> GET STATISTICS FOR QID CURRENT DEFAULT;

Qid                                MXID1100000649721215837305997952000000001930000_4200_Q1
Compile Start Time                  2010/12/06 10:55:40.931000
Compile End Time                   2010/12/06 10:55:42.131845
Compile Elapsed Time                0:00:01.200845
Execute Start Time                 2010/12/06 10:56:16.254686
Execute End Time                   2010/12/06 10:56:18.434873
Execute Elapsed Time                0:00:02.180187
State                               CLOSE
Rows Affected                      0
SQL Error Code                     100
Stats Error Code                   0
Query Type                          SQL_SELECT_NON_UNIQUE
Estimated Accessed Rows             100,010
Estimated Used Rows                100,010
Parent Qid                          NONE
Child Qid                           NONE
Number of SQL Processes            7
Number of Cpus                      1
Execution Priority                 -1
Transaction Id                     18121
Source String                       select * from t100k where b in (select b from t10)
SQL Source Length                  50
Rows Returned                      100
First Row Returned Time           2010/12/06 10:56:18.150977
Last Error before AQR              0
Number of AQR retries              0
Delay before AQR                   0
No. of times reclaimed            0
Stats Collection Type              OPERATOR_STATS
```

Id	LCId	RCId	Paid	ExId	Frag	TDB	Name	Dispatches	Oper CPU	Records	
										Time	Est.
Used Details											
21	20	.	.	10	0	EX_ROOT		15	0	0	0
100											
20	19	.	21	9	0	EX_SPLIT_TOP		13	0	100	
100											
19	18	.	20	9	0	EX_SEND_TOP		20	0	100	
100											
18	17	.	19	9	2	EX_SEND_BOTTOM		72	0	100	
100											
17	16	.	18	9	2	EX_SPLIT_BOTTOM		88	0	100	
100											
16	15	.	17	8	2	EX_HASHJ		1,314	60,000	100	
100											

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15	14	.	16	7	2	EX_SPLIT_TOP	1,343	20,000	100,000
100,000									
14	13	.	15	7	2	EX_SEND_TOP	1,342	120,000	100,000
100,000									
13	12	.	14	7	5	EX_SEND_BOTTOM	1,534	200,000	100,000
100,000									
12	11	.	13	7	5	EX_SPLIT_BOTTOM	493	70,000	100,000
100,000									
11	10	.	12	6	5	EX_SPLIT_TOP	486	70,000	100,000
100,000									
10	9	.	11	5	5	EX_PARTN_ACCESS	1,634	60,000	100,000
0									
9	8	.	10	5	6	EX_EID_ROOT	12	0	100,000
100,000									
8	7	.	9	4	6	EX_DP2_SUBS_OPER	160	170,000	100,000
10									
7	6	.	8	3	2	EX_SPLIT_TOP	16	0	10
10									
6	5	.	7	3	2	EX_SEND_TOP	17	0	10
10									
5	4	.	6	3	3	EX_SEND_BOTTOM	17	0	10
10									
4	3	.	5	3	3	EX_SPLIT_BOTTOM	9	0	10
10									
3	2	.	4	2	3	EX_PARTN_ACCESS	6	0	10
10									
2	1	.	3	2	4	EX_EID_ROOT	3	0	10
0									
1	.	.	1	1	4	EX_DP2_SUBS_OPER	3	100,000	10
10									

--- SQL operation complete.

9.4.6. Using the Parent Query ID

When executed, some SQL statements execute additional SQL statements, resulting in a parent-child relationship. For example, when executed, the UPDATE STATISTICS, MAINTAIN, and CALL statements execute other SQL statements called child queries. The child queries might execute even more child queries, thus introducing a hierarchy of SQL statements with parent-child relationships. The parent query ID maps the child query to the immediate parent SQL statement, helping you to trace the child SQL statement back to the user-issued SQL statement.

The parent query ID is available as a counter, Parent Qid, in the runtime statistics output. See Table 1-1 . A query directly issued by a user will not have a parent query ID and the counter will indicate "None."

9.4.7. Child Query ID

In many cases, a child query will execute in the same node as its parent. In such cases, the GET STATISTICS report on the parent query ID will contain a query ID value for the child query which executed most recently. Conversely, if no child query exists, or the child query is executing in a different node, no child query ID will be reported.

The following examples shows GET STATISTICS output for both the parent and one child query which are executed when the user issues a CREATE TABLE AS command:

```

SQL> -- get statistics for the parent query

SQL> GET STATISTICS FOR QID
+> MXID01001091200212164828759544076000000000217DEFAULT_MXCI_USER00_34SQLCI_DML_LAST
+> ;

Qid
MXID11001091200212164828759544076000000000217DEFAULT_MXCI_USER00_34SQLCI_DML_LAST
Compile Start Time      2011/02/18 14:49:04.606513
Compile End Time        2011/02/18 14:49:04.631802
Compile Elapsed Time   0:00:00.025289
Execute Start Time     2011/02/18 14:49:04.632142
Execute End Time       -1
Execute Elapsed Time   0:03:29.473604
State                  CLOSE
Rows Affected          -1
SQL Error Code         0
Stats Error Code       0
Query Type             SQL_INSERT_NON_UNIQUE
Estimated Accessed Rows 0
Estimated Used Rows    0
Parent Qid              NONE
Child Qid
MXID11001091200212164828759544076000000000217DEFAULT_MXCI_USER00_37_86
Number of SQL Processes 1
Number of Cpus          1
Execution Priority     148
Transaction Id         -1
Source String           create table odetail hash partition by (ordernum, partnum)
as select * from SALES.ODETAIL;
SQL Source Length       91
Rows Returned          0
First Row Returned Time -1
Last Error before AQR   0
Number of AQR retries   0
Delay before AQR        0
No. of times reclaimed 0
Stats Collection Type   OPERATOR_STATS

Id  LCId  RCId  PaId  ExId  Frag  TDB  Name          Dispatches  Oper CPU  Records
Records
Details
2   1     .     .     2     0     EX_ROOT          0          0     0     0
1   .     .     2     1     0     CREATE_TABLE_AS  0          0     0     0
Time Est.  Used Act.  Used
--- SQL operation complete.

```

```

SQL> -- get statistics for the child query
SQL> GET STATISTICS FOR QID
+> MXID11001091200212164828759544076000000000217DEFAULT_MXCI_USER00_37_86
+> ;

Qid
MXID1001091200212164828759544076000000000217DEFAULT_MXCI_USER00_37_86
Compile Start Time      2011/02/18 14:49:07.632898
Compile End Time        2011/02/18 14:49:07.987334
Compile Elapsed Time    0:00:00.354436
Execute Start Time     2011/02/18 14:49:07.987539
Execute End Time       -1
Execute Elapsed Time   0:02:33.173486
State                  OPEN
Rows Affected          -1
SQL Error Code         0
Stats Error Code       0
Query Type             SQL_INSERT_NON_UNIQUE
Estimated Accessed Rows 101
Estimated Used Rows    101
Parent Qid
MXID101001091200212164828759544076000000000217DEFAULT_MXCI_USER00_34SQLCI_DML_LAST
Child Qid              NONE
Number of SQL Processes 1
Number of Cpus          1
Execution Priority     148
Transaction Id          \ARC0101(2).9.9114503
Source String           insert using sideinserts into CAT.SCH.ODETAIL select * from
SALES.ODETAIL;
SQL Source Length       75
Rows Returned          0
First Row Returned Time -1
Last Error before AQR   0
Number of AQR retries   0
Delay before AQR        0
No. of times reclaimed 0
Stats Collection Type   OPERATOR_STATS

Id  LCId  RCId  PaId  ExId  Frag  TDB  Name          Dispatches  Oper  CPU  Records
Records
Time  Est.  Used  Act.  Used
Details
4    3      .    9      3      0    EX_SPLIT_TOP      1          10,062      100      0
3    2      .    4      2      0    EX_PARTN_ACCESS  66          9,649      100      0

