



# Firebird 2.5 Language Reference Update

*Everything new in Firebird SQL since InterBase 6*

Paul Vinkenoog et al.

18 Oct 2011, document version 1.2 — covers Firebird 2.5 and 2.5.1

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# Table of Contents

1. Introduction .....	1
Subject matter .....	1
Versions covered .....	1
Authorship .....	2
Acknowledgments .....	2
2. New in Firebird 2.5 .....	3
Reserved words and keywords .....	3
Miscellany .....	3
Data types and subtypes .....	3
Data Definition Language (DDL) .....	4
Data Manipulation Language (DML) .....	4
PSQL statements .....	4
Security and access control .....	4
Context variables .....	5
Operators and predicates .....	5
Aggregate functions .....	5
Internal functions .....	5
3. Reserved words and keywords .....	6
Added since InterBase 6 .....	6
Newly reserved words .....	6
New non-reserved keywords .....	7
Dropped since InterBase 6 .....	9
No longer reserved, still keywords .....	9
No longer reserved, not keywords .....	10
Possibly reserved in future versions .....	12
4. Miscellaneous language elements .....	13
-- (single-line comment) .....	13
Hexadecimal notation for numerals .....	13
Hexadecimal notation for “binary” strings .....	14
Shorthand datetime casts .....	15
CASE construct .....	16
Simple CASE .....	16
Searched CASE .....	16
5. Data types and subtypes .....	18
BIGINT data type .....	18
BLOB data type .....	18
Text BLOB support in functions and operators .....	18
Various enhancements .....	19
SQL_NULL data type .....	19
Rationale .....	20
Use in practice .....	21
New character sets .....	21
Character set NONE handling changed .....	22
New collations .....	23
Unicode collations for all character sets .....	24
6. DDL statements .....	25
CHARACTER SET .....	25
ALTER CHARACTER SET .....	25
COLLATION .....	25

CREATE COLLATION .....	25
DROP COLLATION .....	28
COMMENT .....	28
DATABASE .....	29
CREATE DATABASE .....	29
ALTER DATABASE .....	30
DOMAIN .....	31
CREATE DOMAIN .....	31
ALTER DOMAIN .....	32
EXCEPTION .....	32
CREATE EXCEPTION .....	32
CREATE OR ALTER EXCEPTION .....	33
RECREATE EXCEPTION .....	33
EXTERNAL FUNCTION .....	34
DECLARE EXTERNAL FUNCTION .....	34
ALTER EXTERNAL FUNCTION .....	34
FILTER .....	35
DECLARE FILTER .....	35
INDEX .....	36
CREATE INDEX .....	36
PROCEDURE .....	38
CREATE PROCEDURE .....	38
ALTER PROCEDURE .....	41
CREATE OR ALTER PROCEDURE .....	42
DROP PROCEDURE .....	43
RECREATE PROCEDURE .....	43
SEQUENCE or GENERATOR .....	43
CREATE SEQUENCE .....	43
CREATE GENERATOR .....	44
ALTER SEQUENCE .....	44
SET GENERATOR .....	45
DROP SEQUENCE .....	45
DROP GENERATOR .....	46
TABLE .....	46
CREATE TABLE .....	46
ALTER TABLE .....	51
RECREATE TABLE .....	55
TRIGGER .....	55
CREATE TRIGGER .....	55
ALTER TRIGGER .....	59
CREATE OR ALTER TRIGGER .....	61
DROP TRIGGER .....	61
RECREATE TRIGGER .....	62
VIEW .....	62
CREATE VIEW .....	62
ALTER VIEW .....	65
CREATE OR ALTER VIEW .....	65
RECREATE VIEW .....	65
7. DML statements .....	67
DELETE .....	67
COLLATE subclause for text BLOB columns .....	67
ORDER BY .....	68

PLAN .....	68
Relation alias makes real name unavailable .....	68
RETURNING .....	68
ROWS .....	69
EXECUTE BLOCK .....	69
COLLATE in variable and parameter declarations .....	71
NOT NULL in variable and parameter declarations .....	72
Domains instead of data types .....	72
TYPE OF COLUMN in parameter and variable declarations .....	73
EXECUTE PROCEDURE .....	73
INSERT .....	74
INSERT ... DEFAULT VALUES .....	75
RETURNING clause .....	75
UNION allowed in feeding SELECT .....	76
MERGE .....	76
SELECT .....	77
Aggregate functions: Extended functionality .....	77
[AS] before relation alias .....	79
COLLATE subclause for text BLOB columns .....	80
Common Table Expressions (“WITH ... AS ... SELECT”) .....	80
Derived tables (“SELECT FROM SELECT”) .....	82
FIRST and SKIP .....	83
GROUP BY .....	85
HAVING: Stricter rules .....	86
JOIN .....	86
ORDER BY .....	88
PLAN .....	91
Relation alias makes real name unavailable .....	92
ROWS .....	92
UNION .....	93
WITH LOCK .....	94
UPDATE .....	95
Changed SET semantics .....	95
COLLATE subclause for text BLOB columns .....	96
ORDER BY .....	96
PLAN .....	97
Relation alias makes real name unavailable .....	97
RETURNING .....	97
ROWS .....	98
UPDATE OR INSERT .....	98
8. Transaction control statements .....	100
RELEASE SAVEPOINT .....	100
ROLLBACK .....	100
ROLLBACK RETAIN .....	100
ROLLBACK TO SAVEPOINT .....	101
SAVEPOINT .....	101
Internal savepoints .....	102
Savepoints and PSQL .....	103
SET TRANSACTION .....	103
IGNORE LIMBO .....	104
LOCK TIMEOUT .....	104
NO AUTO UNDO .....	104

9. PSQL statements .....	106
BEGIN ... END blocks may be empty .....	106
BREAK .....	106
CLOSE cursor .....	107
DECLARE .....	107
DECLARE ... CURSOR .....	107
DECLARE [VARIABLE] with initialization .....	108
DECLARE with DOMAIN instead of datatype .....	109
TYPE OF COLUMN in variable declaration .....	109
COLLATE in variable declaration .....	110
NOT NULL in variable declaration .....	110
EXCEPTION .....	111
Rethrowing a caught exception .....	111
Providing a custom error message .....	111
EXECUTE PROCEDURE .....	112
EXECUTE STATEMENT .....	112
No data returned .....	113
One row of data returned .....	114
Any number of data rows returned .....	114
Improved performance .....	115
WITH {AUTONOMOUS COMMON} TRANSACTION .....	115
WITH CALLER PRIVILEGES .....	115
ON EXTERNAL [DATA SOURCE] .....	115
AS USER, PASSWORD and ROLE .....	117
Parameterized statements .....	118
Caveats with EXECUTE STATEMENT .....	119
EXIT .....	120
FETCH cursor .....	120
FOR EXECUTE STATEMENT ... DO .....	120
FOR SELECT ... INTO ... DO .....	120
AS CURSOR clause .....	122
IN AUTONOMOUS TRANSACTION .....	122
LEAVE .....	123
OPEN cursor .....	124
PLAN allowed in trigger code .....	124
Subqueries as PSQL expressions .....	125
UDFs callable as void functions .....	125
WHERE CURRENT OF valid again for view cursors .....	125
10. Security and access control .....	126
ALTER ROLE .....	126
GRANT and REVOKE .....	126
GRANTED BY .....	126
REVOKE ALL ON ALL .....	127
REVOKE ADMIN OPTION .....	128
The RDB\$ADMIN role .....	128
In normal databases .....	129
In the security database .....	129
AUTO ADMIN MAPPING .....	130
In normal databases .....	130
In the security database .....	131
SQL user management commands .....	131
CREATE USER .....	131

ALTER USER .....	132
DROP USER .....	132
11. Context variables .....	133
CURRENT_CONNECTION .....	133
CURRENT_ROLE .....	133
CURRENT_TIME .....	134
CURRENT_TIMESTAMP .....	134
CURRENT_TRANSACTION .....	135
CURRENT_USER .....	135
DELETING .....	136
GDSCODE .....	136
INSERTING .....	137
NEW .....	137
'NOW' .....	137
OLD .....	138
ROW_COUNT .....	139
SQLCODE .....	139
SQLSTATE .....	140
UPDATING .....	141
12. Operators and predicates .....	142
NULL literals allowed as operands .....	142
(string concatenator) .....	142
Text BLOB concatenation .....	142
Result type VARCHAR or BLOB .....	142
Overflow checking .....	143
ALL .....	143
NULL literals allowed .....	143
UNION as subselect .....	143
ANY / SOME .....	143
NULL literals allowed .....	143
UNION as subselect .....	143
IN .....	144
NULL literals allowed .....	144
UNION as subselect .....	144
IS [NOT] DISTINCT FROM .....	144
NEXT VALUE FOR .....	145
SIMILAR TO .....	145
Building regular expressions .....	147
SOME .....	150
13. Aggregate functions .....	151
LIST() .....	151
MAX() .....	151
MIN() .....	152
14. Internal functions .....	153
ABS() .....	153
ACOS() .....	153
ASCII_CHAR() .....	154
ASCII_VAL() .....	154
ASIN() .....	155
ATAN() .....	155
ATAN2() .....	156
BIN_AND() .....	156

BIN_OR()	157
BIN_SHL()	157
BIN_SHR()	157
BIN_XOR()	158
BIT_LENGTH()	158
CAST()	159
CEIL(), CEILING()	162
CHAR_LENGTH(), CHARACTER_LENGTH()	162
CHAR_TO_UUID()	163
COALESCE()	164
COS()	164
COSH()	165
COT()	165
DATEADD()	165
DATEDIFF()	166
DECODE()	167
EXP()	168
EXTRACT()	168
MILLISECOND	169
WEEK	170
FLOOR()	170
GEN_ID()	170
GEN_UUID()	171
HASH()	171
IIF()	172
LEFT()	172
LN()	173
LOG()	173
LOG10()	174
LOWER()	174
LPAD()	175
MAXVALUE()	176
MINVALUE()	176
MOD()	177
NULLIF()	177
OCTET_LENGTH()	178
OVERLAY()	178
PI()	180
POSITION()	180
POWER()	181
RAND()	181
RDB\$GET_CONTEXT()	182
RDB\$SET_CONTEXT()	183
REPLACE()	184
REVERSE()	185
RIGHT()	185
ROUND()	186
RPAD()	187
SIGN()	188
SIN()	188
SINH()	189
SQRT()	189



SUBSTRING()	190
TAN()	191
TANH()	191
TRIM()	191
TRUNC()	192
UPPER()	193
UUID_TO_CHAR()	194
15. External functions (UDFs)	195
abs	195
acos	195
addDay	196
addHour	196
addMilliSecond	197
addMinute	197
addMonth	198
addSecond	198
addWeek	198
addYear	199
ascii_char	199
ascii_val	200
asin	201
atan	201
atan2	202
bin_and	202
bin_or	203
bin_xor	203
ceiling	203
cos	204
cosh	204
cot	205
dow	205
dpower	206
floor	206
getExactTimestamp	207
i64round	207
i64truncate	207
ln	207
log	208
log10	208
lower	209
lpad	210
ltrim	211
mod	212
*nullif	212
*nvl	213
pi	214
rand	214
right	215
round, i64round	215
rpad	216
rtrim	217
sdow	218

sign .....	218
sin .....	219
sinh .....	219
sqrt .....	220
srand .....	220
sright .....	220
string2blob .....	221
strlen .....	221
substr .....	222
substrlen .....	223
tan .....	224
tanh .....	224
truncate, i64truncate .....	225
Appendix A: Notes .....	227
Character set NONE data accepted “as is” .....	227
Understanding the WITH LOCK clause .....	228
Syntax and behaviour .....	228
How the engine deals with WITH LOCK .....	229
The optional “OF <column-names>” sub-clause .....	230
Caveats using WITH LOCK .....	230
Examples using explicit locking .....	230
A note on CSTRING parameters .....	230
Passing NULL to UDFs in Firebird 2 .....	231
“Upgrading” ib_udf functions in an existing database .....	232
Maximum number of indices in different Firebird versions .....	232
The RDB\$VALID_BLR field .....	233
Appendix B: Reserved words and keywords – full lists .....	234
Reserved words .....	234
Keywords .....	237
Appendix C: Document History .....	245
Appendix D: License notice .....	251

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## List of Tables

5.1. Character sets new in Firebird .....	21
5.2. Collations new in Firebird .....	23
6.1. Specific collation attributes .....	26
6.2. Maximum indexable (VAR)CHAR length .....	37
6.3. Max. indices per table, Firebird 2.0 .....	37
7.1. NULLs placement in ordered columns .....	90
12.1. Comparison of [NOT] DISTINCT to “=” and “<>” .....	145
14.1. Possible CASTs .....	160
14.2. Types and ranges of EXTRACT results .....	169
14.3. Context variables in the SYSTEM namespace .....	182
A.1. How TPB settings affect explicit locking .....	228
A.2. Max. indices per table in Firebird 1.0 – 2.0 .....	232

# Introduction

## Subject matter

What's this book about?

This guide documents the **changes** made in the Firebird SQL language between InterBase 6 and Firebird 2.5.1. It covers the following areas:

- Reserved words
- Data types and subtypes
- DDL statements (Data Definition Language)
- DML statements (Data Manipulation Language)
- Transaction control statements
- PSQL statements (Procedural SQL, used in stored procedures and triggers)
- Security and access control statements
- Context variables
- Operators and predicates
- Aggregate functions
- Internal functions
- UDFs (User Defined Functions, also known as external functions)

To have a complete Firebird 2.5 SQL reference, you need:

- The InterBase 6.0 beta SQL Reference (`LangRef.pdf` and/or `SQLRef.html`)
- This document

Non-SQL topics are **not** discussed in this document. These include:

- ODS versions
- Bug listings
- Installation and configuration
- Upgrade, migration and compatibility
- Server architectures
- API functions
- Connection protocols
- Tools and utilities

Consult the Release Notes for information on these subjects. You can find the Release Notes and other documentation via the Firebird Documentation Index at <http://www.firebirdsql.org/en/documentation/>.

## Versions covered

This document covers all Firebird versions up to and including 2.5.1.

## Authorship

Most of this document was written by the main author. The remainder (2–3%) was lifted from various Firebird Release Notes editions, which in turn contain material from preceding sources like the Whatsnew documents. Authors and editors of the included material are:

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- Adriano dos Santos Fernandes
- Dmitry Yemanov

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## Chapter 2

# New in Firebird 2.5

For users upgrading from Firebird 2.1, this chapter lists the SQL additions and changes in Firebird 2.5 and 2.5.1, with links to the corresponding sections. If you come from an earlier version or are new to Firebird, you may want to [skip this chapter](#).

## Reserved words and keywords

Changed since Firebird 2.1:

- **Newly reserved words:** SIMILAR, SQLSTATE (2.5.1).
- **New non-reserved keywords:** AUTONOMOUS, BIN\_NOT, CALLER, CHAR\_TO\_UUID, COMMON, DATA, FIRSTNAME, GRANTED, LASTNAME, MAPPING, MIDDLENAME, OS\_NAME, SOURCE, TWO\_PHASE and UUID\_TO\_CHAR.
- **No longer reserved, but still keywords:** ACTIVE, AFTER, ASC, ASCENDING, AUTO, BEFORE, COLLATION, COMMITTED, COMPUTED, CONDITIONAL, CONTAINING, CSTRING, DATABASE, DESC, DESCENDING, DESCRIPTOR, DO, DOMAIN, ENTRY\_POINT, EXCEPTION, EXIT, FILE, GEN\_ID, GENERATOR, IF, INACTIVE, INPUT\_TYPE, ISOLATION, KEY, LENGTH, LEVEL, MANUAL, MODULE\_NAME, NAMES, OPTION, OUTPUT\_TYPE, OVERFLOW, PAGE, PAGE\_SIZE, PAGES, PASSWORD, PRIVILEGES, PROTECTED, READ, RESERV, RESERVING, RETAIN, SCHEMA, SEGMENT, SHADOW, SHARED, SINGULAR, SIZE, SNAPSHOT, SORT, STABILITY, STARTING, STARTS, STATEMENT, STATISTICS, SUB\_TYPE, SUSPEND, TRANSACTION, UNCOMMITTED, WAIT, WORK and WRITE.
- **No longer reserved and not keywords:** AUTODDL, BASE\_NAME, BASED, BLOBEDIT, BUFFER, CHECK\_POINT\_LENGTH, COMPILETIME, CONTINUE, DB\_KEY, DEBUG, DESCRIBE, DISPLAY, ECHO, EDIT, EVENT, EXTERN, FOUND, GOTO, GROUP\_COMMIT\_, HELP, IMMEDIATE, INDICATOR, INIT, INPUT, ISQL, LC\_MESSAGES, LC\_TYPE, LEV, LOG\_BUFFER\_SIZE, MAX\_SEGMENT, MAXIMUM, MESSAGE, MINIMUM, NOAUTO, NUM\_LOG\_BUFFERS, OUTPUT, PAGELength, PREPARE, PUBLIC, QUIT, RETURN, RUNTIME, SHELL, SHOW, SQLERROR, SQLWARNING, STATIC, TERMINATOR, TRANSLATE, TRANSLATION, VERSION, WAIT\_TIME and WHENEVER.

## Miscellany

Changed since Firebird 2.1:

- [Hexadecimal notation for numerals](#)
- [Hexadecimal notation for “binary” strings](#)

## Data types and subtypes

Changed since Firebird 2.1:

- SQL\_NULL data type
- GB18030 character set, WIN\_1258 alias
- UNICODE\_CI\_AI collation for UTF8, GB18030 collation for GB18030

## Data Definition Language (DDL)

Changed since Firebird 2.1:

- ALTER CHARACTER SET (set default collation for charset)
- NUMERIC-SORT attribute for Unicode collations
- Default collation for the database
- Classic Server: Altered procedure immediately visible to other clients
- ALTER COLUMN also for generated (computed) columns
- ALTER COLUMN ... TYPE no longer fails if column is used in trigger or SP
- Views can select from stored procedures
- Views can infer column names from derived tables or GROUP BY
- Column list for UNION-based views no longer mandatory
- ALTER VIEW
- CREATE OR ALTER VIEW

## Data Manipulation Language (DML)

Changed since Firebird 2.1:

- UPDATE statement: changed SET semantics

## PSQL statements

Changed since Firebird 2.1:

- TYPE OF COLUMN in variable and parameter declarations
- EXECUTE STATEMENT:
  - Improved performance
  - WITH {AUTONOMOUS|COMMON} TRANSACTION
  - WITH CALLER PRIVILEGES
  - ON EXTERNAL [DATA SOURCE]
  - AS USER, PASSWORD and ROLE
  - Parameterized statements
- IN AUTONOMOUS TRANSACTION
- Subqueries as PSQL expressions

## Security and access control

Changed since Firebird 2.1:

- ALTER ROLE
- GRANTED BY clause
- REVOKE ALL ON ALL
- The RDB\$ADMIN role
- AUTO ADMIN MAPPING
- SQL user management commands:
  - CREATE USER
  - ALTER USER
  - DROP USER

## Context variables

Changed since Firebird 2.1:

- SQLCODE deprecated (2.5.1)
- SQLSTATE context variable (2.5.1)

## Operators and predicates

Changed since Firebird 2.1:

- SIMILAR TO: Regular expressions

## Aggregate functions

Changed since Firebird 2.1:

- LIST() separator may be any string expression

## Internal functions

Changed since Firebird 2.1:

- CAST() as TYPE OF COLUMN
- DATEADD: New unit WEEK. Sub-DAY units allowed with DATES.
- DATEDIFF: New unit WEEK. Sub-DAY units allowed with DATES.
- CHAR\_TO\_UUID()
- LOG() behaviour improved
- LOG10() behaviour improved
- LPAD() now returns VARCHAR of exact end length
- RPAD() now returns VARCHAR of exact end length
- UUID\_TO\_CHAR()



---

## Chapter 3

# Reserved words and keywords

Reserved words are part of the Firebird SQL language. They cannot be used as identifiers (e.g. as table or procedure names), except when enclosed in double quotes in Dialect 3. However, you should avoid this unless you have a compelling reason.

Keywords are also part of the language. They have a special meaning when used in the proper context, but they are not reserved for Firebird's own and exclusive use. You can use them as identifiers without double-quoting.

The following sections present the changes since InterBase 6. Full listings of Firebird 2.5 reserved words and keywords can be found in the [Appendix](#).

## Added since InterBase 6

### *Newly reserved words*

The following reserved words have been added to Firebird:

- BIGINT
- BIT\_LENGTH
- BOTH
- CASE
- CLOSE
- CONNECT
- CROSS
- CURRENT\_CONNECTION
- CURRENT\_ROLE
- CURRENT\_TRANSACTION
- CURRENT\_USER
- DISCONNECT
- FETCH
- GLOBAL
- INSENSITIVE
- LEADING
- LOWER
- OPEN
- RECREATE
- RECURSIVE
- ROW\_COUNT
- ROWS
- SAVEPOINT
- SENSITIVE
- SIMILAR
- SQLSTATE (2.5.1)
- START

TRAILING  
TRIM

## ***New non-reserved keywords***

The following words have been added to Firebird as non-reserved keywords. More than half of them are names of internal functions added between 2.0 and 2.1.