--- SQL operation complete.

```

9.5. Gathering Statistics About RMS

Use the GET STATISTICS FOR RMS command to get information about RMS itself. The GET STATISTICS FOR RMS statement can be used to retrieve information about one node or all nodes. An individual report is provided for each node.

Counter	Description
CPU	The node number of the Trafodion cluster.
RMS Version	Internal version of RMS.
SSCP PID	SQL Statistics control process ID.
SSCP Creation Timestamp	Actual timestamp when SQL statistics control process was created.
SSMP PID	SQL statistics merge process ID.
SSMP Creation Timestamp	Timestamp when SQL statistics merge was created.
Source String Store Len	Storage length of source string.
Stats Heap Allocated	Amount of memory allocated by all the queries executing in the given node in the RMS shared segments at this instance of time.
Stats Heap Used	Amount of memory used by all the queries executing in the given node in the RMS shared segment at this instance of time.
Stats Heap High WM	High amount of memory used by all the queries executing in the given node in the RMS shared segment until now.
No. of Process Regd.	Number of processes registered in the shared segment.
No. of Query Fragments Regd.	Number of query fragments registered in the shared segment.
RMS Semaphore Owner	Process ID that locked the semaphore at this instance of time.
No. of SSCP Opened	Number of Statistics Control Processes opened. Normally, this should be equal to the number of nodes in the Trafodion cluster.
No. of SSCP Open Deleted	Number of Statistics Control Processes with broken communication. Usually, this should be 0.
Last GC Time	The recent timestamp at which the shared segment was garbage collected.
Queries GCed in Last Run	Number of queries that were garbage collected in the recent GC run.
Total Queries GCed	Total number of queries that were garbage collected since the statistics reset timestamp.
SSMP Request Message Count	Count of the number of messages sent from the SSMP process since the statistics reset timestamp.
SSMP Request Message Bytes	Number of messages bytes that are sent as part of the request from the SSMP process since the statistics reset timestamp.
SSMP Reply Message Count	Count of the number of reply messages received by the SSMP process since the statistics reset timestamp.
SSMP Reply Message Bytes	Number of messages bytes that are sent as part of the reply messages received by the SSMP process since the statistics reset timestamp.
SSCP Request Message Count	Count of the number of messages sent from the SSCP process since the statistics reset timestamp.
SSCP Request Message Bytes	Number of messages bytes are sent as part of the request from the SSCP process since the statistics reset timestamp.
SSCP Reply Message Count	Count of the number of reply messages received by the SSCP process since the statistics reset timestamp.
SSCP Reply Message Bytes	Number of messages bytes that are sent as part of the reply messages received by the SSCP process since the statistics reset timestamp.

Counter	Description
RMS Stats Reset Timestamp	Timestamp for resetting RMS statistics.
<pre>SQL> GET STATISTICS FOR RMS ALL;</pre>	
Node name	
CPU	0
RMS Version	2511
SSCP PID	19521
SSCP Priority	0
SSCP Creation Timestamp	2010/12/05 02:32:33.642752
SSMP PID	19527
SSMP Priority	0
SSMP Creation Timestamp	2010/12/05 02:32:33.893440
Source String Store Len	254
Stats Heap Allocated	0
Stats Heap Used	3,002,416
Stats Heap High WM	3,298,976
No.of Process Regd.	157
No.of Query Fragments Regd.	296 RMS Semaphore Owner -1
No.of SSCP Opened	1
No.of SSCP Open Deleted	0
Last GC Time	2010/12/06 10:53:46.777432
Queries GCed in Last Run	55
Total Queries GCed	167
SSMP Request Message Count	58,071
SSMP Request Message Bytes	14,161,144
SSMP Reply Message Count	33,466
SSMP Reply Message Bytes	15,400,424
SSCP Request Message Count	3,737
SSCP Request Message Bytes	837,744
SSCP Reply Message Count	3,736 SSCP
Reply Message Bytes	5,015,176
RMS Stats Reset Timestamp	2010/12/05 14:32:33.891083
<pre>--- SQL operation complete.</pre>	

9.6. Using the QUERYID_EXTRACT Function

Use the QUERYID_EXTRACT function within an SQL statement to extract components of a query ID for use in a SQL query. The query ID, or QID, is a unique, cluster-wide identifier for a query and is generated for dynamic SQL statements whenever a SQL string is prepared.

9.6.1. Syntax of QUERYID_EXTRACT