ABS  
ACCENT  
ACOS  
ALWAYS  
ASCII\_CHAR  
ASCII\_VAL  
ASIN  
ATAN  
ATAN2  
AUTONOMOUS  
BACKUP  
BIN\_AND  
BIN\_OR  
BIN\_NOT  
BIN\_SHL  
BIN\_SHR  
BIN\_XOR  
BLOCK  
BREAK  
CALLER  
CEIL  
CEILING  
CHAR\_TO\_UUID  
COALESCE  
COLLATION  
COMMENT  
COMMON  
COS  
COSH  
COT  
DATA  
DATEADD  
DATEDIFF  
DECODE  
DELETING  
DIFFERENCE  
EXP  
FIRST  
FIRSTNAME  
FLOOR  
GEN\_UUID  
GENERATED  
GRANTED  
HASH

IIF  
INSERTING  
LAST  
LASTNAME  
LEAVE  
LIST  
LN  
LOCK  
LOG  
LOG10  
LPAD  
MAPPING  
MATCHED  
MATCHING  
MAXVALUE  
MIDDLENAME  
MILLISECOND  
MINVALUE  
MOD  
NEXT  
NULLIF  
NULLS  
OS\_NAME  
OVERLAY  
PAD  
PI  
PLACING  
POWER  
PRESERVE  
RAND  
REPLACE  
RESTART  
RETURNING  
REVERSE  
ROUND  
RPAD  
SCALAR\_ARRAY  
SEQUENCE  
SIGN  
SIN  
SINH  
SKIP  
SOURCE  
SPACE  
SQRT  
SUBSTRING  
TAN  
TANH  
TEMPORARY  
TRUNC  
TWO\_PHASE  
WEEK

UPDATING  
UUID\_TO\_CHAR

## Dropped since InterBase 6

### *No longer reserved, still keywords*

The following words are no longer reserved in Firebird 2.5, but are still recognized as keywords:

ACTION  
ACTIVE  
AFTER  
ASC  
ASCENDING  
AUTO  
BEFORE  
CASCADE  
COLLATION  
COMMITTED  
COMPUTED  
CONDITIONAL  
CONTAINING  
CSTRING  
DATABASE  
DESC  
DESCENDING  
DESCRIPTOR  
DO  
DOMAIN  
ENTRY\_POINT  
EXCEPTION  
EXIT  
FILE  
FREE\_IT  
GEN\_ID  
GENERATOR  
IF  
INACTIVE  
INPUT\_TYPE  
ISOLATION  
KEY  
LENGTH  
LEVEL  
MANUAL  
MODULE\_NAME  
NAMES  
OPTION  
OUTPUT\_TYPE  
OVERFLOW  
PAGE

PAGE\_SIZE  
PAGES  
PASSWORD  
PRIVILEGES  
PROTECTED  
READ  
RESERV  
RESERVING  
RESTRICT  
RETAIN  
ROLE  
SCHEMA  
SEGMENT  
SHADOW  
SHARED  
SINGULAR  
SIZE  
SNAPSHOT  
SORT  
STABILITY  
STARTING  
STARTS  
STATEMENT  
STATISTICS  
SUB\_TYPE  
SUSPEND  
TRANSACTION  
TYPE  
UNCOMMITTED  
WAIT  
WEEKDAY  
WORK  
WRITE  
YEARDAY

## ***No longer reserved, not keywords***

The following words are no longer reserved in Firebird 2.5, and not keywords either:

AUTODDL  
BASE\_NAME  
BASED  
BASENAME  
BLOBEDIT  
BUFFER  
CACHE  
CHECK\_POINT\_LEN  
CHECK\_POINT\_LENGTH  
COMPILETIME  
CONTINUE  
DB\_KEY  
DEBUG

DESCRIBE  
DISPLAY  
ECHO  
EDIT  
EVENT  
EXTERN  
FOUND  
GOTO  
GROUP\_COMMIT\_  
GROUP\_COMMIT\_WAIT  
HELP  
IMMEDIATE  
INDICATOR  
INIT  
INPUT  
ISQL  
LC\_MESSAGES  
LC\_TYPE  
LEV  
LOG\_BUF\_SIZE  
LOG\_BUFFER\_SIZE  
LOGFILE  
MAX\_SEGMENT  
MAXIMUM  
MESSAGE  
MINIMUM  
NOAUTO  
NUM\_LOG\_BUFFERS  
NUM\_LOG\_BUFS  
OUTPUT  
PAGELENGTH  
PREPARE  
PUBLIC  
QUIT  
RAW\_PARTITIONS  
RETURN  
RUNTIME  
SHELL  
SHOW  
SQLERROR  
SQLWARNING  
STATIC  
TERMINATOR  
TRANSLATE  
TRANSLATION  
VERSION  
WAIT\_TIME  
WHENEVER

Some of these words still have a special meaning in ESQL and/or ISQL.

## Possibly reserved in future versions

The following words are not reserved in Firebird 2.5, but are better avoided as identifiers because they will likely be reserved – or added as keywords – in future versions:

BOOLEAN  
FALSE  
TRUE  
UNKNOWN

---

## Chapter 4

# Miscellaneous language elements

## -- (single-line comment)

*Available in:* DSQL, PSQL

*Added in:* 1.0

*Changed in:* 1.5

*Description:* A line starting with “--” (two dashes) is a comment and will be ignored. This also makes it easy to quickly comment out a line of SQL.

In Firebird 1.5 and up, the “--” can be placed anywhere on the line, e.g. after an SQL statement. Everything from the double dash to the end of the line will be ignored.

*Example:*

```
-- a table to store our valued customers in:
create table Customers (
  name varchar(32),
  added_by varchar(24),
  custno varchar(8),
  purchases integer      -- number of purchases
)
```

Notice that the second comment is only allowed in Firebird 1.5 and up.

## Hexadecimal notation for numerals

*Available in:* DSQL, PSQL

*Added in:* 2.5

*Description:* In Firebird 2.5 and up, integer values can be entered in hexadecimal notation. Numbers with 1–8 hex digits will be interpreted as INTEGERS; numbers with 9–16 hex digits as BIGINTs.

*Syntax:*

```
0{x|X}<hexdigits>
<hexdigits> ::= 1-16 of <hexdigit>
```



```
<hexdigit> ::= one of 0..9, A..F, a..f
```

*Examples:*

```
select 0x6FAA0D3 from rdb$database -- returns 117088467
select 0x4F9 from rdb$database -- returns 1273
select 0x6E44F9A8 from rdb$database -- returns 1850014120
select 0x9E44F9A8 from rdb$database -- returns -1639646808 (an INTEGER)
select 0x09E44F9A8 from rdb$database -- returns 2655320488 (a BIGINT)
select 0x28ED678A4C987 from rdb$database -- returns 720001751632263
select 0xFFFFFFFFFFFFFFFF from rdb$database -- returns -1
```

*Value ranges:*

- Hex numbers in the range 0 .. 7FFF FFFF are positive INTEGERS with values between 0 .. 2147483647 decimal. You can force them to BIGINT by prepending enough zeroes to bring the total number of hex digits to nine or above, but that only changes their type, not their value.
- Hex numbers between 8000 0000 .. FFFF FFFF require some attention:
  - When written with eight hex digits, as in 0x9E44F9A8, they are interpreted as 32-bit INTEGER values. Since their leftmost bit (sign bit) is set, they map to the negative range -2147483648 .. -1 decimal.
  - With one or more zeroes prepended, as in 0x09E44F9A8, they are interpreted as 64-bit BIGINTs in the range 0000 0000 8000 0000 .. 0000 0000 FFFF FFFF. The sign bit isn't set now, so they map to the positive range 2147483648 .. 4294967295 decimal.

Thus, in this range – and in this range only – prepending a mathematically insignificant 0 results in a totally different value. This is something to be aware of.

- Hex numbers between 1 0000 0000 .. 7FFF FFFF FFFF FFFF are all positive BIGINTs.
- Hex numbers between 8000 0000 0000 0000 .. FFFF FFFF FFFF FFFF are all negative BIGINTs.

## Hexadecimal notation for “binary” strings

*Available in:* DSQL, PSQL

*Added in:* 2.5

*Description:* In Firebird 2.5 and up, string literals can be entered in hexadecimal notation. Each pair of hex digits defines a byte in the string. Strings entered this way will have character set OCTETS by default, but you can force the engine to interpret them otherwise with the introducer syntax.

*Syntax:*

```
{x|X}'<hexstring>'
<hexstring> ::= an even number of <hexdigit>
<hexdigit> ::= one of 0..9, A..F, a..f
```

*Examples:*

```
select x'4E657276656E' from rdb$database
```

```

-- returns 4E657276656E, a 6-byte 'binary' string

select _ascii x'4E657276656E' from rdb$database
-- returns 'Nerven' (same string, now interpreted as ASCII text)

select _iso8859_1 x'53E46765' from rdb$database
-- returns 'Säge' (4 chars, 4 bytes)

select _utf8 x'53C3A46765' from rdb$database
-- returns 'Säge' (4 chars, 5 bytes)

```

*Notes:*

- It is up to the client interface how binary strings are displayed to the user. Isql, for one, uses uppercase letters A-F. FlameRobin uses lowercase letters. Other client programs may have other ideas, e.g. like this, with spaces between the bytes: '4E 65 72 76 65 6E'.
- The hexadecimal notation allows you to insert any byte value (including 00) at any place in the string. However, if you want to coerce it to anything other than OCTETS, it is your responsibility that the byte sequence is valid for the target character set.

## Shorthand datetime casts

*Available in:* DSQL, ESQL, PSQL

*Added in:* IB

*Description:* When converting a string literal to a DATE, TIME or TIMESTAMP, Firebird allows the use of a shorthand “C-style” cast. This feature already existed in InterBase 6, but was never properly documented.

*Syntax:*

```
datatype 'date/timestring'
```

*Examples:*

```
update People set AgeCat = 'Old'
  where BirthDate < date '1-Jan-1943'
```

```
insert into Appointments
  (Employee_Id, Client_Id, App_date, App_time)
values
  (973, 8804, date 'today' + 2, time '16:00')
```

```
new.lastmod = timestamp 'now';
```

*Note:* Please be advised that these shorthand expressions are evaluated immediately at parse time and stay the same as long as the statement remains prepared. Thus, even if a query is executed multiple times, the value for e.g. “timestamp 'now'” won't change, no matter how much time passes. If you need the value to progress (i.e. be evaluated upon every call), use a full cast.

*See also:* [CAST](#)

## CASE construct

Available in: DSQL, PSQL

Added in: 1.5

*Description:* A CASE construct returns exactly one value from a number of possibilities. There are two syntactic variants:

- The simple CASE, comparable to a Pascal `case` or a C `switch`.
- The searched CASE, which works like a series of “if ... else if ... else if” clauses.

### Simple CASE

*Syntax:*

```
CASE <test-expr>
  WHEN <expr> THEN result
  [WHEN <expr> THEN result ...]
  [ELSE defaultresult]
END
```

When this variant is used, `<test-expr>` is compared to `<expr> 1`, `<expr> 2` etc., until a match is found, upon which the corresponding result is returned. If there is no match and there is an ELSE clause, `defaultresult` is returned. If there is no match and no ELSE clause, NULL is returned.

The match is determined with the “=” operator, so if `<test-expr>` is NULL, it won't match any of the `<expr>`s, not even those that are NULL.

The results don't have to be literal values: they may also be field or variable names, compound expressions, or NULL literals.

A shorthand form of the simple CASE construct is the `DECODE()` function, available since Firebird 2.1.

*Example:*

```
select name,
       age,
       case upper(sex)
         when 'M' then 'Male'
         when 'F' then 'Female'
         else 'Unknown'
       end,
       religion
from people
```

### Searched CASE

*Syntax:*

```
CASE
```

```
WHEN <bool_expr> THEN result
  [WHEN <bool_expr> THEN result ...]
  [ELSE defaultresult]
END
```

Here, the *<bool\_expr>*s are tests that give a ternary boolean result: TRUE, FALSE, or NULL. The first expression evaluating to TRUE determines the result. If no expression is TRUE and there is an ELSE clause, *defaultresult* is returned. If no expression is TRUE and there is no ELSE clause, NULL is returned.

As with the simple CASE, the results don't have to be literal values: they may also be field or variable names, compound expressions, or NULL literals.

*Example:*

```
CanVote = case
  when Age >= 18 then 'Yes'
  when Age < 18 then 'No'
  else 'Unsure'
end;
```

# Data types and subtypes

## BIGINT data type

*Added in:* 1.5

*Description:* BIGINT is the SQL99-compliant 64-bit signed integer type. It is available in Dialect 3 only.

BIGINT numbers range from  $-2^{63} .. 2^{63}-1$ , or -9,223,372,036,854,775,808 .. 9,223,372,036,854,775,807.

Since Firebird 2.5, BIGINT numbers may be entered in hexadecimal form, with 9–16 hex digits. Shorter hex numerals are interpreted as INTEGERS.

*Examples:*

```
create table WholeLottaRecords (  
  id bigint not null primary key,  
  description varchar(32)  
)
```

```
insert into MyBigints values (  
  -236453287458723,  
  328832607832,  
  22,  
  -56786237632476,  
  0x6F55A09D42,           -- 478177959234  
  0X7FFFFFFFFFFFFFFFFF,  -- 9223372036854775807  
  0xffffffffffffffff,    -- -1  
  0x80000000,            -- -2147483648, an INTEGER  
  0x080000000,          -- 2147483648, a BIGINT  
  0XFFFFFFFF,           -- -1, an INTEGER  
  0X0FFFFFFFF,         -- 4294967295, a BIGINT  
)
```

The hexadecimal INTEGERS in the second example will be automatically cast to BIGINT before insertion into the table. However, this happens *after* the numerical value has been established, so 0x80000000 (8 digits) and 0x080000000 (9 digits) will be stored as different values. For more information on this difference, see [Hexadecimal notation for numerals](#), in particular the paragraph [Value ranges](#).

## BLOB data type

### ***Text BLOB support in functions and operators***

*Changed in:* 2.1, 2.1.5, 2.5.1

*Description:* Text BLOBs of any length and character set (including multi-byte sets) are now supported by practically every internal text function and operator. In a few cases there are limitations or bugs.

*Level of support:*

- Full support for:
  - = (assignment);
  - =, <>, <, <=, >, >= and synonyms (comparison);
  - || (concatenation);
  - BETWEEN, IS [NOT] DISTINCT FROM, IN, ANY|SOME and ALL.
- Support for STARTING [WITH], LIKE and CONTAINING:
  - In versions 2.1–2.1.4 and 2.5, an error is raised if the second operand is 32 KB or longer, or if the first operand is a BLOB with character set NONE and the second operand is a BLOB of any length and character set.
  - In versions 2.5.1 and up (as well as 2.1.5 and up in the 2.1 branch), each operand can be a BLOB of any length and character set.
- SELECT DISTINCT, ORDER BY and GROUP BY work on the BLOB ID, not the contents. This makes them as good as useless, except that SELECT DISTINCT weeds out multiple NULLs, if present. GROUP BY behaves oddly in that it groups together equal rows if they are adjacent, but not if they are apart.
- Any issues with BLOBs in [internal functions](#) and [aggregate functions](#) are discussed in their respective sections.

## Various enhancements

*Changed in:* 2.0

*Description:* In Firebird 2.0, several enhancements have been implemented for text BLOBs:

- DML COLLATE clauses are now supported.
- Equality comparisons can be performed on the full BLOB contents.
- Character set conversions are possible when assigning a BLOB to a BLOB or a string to a BLOB. When defining binary BLOBs, the mnemonic `binary` can now be used instead of the integer 0.

*Examples:*

```
select NameBlob from MyTable
  where NameBlob collate pt_br = 'João'
```

```
create table MyPictures (
  id int not null primary key,
  title varchar(40),
  description varchar(200),
  picture blob sub_type binary
)
```

## SQL\_NULL data type

*Added in:* 2.5

*Description:* The SQL\_NULL data type is of little or no interest to end users. It can hold no data, only a state: NULL or NOT NULL. It is also not possible to declare columns, variables or PSQL parameters of type SQL\_NULL. At present, its only purpose is to support the “? IS NULL” syntax in SQL statements with positional parameters. Application developers can make use of this when constructing queries that contain one or more optional filter terms.

*Syntax:* If a statement containing the following predicate is prepared:

```
? <op> NULL
```

Firebird will describe the parameter (?) as being of type SQL\_NULL. <op> can be any comparison operator, but the only one that makes sense in practice is “IS” (and possibly, in some rare cases, “NOT IS”).

## Rationale

In itself, having a query with a “WHERE ? IS NULL” clause doesn't make a lot of sense. You could use such a parameter as an on/off switch, but that hardly warrants inventing a whole new data type. After all, such switches can also be constructed with a CHAR, SMALLINT or other parameter type. The reason for adding the SQL\_NULL type is that developers of applications, connectivity toolsets, drivers etc. want to be able to support queries with optional filters like these:

```
select make, model, weight, price, in_stock from automobiles
  where (make = :make or :make is null)
     and (model = :model or :model is null)
     and (price <= :maxprice or :maxprice is null)
```

The idea is that the end user can optionally enter choices for the parameters *:make*, *:model* and *:maxprice*. Wherever a choice is entered, the corresponding filter should be applied. Wherever a parameter is left unset (NULL), there should be no filtering on that attribute. If all are unset, the entire table AUTOMOBILES should be shown.

Unfortunately, named parameters like *:make* and *:model* only exist on the application level. Before the query is passed to Firebird for preparation, it must be converted to this form:

```
select make, model, weight, price, in_stock from automobiles
  where (make = ? or ? is null)
     and (model = ? or ? is null)
     and (price <= ? or ? is null)
```

Instead of three named parameters, each occurring twice, we now have six positional parameters. There is *no* way that Firebird can tell whether some of them actually refer to the same application-level variable. (The fact that, in this example, they happen to be within the same pair of parentheses doesn't mean anything.) This in turn means that Firebird also cannot determine the *data type* of the “? is null” parameters. This last problem could be solved by casting:

```
select make, model, weight, price, in_stock from automobiles
  where (make = ? or cast(? as type of column automobiles.make) is null)
     and (model = ? or cast(? as type of column automobiles.model) is null)
     and (price <= ? or cast(? as type of column automobiles.price) is null)
```

...but this is rather cumbersome. And there is another issue: wherever a filter term is *not* NULL, its value will be passed twice to the server: once in the parameter that is compared against the table column, and once in the parameter that is tested for NULL. This is a bit of a waste. But the only alternative is to set up no less than *eight*

separate queries (2 to the power of the number of optional filters), which is even more of a headache. Hence the decision to implement a dedicated SQL\_NULL data type.

## Use in practice

*Notice: The following discussion assumes familiarity with the Firebird API and the passing of parameters via XSQLVAR structures. Readers without this knowledge won't have to deal with the SQL\_NULL data type anyway and can skip this section.*

As usual, the application passes the parameterized query in ?-form to the server. It is not possible to merge pairs of “identical” parameters into one. So, for e.g. two optional filters, four positional parameters are needed:

```
select size, colour, price from shirts
  where (size = ? or ? is null)
  and (colour = ? or ? is null)
```

After the call to `isc_dsqli_describe_bind()`, the `sqltype` of the 2nd and 4th parameter will be set to SQL\_NULL. As said, Firebird has no knowledge of their special relation with the 1st and 3d parameter – this is entirely the responsibility of the programmer. Once the values for size and colour have been set (or left unset) by the user and the query is about to be executed, each pair of XSQLVARs must be filled as follows:

*User has filled in a value*

- First parameter (value compare): set `*sqldata` to the supplied value and `*sqlind` to 0 (for NOT NULL);
- Second parameter (NULL test): set `sqldata` to null (null pointer, not SQL NULL) and `*sqlind` to 0 (for NOT NULL).

*User has left the field blank*

- Both parameters: set `sqldata` to null (null pointer, not SQL NULL) and `*sqlind` to -1 (indicating NULL).

In other words: The value compare parameter is always set as usual. The SQL\_NULL parameter is set the same, except that `sqldata` remains null at all times.

## New character sets

*Added in:* 1.0, 1.5, 2.0, 2.1, 2.5

The following table lists the character sets added in Firebird.

**Table 5.1. Character sets new in Firebird**

Name	Max bytes/ch.	Languages	Added in
CP943C	2	Japanese	2.1
DOS737	1	Greek	1.5
DOS775	1	Baltic	1.5
DOS858	1	= DOS850 plus € sign	1.5
DOS862	1	Hebrew	1.5



Name	Max bytes/ch.	Languages	Added in
DOS864	1	Arabic	1.5
DOS866	1	Russian	1.5
DOS869	1	Modern Greek	1.5
GB18030	4	Chinese	2.5
GBK	2	Chinese	2.1
ISO8859_2	1	Latin-2, Central European	1.0
ISO8859_3	1	Latin-3, Southern European	1.5
ISO8859_4	1	Latin-4, Northern European	1.5
ISO8859_5	1	Cyrillic	1.5
ISO8859_6	1	Arabic	1.5
ISO8859_7	1	Greek	1.5
ISO8859_8	1	Hebrew	1.5
ISO8859_9	1	Latin-5, Turkish	1.5
ISO8859_13	1	Latin-7, Baltic Rim	1.5
KOI8R	1	Russian	2.0
KOI8U	1	Ukrainian	2.0
TIS620	1	Thai	2.1
UTF8 <sup>(*)</sup>	4	All	2.0
WIN1255	1	Hebrew	1.5
WIN1256	1	Arabic	1.5
WIN1257	1	Baltic	1.5
WIN1258	1	Vietnamese	2.0
WIN_1258 (alias for WIN1258)	1	Vietnamese	2.5

<sup>(\*)</sup>In Firebird 1.5, UTF8 is an alias for UNICODE\_FSS. This character set has some inherent problems. In Firebird 2, UTF8 is a character set in its own right, without the drawbacks of UNICODE\_FSS.

## Character set NONE handling changed

*Changed in:* 1.5.1

*Description:* Firebird 1.5.1 has improved the way character set NONE data are moved to and from fields or variables with another character set, resulting in fewer transliteration errors. For more details, see the [Note](#) at the end of the book.

## New collations

*Added in:* 1.0, 1.5, 1.5.1, 2.0, 2.1, 2.5

The following table lists the collations added in Firebird. The “Details” column is based on what has been reported in the Release Notes and other documents. The information in this column is probably incomplete; some collations with an empty Details field may still be case insensitive (ci), accent insensitive (ai) or dictionary-sorted (dic).

Please note that the default – binary – collations for new character sets are not listed here, as doing so would add no meaningful information.

**Table 5.2. Collations new in Firebird**

Character set	Collation	Language	Details	Added in
CP943C	CP943C_UNICODE	Japanese		2.1
GB18030	GB18030_UNICODE	Chinese		2.5
GBK	GBK_UNICODE	Chinese		2.1
ISO8859_1	ES_ES_CI_AI	Spanish	ci, ai	2.0
	FR_FR_CI_AI	French	ci, ai	2.1
	PT_BR	Brazilian Portuguese	ci, ai	2.0
ISO8859_2	CS_CZ	Czech		1.0
	ISO_HUN	Hungarian		1.5
	ISO_PLK	Polish		2.0
ISO8859_13	LT_LT	Lithuanian		1.5.1
UTF8	UCS_BASIC	All		2.0
	UNICODE	All	dic	2.0
	UNICODE_CI	All	ci	2.1
	UNICODE_CI_AI	All	ci, ai	2.5
WIN1250	BS_BA	Bosnian		2.0
	PXW_HUN	Hungarian	ci	1.0
	WIN_CZ	Czech	ci	2.0
	WIN_CZ_CI_AI	Czech	ci, ai	2.0
WIN1251	WIN1251_UA	Ukrainian and Russian		1.5
WIN1252	WIN_PTBR	Brazilian Portuguese	ci, ai	2.0
WIN1257	WIN1257_EE	Estonian	dic	2.0

Character set	Collation	Language	Details	Added in
	WIN1257_LT	Lithuanian	dic	2.0
	WIN1257_LV	Latvian	dic	2.0
KOI8R	KOI8R_RU	Russian	dic	2.0
KOI8U	KOI8U_UA	Ukrainian	dic	2.0
TIS620	TIS620_UNICODE	Thai		2.1

#### A note on the UTF8 collations

The UCS\_BASIC collation sorts in Unicode code-point order: A, B, a, b, á... This is exactly the same as UTF8 with no collation specified. UCS\_BASIC was added to comply with the SQL standard.