```
QUERYID_EXTRACT ( 'query-id' , 'attribute' )
```

The syntax of the QUERYID_EXTRACT function is:

- *query-id*

is the query ID in string format.

- *attribute*

is the attribute to be extracted. The value of *attribute* can be one of these parts of the query ID:

Attribute Value	Description
SEGMENTNUM	Logical node ID in Trafodion cluster
CPUNUM or CPU	Logical node ID in Trafodion cluster
PIN	Linux process ID number
EXESTARTTIME	Executor start time
SESSIONNUM	Session number
USERNAME	User name
SESSIONNAME	Session name
SESSIONID	Session ID
QUERYNUM	Query number
STMTNAME	Statement ID or handle



The SEGMENTNUM and CPUNUM attributes are the same.

The result data type of the QUERYID_EXTRACT function is a VARCHAR with a length sufficient to hold the result. All values are returned in string format. Here is the QUERYID_EXTRACT function in a SELECT statement:

```
SELECT QUERYID_EXTRACT( '_query-id_ ' , '_attribute-value_ ' ) FROM (VALUES(1)) AS t1;
```

9.6.2. Examples of QUERYID_EXTRACT

- This command returns the node number of the query ID:

```
SQL> SELECT
  +> SUBSTR(
  +>   QUERYID_EXTRACT(
  +>     'MXID11000022675212170554548762240000000000206U6553500_21_S1' , 'CPU'
  +>   ), 1, 20
  +> ) FROM (VALUES(1))
  +> AS t1;

(EXPR)
-----
0

--- 1 row(s) selected.
```

- This command returns the PIN of the query ID:

```
SQL> SELECT
  +> SUBSTR(
  +>   QUERYID_EXTRACT(
  +>     'MXID11000022675212170554548762240000000000206U6553500_21_S1' , 'PIN'
  +>   ), 1, 20
  +> ) FROM (VALUES(1)) AS t1;

(EXPR)
-----
22675

--- 1 row(s) selected.
```

9.7. Statistics for Each Fragment-Instance of an Active Query

You can retrieve statistics for a query while it executes by using the STATISTICS table-valued function. Depending on the syntax used, you can obtain statistics summarizing each parallel fragment-instance of the query, or for any operator in each fragment-instance.

9.7.1. Syntax of STATISTICS Table-Valued Function

```
TABLE(STATISTICS (NULL, 'qid-str'))
qid-str is:
    QID=query-id [ ,{ TDBID_DETAIL=tdb-id | DETAIL=1 } ]
```

- *query-id*

is the system-generated query ID. For example:

```
QID=MXID11000022675212170554548762240000000000206U6553500_21_S1
```

- *tdb-id*

is the TDB ID of a given operator. TDB values can be obtained from the report returned from the GET STATISTICS command.

9.7.2. Considerations For Obtaining Statistics For Each Fragment-Instance of an Active Query

If the DETAIL=1 or TDBID_DETAIL=*tdb_id* options are used when the query is not executing, the STATISTICS table-valued function will not return any results.

The STATISTICS table-valued function can be used with a SELECT statement to return several columns. Many different counters exist in the *variable_info* column. The counters in this column are formatted as token-value pairs and the counters reported will depend on which option is used: DETAIL=1 or TDBID_DETAIL=*tdb_id*. If the TDBID_DETAIL option is used, the counters reported will also depend on the type of operator specified by the *tdb_id*. The reported counters can also be determined by the statsRowType counter.

The tokens for these counters are listed in the column [Displaying SQL Runtime Statistics](#),[Displaying SQL Runtime Statistics>>](#).

- This query lists process names of all ESPs of an executing query identified by the given QID:

```
SQL> SELECT
+> SUBSTR(VARIABLE_INFO,
+> POSITION('ProcessId:' IN variable_info), 20) AS processes
+>FROM
+>TABLE(statistics(NULL,
+>'QID=MXID1100003268421217081158116067200000000206U6553500_19_S1,DETAIL=1' ))
+>GROUP BY 1;

PROCESSES
-----
ProcessId: $Z0000GS
ProcessId: $Z0000GT
ProcessId: $Z0000GU
ProcessId: $Z0000GV
ProcessId: $Z0102IQ
ProcessId: $Z000RNU
ProcessId: $Z0102IR
ProcessId: $Z0102IS
ProcessId: $Z0102IT

--- 9 row(s) selected.
```

- This query gives BMO heap used for the hash join identified as TDB #15 in an executing query identified by the given QID:

```
SQL>SELECT CAST (
  +> SUBSTR(variable_info,
  +> POSITION('bmoHeapUsed:' IN variable_info),
  +> POSITION('bmoHeapUsed:' in variable_info) +
  +> 13 + (POSITION(' ' IN
  +> SUBSTR(variable_info,
  +> 13 + POSITION('bmoHeapUsed:' IN variable_info))) -
  +> POSITION('bmoHeapUsed:' IN variable_info)))
  +> AS CHAR(25))
  +> FROM TABLE(statistics(NULL,
  +>'QID=MXID1100002170621217073391150416000000000206U6553500_25_S1,TDBID_DETAIL=15'))
);

(EXPR)
-----
bmoHeapUsed: 3147
--- 8 row(s) selected.
```

Chapter 10. Reserved Words

The words listed in this appendix are reserved for use by Trafodion SQL. To prevent syntax errors, avoid using these words as identifiers in Trafodion SQL. In Trafodion SQL, if an operating system name contains a reserved word, you must enclose the reserved word in double quotes ("") to access that column or object.



In Trafodion SQL, ABSOLUTE, DATA, EVERY, INITIALIZE, OPERATION, PATH, SPACE, STATE, STATEMENT, STATIC, and START are not reserved words.

Trafodion SQL treats these words as reserved when they are part of Trafodion SQL stored text. They cannot be used as identifiers unless you enclose them in double quotes.

10.1. Reserved SQL Identifiers: A

ACTION	ADD	ADMIN	AFTER	AGGREGATE
ALIAS		ALL	ALLOCATE	ALTER
AND	ANY	ARE	ARRAY	AS
ASC	ASSERTION	ASYNC	AT	AUTHORIZATION

10.2. Reserved SQL Identifiers: B

BEFORE	BEGIN	BETWEEN	BINARY	BIT
BIT_LENGTH	BLOB	BOOLEAN	BOTH	BREADTH
BY				

10.3. Reserved SQL Identifiers: C

CALL	CASCADE	CASCADED	CASE	CAST
CATALOG	CHAR	CHARACTER	CHARACTER_LENGTH	CHAR_LENGTH
CHECK	CLASS	CLOB	CLOSE	COALESCE
COLLATE	COLLATION	COLUMN	COMMIT	COMPLETION
CONNECT	CONNECTION	CONSTRAINT	CONSTRAINTS	CONSTRUCTOR
CONTINUE	CONVERT	CORRESPONDING	COUNT	CREATE
CROSS	CUBE	CURRENT	CURRENT_DATE	CURRENT_PATH
CURRENT_ROLE	CURRENT_TIME	CURRENT_TIMESTAMP	CURRENT_USER	CURRNT_USR_INTN
CURSOR	CYCLE			

10.4. Reserved SQL Identifiers: D

DATE	DATETIME	DAY	DEALLOCATE	DEC
DECIMAL	DECLARE	DEFAULT	DEFERRABLE	DEFERRED
DELETE	DEPTH	DEREF	DESC	DESCRIBE
_DESCRIPTOR	DESTROY	DESTRUCTOR	DETERMINISTIC	DIAGNOSTICS
DICTIONARY	DISCONNECT	DISTINCT	DOMAIN	DOUBLE
DROP	DYNAMIC			

10.5. Reserved SQL Identifiers: E

EACH	ELSE	ELSEIF	END	END-EXEC
EQUALS	ESCAPE	EXCEPT	EXCEPTION	EXEC
EXECUTE	EXISTS	EXTERNAL	EXTRACT	

10.6. Reserved SQL Identifiers: F

FALSE	FETCH	FIRST	FLOAT	FOR
FOREIGN	FOUND	FRACTION	FREE	FROM
FULL	FUNCTION			

10.7. Reserved SQL Identifiers G

GENERAL	GET	GLOBAL	GO	GOTO
GRANT	GROUP	GROUPING		

10.8. Reserved SQL Identifiers: H

10.9. Reserved SQL Identifiers: I

IDENTITY	IF	IGNORE	IMMEDIATE	IN
INDICATOR	INITIALLY	INNER	INOUT	INPUT