The UNICODE collation sorts usingUCA (Unicode Collation Algorithm): a, A, á, b, B...

UNICODE\_CI is truly case-insensitive. In a search for e.g. 'Apple', it will also find 'apple', 'APPLE' and 'aPPLe'.

UNICODE\_CI\_AI is accent-insensitive as well. According to this collation, 'APPEL' equals 'Appèl'.

## Unicode collations for all character sets

Added in: 2.1

Firebird now comes with UNICODE collations for all the standard character sets. However, except for the ones listed in the [new collations table](#) in the previous section, these collations are not automatically available in your databases. Instead, they must be added with the CREATE COLLATION statement, like this:

```
create collation ISO8859_1_UNICODE for ISO8859_1
```

The new Unicode collations all have the name of their character set with \_UNICODE added. (The built-in Unicode collations for UTF8 are the exception to the rule.) They are defined, along with the other collations, in the manifest file `fbintl.conf` in Firebird's `intl` subdirectory.

Collations may also be registered under a user-chosen name, e.g.:

```
create collation LAT_UNI for ISO8859_1 from external ('ISO8859_1_UNICODE')
```

See [CREATE COLLATION](#) for the full syntax.

---

## Chapter 6

# DDL statements

The statements in this chapter are grouped by the type of database object they operate on. For instance, ALTER DATABASE, CREATE DATABASE and DROP DATABASE are all found under *DATABASE*; DECLARE EXTERNAL FUNCTION and ALTER EXTERNAL FUNCTION are under *EXTERNAL FUNCTION*; etc.

## CHARACTER SET

### ALTER CHARACTER SET

*Available in:* DSQL

*Added in:* 2.5

*Description:* With ALTER CHARACTER SET, the default collation of a character set can be changed. This will affect all future usage of the character set, except where overridden by an explicit COLLATE clause. The collation of existing domains, columns and PSQL variables will not be changed.

*Syntax:*

```
ALTER CHARACTER SET charset SET DEFAULT COLLATION collation
```

*Example:*

```
alter character set utf8 set default collation unicode_ci_ai
```

*Notes:*

- If you use SET DEFAULT COLLATION on the default character set of the database, you have effectively set (or overridden) the default collation for the database.
- If you use SET DEFAULT COLLATION on the connection character set, string constants will be interpreted according to the new default collation (unless character set and/or collation are overridden). In most situations, this will make no difference, but comparisons may have another outcome if the collation changes.

## COLLATION

### CREATE COLLATION

*Available in:* DSQL

Added in: 2.1

Changed in: 2.5

*Description:* Adds a collation to the database. The collation must already be present on your system (typically in a library file) and must be properly registered in a `.conf` file in the `intl` subdirectory of your Firebird installation. You may also base the collation on one that is already present in the database.

*Syntax:*

```
CREATE COLLATION collname
  FOR charset
  [FROM basecoll | FROM EXTERNAL ('extname')]
  [NO PAD | PAD SPACE]
  [CASE [IN]SENSITIVE]
  [ACCENT [IN]SENSITIVE]
  ['<specific-attributes>']

collname           ::= the name to use for the new collation
charset           ::= a character set present in the database
basecoll          ::= a collation already present in the database
extname           ::= the collation name used in the .conf file
<specific-attributes> ::= <attribute> [; <attribute> ...]
<attribute>        ::= attrname=attrvalue
```

- If no FROM clause is present, Firebird will scan the `.conf` file(s) in your `intl` subdirectory for a collation with the name specified after CREATE COLLATION. That is, omitting the FROM clause is the same as specifying “FROM EXTERNAL (`'collname'`)”.
- The single-quoted `extname` is case-sensitive and must be exactly equal to the collation name in the `.conf` file. The `collname`, `charset` and `basecoll` parameters are case-insensitive, unless surrounded by double-quotes.

*Specific attributes:* The table below lists the available specific attributes. Not all specific attributes apply to every collation, even if specifying them doesn't cause an error. Please note that specific attributes are case sensitive. In the table below, “1 bpc” indicates that an attribute is valid for collations of character sets using 1 byte per character (so-called *narrow character sets*). “UNI” stands for “UNICODE collations”.

**Table 6.1. Specific collation attributes**

Name	Values	Valid for	Comment
DISABLE-COMPRESSIONS	0, 1	1 bpc	Disables compressions (aka contractions). Compressions cause certain character sequences to be sorted as atomic units, e.g. Spanish <code>c+h</code> as a single character <code>ch</code> .
DISABLE-EXPANSIONS	0, 1	1 bpc	Disables expansions. Expansions cause certain characters (e.g. ligatures or unlauded vowels) to be treated as character sequences and sorted accordingly.
ICU-VERSION	default or <i>M.m</i>	UNI	Specifies the ICU library version to use. Valid values are the ones defined in the applicable <code>&lt;intl_module&gt;</code> element in <code>intl/fbintl.conf</code> . Format: either the string literal “default”

Name	Values	Valid for	Comment
			or a major+minor version number like “3.0” (both unquoted).
LOCALE	xx_YY	UNI	Specifies the collation locale. Requires complete version of ICU libraries. Format: a locale string like “du_NL” (unquoted).
MULTI-LEVEL	0, 1	1 bpc	Uses more than one ordering level.
NUMERIC-SORT	0, 1	UNI	Treats contiguous groups of decimal digits in the string as atomic units and sorts them numerically. (This is also known as <i>natural sorting</i> .)
SPECIALS-FIRST	0, 1	1 bpc	Orders special characters (spaces, symbols etc.) before alphanumeric characters.

*Note:* The NUMERIC-SORT specific attribute was added in Firebird 2.5.

*Examples:*

Simplest form, using the name as found in the .conf file (case-insensitive):

```
create collation iso8859_1_unicode for iso8859_1
```

Using a custom name. Notice how the “external” name must now *exactly* match the name in the .conf file:

```
create collation lat_uni
  for iso8859_1
  from external ('ISO8859_1_UNICODE')
```

Based on a collation already present in the database:

```
create collation es_es_nopad_ci
  for iso8859_1
  from es_es
  no pad
  case insensitive
```

With a special attribute (case-sensitive!):

```
create collation es_es_ci_compr
  for iso8859_1
  from es_es
  case insensitive
  'DISABLE-COMPRESSIONS=0'
```

### Tip

If you want to add a new character set with its default collation in your database, declare and run the stored procedure `sp_register_character_set(name, max_bytes_per_character)`, found in `misc/intl.sql` under your Firebird installation directory. Please note: in order for this to work, the character set must be present on your system and registered in a .conf file in the intl subdirectory.

## DROP COLLATION

Available in: DSQL

Added in: 2.1

*Description:* Removes a collation from the database. Only user-added collations can be removed in this way.

*Syntax:*

```
DROP COLLATION name
```

### Tip

If you want to remove an entire character set with all its collations from your database, declare and run the stored procedure `sp_unregister_character_set(name)`, found in `misc/intl.sql` under your Firebird installation directory.

## COMMENT

Available in: DSQL

Added in: 2.0

*Description:* Allows you to enter comments for metadata objects. The comments will be stored in the various RDB\$DESCRIPTION text BLOB fields in the system tables, from where client applications can pick them up.

*Syntax:*

```
COMMENT ON <object> IS {'sometext' | NULL}

<object>      ::=  DATABASE
                  | <basic-type> objectname
                  | COLUMN relationname.fieldname
                  | PARAMETER procname.paramname

<basic-type> ::=  CHARACTER SET | COLLATION | DOMAIN | EXCEPTION
                  | EXTERNAL FUNCTION | FILTER | GENERATOR | INDEX
                  | PROCEDURE | ROLE | SEQUENCE | TABLE | TRIGGER | VIEW
```

### Note

If you enter an empty comment ( ' '), it will end up as NULL in the database.

*Examples:*

```
comment on database is 'Here''s where we keep all our customer records.'
```

```
comment on table Metals is 'Also for alloys'
```

```
comment on column Metals.IsAlloy is '0 = pure metal, 1 = alloy'
```

```
comment on index ix_sales is 'Set inactive during bulk inserts!'
```

## DATABASE

### CREATE DATABASE

Available in: DSQL, ESQL

Syntax (partial):

```
CREATE {DATABASE | SCHEMA}
    ...
    [PAGE_SIZE [=] size]
    ...
    [DEFAULT CHARACTER SET charset [COLLATION collation]]
    ...
    [DIFFERENCE FILE 'filepath']

size ::= 4096 | 8192 | 16384
```

- If the user supplies a size smaller than 4096, it will be silently converted to 4096. Other numbers not equal to any of the supported sizes will be silently converted to the next lower supported size.

### 16 Kb page size supported, 1 and 2 Kb deprecated

Changed in: 1.0, 2.1

*Description:* Firebird 1.0 has raised the maximum database page size from 8192 to 16384 bytes. In Firebird 2.1 and up, page sizes 1024 and 2048 are deprecated as inefficient. Firebird will no longer create databases with these page sizes, but it will connect to existing small-page databases without any problem.

### Default collation for the database

Added in: 2.5

*Description:* In Firebird 2.5 and up, you can specify a collation with the default character set, as shown in the Syntax block above. If present, this collation will become the default collation for the default character set (and hence for the entire database, except where another character set is used).

*Example:*

```
create database "colltest.fdb" default character set iso8859_1 collation du_nl
```

*Please notice:* The keyword to use here is COLLATION, not the usual COLLATE.

### DIFFERENCE FILE parameter

Added in: 2.0

*Description:* The DIFFERENCE FILE parameter was added in Firebird 2.0, but not documented at the time. For a full description, see [ALTER DATABASE :: ADD DIFFERENCE FILE](#).



## ALTER DATABASE

Available in: DSQL, ESQL

Description: Alters a database's file organisation or toggles its “safe-to-copy” state.

Syntax:

```
ALTER {DATABASE | SCHEMA}
  [<add_sec_clause> [<add_sec_clause> ...]]
  [ADD DIFFERENCE FILE 'filepath' | DROP DIFFERENCE FILE]
  [{BEGIN | END} BACKUP]

<add_sec_clause> ::= ADD <sec_file> [<sec_file> ...]

<sec_file> ::= FILE 'filepath'
              [STARTING [AT [PAGE]] pagenum]
              [LENGTH [=] num [PAGE[S]]]
```

The DIFFERENCE FILE and BACKUP clauses, added in Firebird 2.0, are not available in ESQL.

## BEGIN BACKUP

Available in: DSQL

Added in: 2.0

Description: Freezes the main database file so that it can be backed up safely by filesystem means, even while users are connected and perform operations on the data. Any mutations to the database will be written to a separate file, the *delta file*. Contrary to what the syntax suggests, this statement does *not* initiate the backup itself; it merely creates the conditions.

Example:

```
alter database begin backup
```

## END BACKUP

Available in: DSQL

Added in: 2.0

Description: Merges the delta file back into the main database file and restores the normal state of operation, thus closing the time window during which safe backups could be made via the filesystem. (Safe backups with `gbak` are still possible.)

Example:

```
alter database end backup
```

### Tip

Instead of BEGIN and END BACKUP, consider using Firebird's `nbackup` tool: it can freeze and unfreeze the main database file as well as make full and incremental backups. A manual for `nbackup` is available via the [Firebird Documentation Index](#).

## ADD DIFFERENCE FILE

Available in: DSQL

Added in: 2.0

*Description:* Presets path and name of the delta file to which mutations are written when the database goes into “copy-safe” mode after an ALTER DATABASE BEGIN BACKUP command.

*Example:*

```
alter database add difference file 'C:\Firebird\Databases\Fruitbase.delta'
```

*Notes:*

- This statement doesn't really add any file. It just overrides the default path and name for the delta file that will be created if and when the database enters copy-safe mode.
- If you provide a relative path or a bare filename here, it will be appended to the current directory as seen from the server. On Windows, this is often the system directory.
- If you want to change an existing setting, **DROP** the old one first and then **ADD** the new one.
- When not overridden, the delta file gets the same path and filename as the database itself, but with the extension `.delta`

## DROP DIFFERENCE FILE

Available in: DSQL

Added in: 2.0

*Description:* Removes the delta file path and name that were previously set with ALTER DATABASE ADD DIFFERENCE FILE. This statement doesn't really drop a file. It only erases the preset path and/or filename that would otherwise have been used the next time the database went into copy-safe mode, and reverts to the default behaviour.

*Example:*

```
alter database drop difference file
```

# DOMAIN

## CREATE DOMAIN

Available in: DSQL, ESQL

## Context variables as defaults

Changed in: IB

*Description:* Any context variable that is assignment-compatible to the new domain's data type can be used as a default. This was already the case in InterBase 6, but the *Language Reference* only mentioned USER.

*Example:*

```
create domain DDate as
  date
  default current_date
  not null
```

## ALTER DOMAIN

*Available in:* DSQL, ESQL

### Warning

If a domain's definition is changed, existing PSQL code using that domain may become invalid. For information on how to detect this, please read the note *The RDB\$VALID\_BLR field*, near the end of this document.

## Rename domain

*Added in:* IB

*Description:* Renaming of a domain is possible with the TO clause. This feature was introduced in InterBase 6, but left out of the *Language Reference*.

*Example:*

```
alter domain posint to plusint
```

- The TO clause can be combined with other clauses and need not come first in that case.

## SET DEFAULT to any context variable

*Changed in:* IB

*Description:* Any context variable that is assignment-compatible to the domain's data type can be used as a default. This was already the case in InterBase 6, but the *Language Reference* only mentioned USER.

*Example:*

```
alter domain DDate
  set default current_date
```

# EXCEPTION

## CREATE EXCEPTION

*Available in:* DSQL, ESQL

## Message length increased

*Changed in:* 2.0

*Description:* In Firebird 2.0 and higher, the maximum length of the exception message has been raised from 78 to 1021.

*Example:*

```
create exception Ex_TooManyManagers
'Too many managers: An attempt was made to create more managers than the
maximum defined in the Limits table. If you really need to create more
managers than you have now, raise the limit first. However, please consult
your department''s manager before doing so. Otherwise, your decision may
be overturned later and the additional manager(s) removed.'
```

### Note

The maximum exception message length depends on a certain system table field. Therefore, pre-2.0 databases need to be backed up and restored under Firebird 2.x before they can store exception messages of up to 1021 bytes.

## CREATE OR ALTER EXCEPTION

*Available in:* DSQL

*Added in:* 2.0

*Description:* If the exception does not yet exist, it is created just as if CREATE EXCEPTION were used. If it already exists, it is altered. Existing dependencies are preserved.

*Syntax:* Exactly the same as for CREATE EXCEPTION.

## RECREATE EXCEPTION

*Available in:* DSQL

*Added in:* 2.0

*Description:* Creates or recreates an exception. If an exception with the same name already exists, RECREATE EXCEPTION will try to drop it and create a new exception. This will fail if there are existing dependencies on the exception.

*Syntax:* Exactly the same as CREATE EXCEPTION.

### Note

If you use RECREATE EXCEPTION on an exception that has dependent objects, you may not get an error message until you try to commit your transaction.

## EXTERNAL FUNCTION

### DECLARE EXTERNAL FUNCTION

Available in: DSQL, ESQL

Description: This statement makes an external function (UDF) available in the database.

Syntax:

```
DECLARE EXTERNAL FUNCTION localname
  [<arg_type_decl> [, <arg_type_decl> ...]]
  RETURNS {<return_type_decl> | PARAMETER i-based_pos} [FREE_IT]
  ENTRY_POINT 'function_name' MODULE_NAME 'library_name'

<arg_type_decl>      ::= sqltype [BY DESCRIPTOR] | CSTRING(length)
<return_type_decl> ::= sqltype [BY {DESCRIPTOR|VALUE}] | CSTRING(length)
```

#### Restrictions

- The BY DESCRIPTOR passing method is not supported in ESQL.

You may choose *localname* freely; this is the name by which the function will be known to your database. You may also vary the *length* argument of CSTRING parameters (more about CSTRINGS in the [note](#) near the end of the book).

### BY DESCRIPTOR parameter passing

Available in: DSQL

Added in: 1.0

Description: Firebird introduces the possibility to pass parameters BY DESCRIPTOR; this mechanism facilitates the processing of NULLs in a meaningful way. Notice that this only works if the person who wrote the function has implemented it. Simply adding “BY DESCRIPTOR” to an existing declaration does not make it work – on the contrary! Always use the declaration block provided by the function designer.

### RETURNS PARAMETER *n*

Available in: DSQL, ESQL

Added in: IB 6

Description: In order to return a BLOB, an extra input parameter must be declared and a “RETURNS PARAMETER *n*” clause added – *n* being the position of said parameter. This clause dates back to InterBase 6 beta, but somehow didn't make it into the *Language Reference* (it is documented in the *Developer's Guide* though).

### ALTER EXTERNAL FUNCTION

Available in: DSQL

*Added in:* 2.0

*Description:* Alters an external function's module name and/or entry point. Existing dependencies are preserved.

*Syntax:*

```
ALTER EXTERNAL FUNCTION funcname
    <modification> [<modification>]

<modification> ::= ENTRY_POINT 'new-entry-point'
                | MODULE_NAME 'new-module-name'
```

*Example:*

```
alter external function Phi module_name 'NewUdfLib'
```

## FILTER

### DECLARE FILTER

*Available in:* DSQL, ESQL

*Changed in:* 2.0

*Description:* Makes a BLOB filter available to the database.

*Syntax:*

```
DECLARE FILTER filtername
    INPUT_TYPE <sub_type> OUTPUT_TYPE <sub_type>
    ENTRY_POINT 'function_name' MODULE_NAME 'library_name'

<sub_type> ::= number | <mnemonic>
<mnemonic> ::= binary | text | blr | acl | ranges | summary | format
              | transaction_description | external_file_description
              | user_defined
```

- In Firebird 2 and up, no two BLOB filters in a database may have the same combination of input and output type. Declaring a filter with an already existing input-output type combination will fail. Restoring pre-2.0 databases that contain such “duplicate” filters will also fail.
- The possibility to indicate the BLOB types with their mnemonics instead of numbers was added in Firebird 2. The `binary` mnemonic for subtype 0 was also added in Firebird 2. The predefined mnemonics are case-insensitive.

*Example:*

```
declare filter Funnel
    input_type blr output_type text
    entry_point 'blr2asc' module_name 'myfilterlib'
```

*User-defined mnemonics:* If you want to define mnemonics for your own BLOB subtypes, you can add them to the RDB\$TYPES system table as shown below. Once committed, the mnemonics can be used in subsequent filter declarations.

```
insert into rdb$types (rdb$field_name, rdb$type, rdb$type_name)
values ('RDB$FIELD_SUB_TYPE', -33, 'MIDI')
```

The value for `rdb$field_name` must always be `'RDB$FIELD_SUB_TYPE'`. If you define your mnemonics in all-upercase, you can use them case-insensitively and unquoted in your filter declarations.

## INDEX

### CREATE INDEX

Available in: DSQL, ESQL

*Description:* Creates an index on a table for faster searching, sorting and/or grouping.

*Syntax:*

```
CREATE [UNIQUE] [ASC[ENDING] | [DESC[ENDING]] INDEX indexname
ON tablename
{ (<col> [, <col> ...]) | COMPUTED BY (expression) }
```

*<col>* ::= a column not of type ARRAY, BLOB or COMPUTED BY

### UNIQUE indices now allow NULLS

Changed in: 1.5

*Description:* In compliance with the SQL-99 standard, NULLs – even multiple – are now allowed in columns that have a UNIQUE index defined on them. For a full discussion, see [CREATE TABLE :: UNIQUE constraints now allow NULLs](#). As far as NULLs are concerned, the rules for unique indices are exactly the same as those for unique keys.

### Indexing on expressions

Added in: 2.0

*Description:* Instead of one or more columns, you can now also specify a single COMPUTED BY expression in an index definition. Expression indices will be used in appropriate queries, provided that the expression in the WHERE, ORDER BY or GROUP BY clause exactly matches the expression in the index definition. Multi-segment expression indices are not supported, but the expression itself may involve multiple columns.

*Examples:*

```
create index ix_upname on persons computed by (upper(name));
commit;

-- the following queries will use ix_upname:
select * from persons order by upper(name);
select * from persons where upper(name) starting with 'VAN';
delete from persons where upper(name) = 'BROWN';
delete from persons where upper(name) = 'BROWN' and age > 65;
```

```
create descending index ix_events_yt
on MyEvents
computed by (extract(year from StartDate) || Town);
```

```
commit;

-- the following query will use ix_events_yt:
select * from MyEvents
order by extract(year from StartDate) || Town desc;
```

## Maximum index key length increased

*Changed in: 2.0*

*Description:* The maximum length of index keys, which used to be fixed at 252 bytes, is now equal to 1/4 of the page size, i.e. varying from 256 to 4096. The maximum indexable string length in bytes is 9 less than the key length. The table below shows the indexable string lengths in characters for the various page sizes and character sets.

**Table 6.2. Maximum indexable (VAR)CHAR length**

Page size	Maximum indexable string length per charset type			
	1 byte/char	2 bytes/char	3 bytes/char	4 bytes/char
1024	247	123	82	61
2048	503	251	167	125
4096	1015	507	338	253
8192	2039	1019	679	509
16384	4087	2043	1362	1021

## Maximum number of indices per table increased

*Changed in: 1.0.3, 1.5, 2.0*

*Description:* The maximum number of 65 indices per table has been removed in Firebird 1.0.3, reintroduced at the higher level of 257 in Firebird 1.5, and removed once again in Firebird 2.0.

Although there is no longer a “hard” ceiling, the number of indices creatable in practice is still limited by the database page size and the number of columns per index, as shown in the table below.

**Table 6.3. Max. indices per table, Firebird 2.0**

Page size	Number of indices depending on column count		
	1 col	2 cols	3 cols
1024	50	35	27
2048	101	72	56
4096	203	145	113
8192	408	291	227
16384	818	584	454



Please be aware that under normal circumstances, even 50 indices is way too many and will drastically reduce mutation speeds. The maximum was removed to accommodate data-warehousing applications and the like, which perform lots of bulk operations with the indices temporarily inactivated.

For a full table also including Firebird versions 1.0–1.5, see the [Notes](#) at the end of the book.

## PROCEDURE

A stored procedure (SP) is a code module that can be called by the client, by another stored procedure, an executable block or a trigger. Stored procedures, executable blocks and triggers are written in Procedural SQL (PSQL). Most SQL statements are also available in PSQL, sometimes with restrictions or extensions. Notable exceptions are DDL and transaction control statements.