INSENSITIVE	INSERT	INT	INTEGER	INTERSECT
INTERVAL	INTO	IS	ISOLATION	ITERATE

10.10. Reserved SQL Identifiers J

10.11. Reserved SQL Identifiers: K

10.12. Reserved SQL Identifiers: L

LANGUAGE	LARGE	LAST	LATERAL	LEADING
LEAVE	LEFT	LESS	LEVEL	LIKE
LIMIT	LOCAL	LOCALTIME	LOCALTIMESTAMP	LOCATOR
LOOP	LOWER			

10.13. Reserved SQL Identifiers: M

MAINTAIN	MAP	MATCH	MATCHED	MAX
MERGE	MIN	MINUTE	MODIFIES	MODIFY
MODULE	MONTH			

10.14. Reserved SQL Identifiers: N

NAMES	NATIONAL	NATURAL	NCHAR	NCLOB
NEW	NEXT	NO	NONE	NOT
NULL	NULLIF	NUMERIC		

10.15. Reserved SQL Identifiers: O

OCTET_LENGTH	OF	OFF	OID	OLD
ON	ONLY	OPEN	OPERATORS	OPTION
OPTIONS	OR	ORDER	ORDINALITY	OTHERS
OUT	OUTER	OUTPUT	OVERLAPS	

10.16. Reserved SQL Identifiers: P

PAD	PARAMETER	PARAMETERS	PARTIAL	PENDANT
POSITION	POSTFIX	PRECISION	PREFIX	PREORDER
PREPARE	PRESERVE	PRIMARY	PRIOR	PRIVATE
PRIVILEGES	PROCEDURE	PROTECTED	PROTOTYPE	PUBLIC

10.17. Reserved SQL Identifiers: Q

10.18. Reserved SQL Identifiers: R

READ	READS	REAL	RECURSIVE	REF
REFERENCES	REFERENCING	RELATIVE	REORG	REORGANIZE
REPLACE	RESIGNAL	RESTRICT	RESULT	RETURN
RETURNS	REVOKE	RIGHT	ROLLBACK	ROLLUP
ROUTINE	ROW	ROWS		

10.19. Reserved SQL Identifiers: S

SAVEPOINT	SCHEMA	SCOPE	SCROLL	SEARCH
SECOND	SECTION	SELECT	SENSITIVE	SESSION
SESSION_USER	SESSN_USR_INTN	SET	SETS	SIGNAL
SIMILAR	SIZE	SMALLINT	SOME	SPECIFIC
SPECIFICTYPE	SQL	SQL_CHAR	SQL_DATE	SQL_DECIMAL
SQL_DOUBLE	SQL_FLOAT	SQL_INTEGER	SQL_REAL	
SQL_SMALLINT	SQL_TIME	SQL_TIMESTAMP	SQL_VARCHAR	SQLCODE
SQLERROR	SQLEXCEPTION	SQLSTATE	SQLWARNING	STRUCTURE
SUBSTRING	SUM	SYNONYM	SYSTEM_USER	

10.20. Reserved SQL Identifiers: T

TABLE	TEMPORARY	TERMINATE	TEST	THAN
THEN	THERE	TIME	TIMESTAMP	TIMEZONE_HOUR
TIMEZONE_MINUTE	TO	TRAILING	TRANSACTION	TRANSLATE
TRANSLATION	TRANSPOSE	TREAT	TRIGGER	TRIM
TRUE				

10.21. Reserved SQL Identifiers: U

UNDER	UNION	UNIQUE	UNKNOWN	UNNEST
UPDATE	UPPER	UPSHIFT	USAGE	USER
USING				

10.22. Reserved SQL Identifiers: V

VALUE	VALUES	VARCHAR	VARIABLE	VARYING
VIEW	VIRTUAL	VISIBLE		

10.23. Reserved SQL Identifiers: W

WAIT	WHEN	WHENEVER	WHERE	WHILE
WITH	WITHOUT	WORK	WRITE	

10.24. Reserved SQL Identifiers Y

10.25. Reserved SQL Identifiers: Z

Chapter 11. Limits

This section lists limits for various parts of Trafodion SQL.

Column Names	Up to 128 characters long, or 256 bytes of UTF8 text, whichever is less.
Schema Names	Up to 128 characters long, or 256 bytes of UTF8 text, whichever is less.
Table Names	ANSI names are of the form <i>schema.object</i> , where each part can be up to 128 characters long, or 256 bytes of UTF8 text, whichever is less.