Stored procedures can accept and return multiple parameters.

### CREATE PROCEDURE

*Available in:* DSQL, ESQL

*Description:* Creates a stored procedure.

*Syntax:*

```
CREATE PROCEDURE procname
  [(inparam> [, inparam> ...])]
  [RETURNS (outparam> [, outparam> ...])]
AS
  [declarations>]
BEGIN
  [PSQL statements>]
END

<inparam>      ::= <param_decl> [{= | DEFAULT} value]
<outparam>     ::= <param_decl>
<param_decl>   ::= paramname <type> [NOT NULL] [COLLATE collation]
<type>         ::= sql_datatype | [TYPE OF] domain | TYPE OF COLUMN rel.col
<declarations> ::= See PSQL::DECLARE for the exact syntax

/* If sql_datatype is a string type, it may include a character set */
```

### TYPE OF COLUMN in parameter and variable declarations

*Added in:* 2.5

*Description:* Analogous to the “TYPE OF *domain*” syntax supported since version 2.1, it is now also possible to declare variables and parameters as having the type of an existing table or view column. Only the type itself is used; in the case of string types, this includes the character set and the collation. Constraints and default values are never copied from the source column.

*Example:*

```
/* Assuming DDL autocommit and connection charset UTF8 */
```

```

create domain dphrase as
  varchar(200) character set utf8 collate unicode_ci_ai;

create table phrases (phrase dphrase);

set term #;
create procedure equalphrases (a type of column phrases.phrase,
                               b type of column phrases.phrase)
  returns (res varchar(30))
as
begin
  if (a = b) then res = 'Yes'; else res = 'No';
  suspend;
end#
set term ;#

select res from equalphrases('Appel', 'appèl');

-- result is 'Yes'

```

### Warnings

- For text types, character set and collation are included by TYPE OF COLUMN – just as when [TYPE OF] *<domain>* is used. However, due to a bug, the collation is not always taken into consideration when comparisons (e.g. equality tests) are made. In cases where the collation is of importance, test your code thoroughly before deploying! This bug is fixed for Firebird 3.
- If the column's type is changed at a later time, PSQL code using that column may become invalid. For information on how to detect this, please read the note *The RDB\$VALID\_BLR field*, near the end of this document.

## Domains supported in parameter and variable declarations

*Changed in: 2.1*

*Description:* Firebird 2.1 and up support the use of domains instead of SQL data types when declaring input/output parameters and local variables. With the “TYPE OF” modifier, only the domain's type is used – not its NOT NULL setting, CHECK constraint and/or default value. If the domain is of a text type, its character set and collation are always preserved.

*Example:*

```

create domain bool3
  smallint
  check (value is null or value in (0,1));

create domain bigposnum
  bigint
  check (value >= 0);

/* Determines if A is a multiple of B: */
set term #;
create procedure ismultiple (a bigposnum, b bigposnum)
  returns (res bool3)
as
  declare ratio type of bigposnum;      -- ratio is a bigint

```

```

declare remainder type of bigposnum; -- so is remainder
begin
  if (a is null or b is null) then res = null;
  else if (b = 0) then
  begin
    if (a = 0) then res = 1; else res = 0;
  end
  else
  begin
    ratio = a / b;                -- integer division!
    remainder = a - b*ratio;
    if (remainder = 0) then res = 1; else res = 0;
  end
end#
set term ;#

```

**Warning**

If a domain's definition is changed, existing PSQL code using that domain may become invalid. For information on how to detect this, please read the note *The RDB\$VALID\_BLR field*, near the end of this document.

**COLLATE in variable and parameter declarations**

*Changed in: 2.1*

*Description:* Firebird 2.1 and up allow COLLATE clauses in declarations of input/output parameters and local variables.

*Example:*

```

create procedure SpanishToDutch
  (es_1 varchar(20) character set iso8859_1 collate es_es,
   es_2 my_char_domain collate es_es)
returns
  (nl_1 varchar(20) character set iso8859_1 collate du_nl,
   nl_2 my_char_domain collate du_nl)
as
declare s_temp varchar(100) character set utf8 collate unicode;
begin
  ...
  ...
end

```

**NOT NULL in variable and parameter declarations**

*Changed in: 2.1*

*Description:* Firebird 2.1 and up allow NOT NULL constraints in declarations of input/output parameters and local variables.

*Example:*

```

create procedure RegisterOrder
  (order_no int not null, description varchar(200) not null)
returns
  (ticket_no int not null)

```

```
as
declare temp int not null;
begin
    ...
    ...
end
```

## Default argument values

*Changed in: 2.0*

*Description:* It is now possible to provide default values for stored procedure arguments, allowing the caller to omit one or more items (possibly even all) from the end of the argument list.

*Syntax:*

```
CREATE PROCEDURE procname (<inparam> [, <inparam> ...])
    ...

<inparam> ::= paramname datatype [{= | DEFAULT} value]
```

**Important:** If you provide a default value for a parameter, you must do the same for any and all parameters following it.

## BEGIN ... END blocks may be empty

*Changed in: 1.5*

*Description:* BEGIN ... END blocks may be empty in Firebird 1.5 and up, allowing you to write stub code without having to resort to dummy statements.

*Example:*

```
create procedure grab_ints (a integer, b integer)
as
begin
end
```

## ALTER PROCEDURE

*Available in: DSQL, ESQL*

### Default argument values

*Added in: 2.0*

*Description:* You can now provide default values for stored procedure arguments, allowing the caller to omit one or more items from the end of the argument list. See [CREATE PROCEDURE](#) for syntax and details.

*Example:*

```
alter procedure TestProc
(a int, b int default 1007, s varchar(12) = '-')
    ...
```

## Classic Server: Altered procedure immediately visible to other clients

*Changed in: 2.5*

*Description:* Traditionally, when a client used ALTER PROCEDURE on a Classic server, other clients would keep seeing (and possibly executing) the old version for the duration of their connection. This has been fixed in 2.5. Now, all clients see the new version as soon as the changes have been committed.

## COLLATE in variable and parameter declarations

*Changed in: 2.1*

*Description:* Firebird 2.1 and up allow COLLATE clauses in declarations of input/output parameters and local variables. See [CREATE PROCEDURE](#) for syntax and details.

## Domains supported in parameter and variable declarations

*Changed in: 2.1*

*Description:* Firebird 2.1 and up support the use of domains instead of SQL data types when declaring input/output parameters and local variables. See [CREATE PROCEDURE](#) for syntax and details.

## NOT NULL in variable and parameter declarations

*Changed in: 2.1*

*Description:* Firebird 2.1 and up allow NOT NULL constraints in declarations of input/output parameters and local variables. See [CREATE PROCEDURE](#) for syntax and details.

## Restriction on altering used procedures

*Changed in: 2.0, 2.0.1*

*Description:* In Firebird 2.0 only, a restriction is in place which prevents anyone from dropping, altering or recreating a trigger or stored procedure if it has been used since the database was opened. This restriction has been removed again in version 2.0.1. Still, performing these operations on a live database is potentially risky and should only be done with the utmost care.

## TYPE OF COLUMN in parameter and variable declarations

*Added in: 2.5*

*Description:* Analogous to the “TYPE OF *domain*” syntax supported since version 2.1, it is now also possible to declare variables and parameters as having the type of an existing table or view column. See [CREATE PROCEDURE](#) for syntax and details.

## CREATE OR ALTER PROCEDURE

*Available in: DSQL*

*Added in: 1.5*

*Description:* If the procedure does not yet exist, it is created just as if CREATE PROCEDURE were used. If it already exists, it is altered and recompiled. Existing permissions and dependencies are preserved.

*Syntax:* Exactly the same as for CREATE PROCEDURE.

## **DROP PROCEDURE**

*Available in:* DSQL, ESQL

### **Restriction on dropping used procedures**

*Changed in:* 2.0, 2.0.1

*Description:* In Firebird 2.0 only, a restriction is in place which prevents anyone from dropping, altering or recreating a trigger or stored procedure if it has been used since the database was opened. This restriction has been removed again in version 2.0.1. Still, performing these operations on a live database is potentially risky and should only be done with the utmost care.

## **RECREATE PROCEDURE**

*Available in:* DSQL

*Added in:* 1.0

*Description:* Creates or recreates a stored procedure. If a procedure with the same name already exists, RECREATE PROCEDURE will try to drop it and create a new procedure. RECREATE PROCEDURE will fail if the existing SP is in use.

*Syntax:* Exactly the same as [CREATE PROCEDURE](#).

### **Restriction on recreating used procedures**

*Changed in:* 2.0, 2.0.1

*Description:* In Firebird 2.0 only, a restriction is in place which prevents anyone from dropping, altering or recreating a trigger or stored procedure if it has been used since the database was opened. This restriction has been removed again in version 2.0.1. Still, performing these operations on a live database is potentially risky and should only be done with the utmost care.

## **SEQUENCE or GENERATOR**

### **CREATE SEQUENCE**

*Available in:* DSQL

*Added in:* 2.0

*Description:* Creates a new sequence or generator. SEQUENCE is the SQL-compliant term for what InterBase and Firebird have always called a generator. CREATE SEQUENCE is fully equivalent to CREATE GENERATOR and is the recommended syntax from Firebird 2.0 onward.

*Syntax:*

```
CREATE SEQUENCE sequence-name
```

*Example:*

```
create sequence seqtest
```

Because internally sequences and generators are the same thing, you can freely mix the generator and sequence syntaxes, even when operating on the same object. This is not recommended however.

Sequences (or generators) are always stored as 64-bit integer values, regardless of the database dialect. However:

- If the *client* dialect is set to 1, the server passes generator values as truncated 32-bit values to the client.
- If generator values are fed into a 32-bit field or variable, all goes well until the actual value exceeds the 32-bit range. At that point, a dialect 3 database will raise an error whereas a dialect 1 database will silently truncate the value (which could also lead to an error, e.g. if the receiving field has a unique key defined on it).

*See also:* [ALTER SEQUENCE](#), [NEXT VALUE FOR](#), [DROP SEQUENCE](#)

## CREATE GENERATOR

*Available in:* DSQL, ESQL

*Better alternative:* [CREATE SEQUENCE](#)

## CREATE SEQUENCE preferred

*Changed in:* 2.0

*Description:* From Firebird 2.0 onward, the SQL-compliant [CREATE SEQUENCE](#) syntax is preferred.

## Maximum number of generators significantly raised

*Changed in:* 1.0

*Description:* InterBase reserved only one database page for generators, limiting the total number to 123 (on 1K pages) – 1019 (on 8K pages). Firebird has done away with that limit; you can now create more than 32,000 generators per database.

## ALTER SEQUENCE

*Available in:* DSQL

*Added in:* 2.0

*Description:* (Re)initializes a sequence or generator to the given value. SEQUENCE is the SQL-compliant term for what InterBase and Firebird have always called a generator. “ALTER SEQUENCE ... RESTART WITH” is fully equivalent to “SET GENERATOR ... TO” and is the recommended syntax from Firebird 2.0 onward.

*Syntax:*

```
ALTER SEQUENCE sequence-name RESTART WITH <newval>
```

```
<newval> ::= A signed 64-bit integer value.
```

*Example:*

```
alter sequence seqtest restart with 0
```

### Warning

Careless use of ALTER SEQUENCE is a mighty fine way of screwing up your database! Under normal circumstances you should only use it right after CREATE SEQUENCE, to set the initial value.

*See also:* [CREATE SEQUENCE](#)

## SET GENERATOR

*Available in:* DSQL, ESQL

*Better alternative:* [ALTER SEQUENCE](#)

*Description:* (Re)initializes a generator or sequence to the given value. From Firebird 2 onward, the SQL-compliant [ALTER SEQUENCE](#) syntax is preferred.

*Syntax:*

```
SET GENERATOR generator-name TO <new-value>
```

```
<new-value> ::= A 64-bit integer.
```

### Warning

Once a generator or sequence is up and running, you should not tamper with its value (other than retrieving next values with GEN\_ID or NEXT VALUE FOR) unless you know exactly what you are doing.

## DROP SEQUENCE

*Available in:* DSQL

*Added in:* 2.0

*Description:* Removes a sequence or generator from the database. Its (very small) storage space will be freed for re-use after a backup-restore cycle. SEQUENCE is the SQL-compliant term for what InterBase and Firebird have always called a generator. DROP SEQUENCE is fully equivalent to DROP GENERATOR and is the recommended syntax from Firebird 2.0 onward.

*Syntax:*

```
DROP SEQUENCE sequence-name
```

*Example:*

```
drop sequence seqtest
```

*See also:* [CREATE SEQUENCE](#)



## DROP GENERATOR

Available in: DSQL

Added in: 1.0

Better alternative: [DROP SEQUENCE](#)

*Description:* Removes a generator or sequence from the database. Its (very small) storage space will be freed for re-use after a backup-restore cycle.

*Syntax:*

```
DROP GENERATOR generator-name
```

From Firebird 2.0 onward, the SQL-compliant [DROP SEQUENCE](#) syntax is preferred.

# TABLE

## CREATE TABLE

Available in: DSQL, ESQL

### Global Temporary Tables (GTTs)

Added in: 2.1

*Description:* Global temporary tables have persistent metadata, but their contents are transaction-bound (the default) or connection-bound. Every transaction or connection has its own private instance of a GTT, isolated from all the others. Instances are only created if and when the GTT is referenced, and destroyed upon transaction end or disconnection. To modify or remove a GTT's metadata, ALTER TABLE and DROP TABLE can be used.

*Syntax:*

```
CREATE GLOBAL TEMPORARY TABLE name
(column_def [, column_def | table_constraint ...])
[ON COMMIT {DELETE | PRESERVE} ROWS]
```

- ON COMMIT DELETE ROWS creates a transaction-level GTT (the default), ON COMMIT PRESERVE ROWS a connection-level GTT.
- An EXTERNAL [FILE] clause is not allowed on a global temporary table.

*Restrictions:* GTTs can be “dressed up” with all the features and paraphernalia of ordinary tables (keys, references, indices, triggers...) but there are a few restrictions:

- GTTs and regular tables cannot reference one another.
- A connection-bound (“PRESERVE ROWS”) GTT cannot reference a transaction-bound (“DELETE ROWS”) GTT.

- Domain constraints cannot reference any GTT.
- The destruction of a GTT instance at the end of its life cycle does *not* cause any before/after delete triggers to fire.

*Example:*

```
create global temporary table MyConnGTT (
  id int not null primary key,
  txt varchar(32),
  ts timestamp default current_timestamp
)
on commit preserve rows;

commit;

create global temporary table MyTxGTT (
  id int not null primary key,
  parent_id int not null references MyConnGTT(id),
  txt varchar(32),
  ts timestamp default current_timestamp
);

commit;
```

### Tip

In an existing database, it's not always easy to tell a regular table from a GTT, or a transaction-level GTT from a connection-level GTT. Use this query to find out a table's type:

```
select t.rdb$type_name
  from rdb$relations r
  join rdb$types t on r.rdb$relation_type = t.rdb$type
  where t.rdb$field_name = 'RDB$RELATION_TYPE'
  and r.rdb$relation_name = 'TABLENAME'
```

Or, for an overview of all your relations:

```
select r.rdb$relation_name, t.rdb$type_name
  from rdb$relations r
  join rdb$types t on r.rdb$relation_type = t.rdb$type
  where t.rdb$field_name = 'RDB$RELATION_TYPE'
  and coalesce (r.rdb$system_flag, 0) = 0
```

## GENERATED ALWAYS AS

*Added in:* 2.1

*Description:* Instead of COMPUTED [BY], you may also use the SQL-2003-compliant equivalent GENERATED ALWAYS AS for computed fields.

*Syntax:*

```
colname [coltype] GENERATED ALWAYS AS (expression)
```

*Example:*

```
create table Persons (
  id int primary key,
  firstname varchar(24) not null,
  middlename varchar(24),
  lastname varchar(24) not null,
  fullname varchar(74) generated always as
    (firstname || coalesce(' ' || middlename, '') || ' ' || lastname),
  street varchar(32),
  ...
  ...
)
```

*Note:* GENERATED ALWAYS AS is not currently supported in index definitions.

## CHECK accepts NULL outcome

*Changed in:* 2.0

*Description:* If a CHECK constraint resolves to NULL, Firebird versions before 2.0 reject the input. Following the SQL standard to the letter, Firebird 2.0 and above let NULLs pass and only consider the check failed if the outcome is false.

*Example:*

Checks like these:

```
check (value > 10000)
```

```
check (Town like 'Amst%')
```

```
check (upper(value) in ( 'A', 'B', 'X' ))
```

```
check (Minimum <= Maximum)
```

all *fail* in pre-2.0 Firebird versions if the value to be checked is NULL. In 2.0 and above they *succeed*.

### Warning

This change may cause existing databases to behave differently when migrated to Firebird 2.0+. Carefully examine your CREATE/ALTER TABLE statements and add “and XXX is not null” predicates to your CHECKS if they should continue to reject NULL input.

## Context variables as column defaults

*Changed in:* IB

*Description:* Any context variable that is assignment-compatible to the column datatype can be used as a default. This was already the case in InterBase 6, but the *Language Reference* only mentioned USER.

*Example:*

```
create table MyData (
  id int not null primary key,
```

```
record_created timestamp default current_timestamp,  
    ...  
)
```

## FOREIGN KEY without target column references PK

*Changed in:* IB

*Description:* If you create a foreign key without specifying a target column, it will reference the **primary key** of the target table. This was already the case in InterBase 6, but the IB Language Reference wrongly states that in such cases, the engine scans the target table for a column with the same name as the referencing column.

*Example:*

```
create table eik (  
    a int not null primary key,  
    b int not null unique  
);  
  
create table beuk (  
    b int references eik  
);  
  
-- beuk.b references eik.a, not eik.b !
```

## FOREIGN KEY creation no longer requires exclusive access

*Changed in:* 2.0

*Description:* In Firebird 2.0 and above, creating a foreign key constraint no longer requires exclusive access to the database.

## UNIQUE constraints now allow NULLS

*Changed in:* 1.5

*Description:* In compliance with the SQL-99 standard, NULLs – even multiple – are now allowed in columns with a UNIQUE constraint. It is therefore possible to define a UNIQUE key on a column that has no NOT NULL constraint.

For UNIQUE keys that span multiple columns, the logic is a little complicated:

- Multiple rows having *all* the UK columns NULL are allowed.
- Multiple rows having a *different subset* of UK columns NULL are allowed.
- Multiple rows having the *same subset* of UK columns NULL and the rest filled with regular values and those regular values *differ* in at least one column, are allowed.
- Multiple rows having the *same subset* of UK columns NULL and the rest filled with regular values and those regular values are the *same* in every column, are forbidden.

One way of summarizing this is as follows: In principle, all NULLs are considered distinct. But if two rows have exactly the same subset of UK columns filled with non-NULL values, the NULL columns are ignored and the non-NULL columns are decisive, just as if they constituted the entire unique key.

## USING INDEX subclause

Available in: DSQL

Added in: 1.5

*Description:* A USING INDEX subclause can be placed at the end of a primary, unique or foreign key definition. Its purpose is to

- provide a user-defined name for the automatically created index that enforces the constraint, and
- optionally define the index to be ascending or descending (the default being ascending).

Without USING INDEX, indices enforcing named constraints are named after the constraint (this is new behaviour in Firebird 1.5) and indices for unnamed constraints get names like RDB\$FOREIGN13 or something equally romantic.

### Note

You must always provide a *new* name for the index. It is not possible to use pre-existing indices to enforce constraints.

USING INDEX can be applied at field level, at table level, and (in ALTER TABLE) with ADD CONSTRAINT. It works with named as well as unnamed key constraints. It does *not* work with CHECK constraints, as these don't have their own enforcing index.

*Syntax:*

```
[CONSTRAINT constraint-name]
  <constraint-type> <constraint-definition>
  [USING [ASC[ENDING] | DESC[ENDING]] INDEX index_name]
```

*Examples:*

The first example creates a primary key constraint PK\_CUST using an index named IX\_CUSTNO:

```
create table customers (
  custno int not null constraint pk_cust primary key using index ix_custno,
  ...
```

This, however:

```
create table customers (
  custno int not null primary key using index ix_custno,
  ...
```

...will give you a PK constraint called INTEG\_7 or something similar, and an index IX\_CUSTNO.

Some more examples:

```
create table people (
  id int not null,
  nickname varchar(12) not null,
  country char(4),
  ..
```

```
..
constraint pk_people primary key (id),
constraint uk_nickname unique (nickname) using index ix_nick
)
```

```
alter table people
add constraint fk_people_country
foreign key (country) references countries(code)
using desc index ix_people_country
```

**Important**

If you define a descending constraint-enforcing index on a primary or unique key, be sure to make any foreign keys referencing it descending as well.

## ALTER TABLE

Available in: DSQL, ESQL

### ADD column: Context variables as defaults

Changed in: IB

*Description:* Any context variable that is assignment-compatible to the new column's datatype can be used as a default. This was already the case in InterBase 6, but the *Language Reference* only mentioned USER.

*Example:*

```
alter table MyData
add MyDay date default current_date
```

### ALTER COLUMN also for generated (computed) columns

Available in: DSQL

Added in: 2.5

*Description:* Firebird 2.5 supports the altering of generated (computed) columns, something that was previously impossible. Only the data type and the generation expression can be changed; you cannot change a base column into a generated column or vice versa.

*Syntax:*

```
ALTER TABLE tablename ALTER [COLUMN] gencolname
[TYPE datatype]
{GENERATED ALWAYS AS | COMPUTED BY} (expression)
```

*Example:*

```
create table nums (a int, b generated always as (3*a));
commit;

alter table nums alter b generated always as (4*a + 7);
commit;
```

Notice that you can use `GENERATED ALWAYS AS` when altering columns defined with `COMPUTED BY` and vice versa.

## ALTER COLUMN ... TYPE no longer fails if column is used in trigger or SP

Changed in: 2.5

*Description:* Previously, if a table column was referenced in a stored procedure or trigger, the column's type could not be changed, even if the change would not break the PSQL code. Now such changes are permitted – even if they *do* break the code.

### Warning

This means that, in the current situation, you can commit changes that break SP's or triggers without getting as much as a warning! For information on how to track down invalidated PSQL modules after a column type change, please read the note *The RDB\$VALID\_BLR field*, near the end of this document.

## ALTER COLUMN: DROP DEFAULT

Available in: DSQL

Added in: 2.0

*Description:* Firebird 2 adds the possibility to drop a column-level default. Once the default is dropped, there will either be no default in place or – if the column's type is a DOMAIN with a default – the domain default will resurface.

*Syntax:*

```
ALTER TABLE tablename ALTER [COLUMN] colname DROP DEFAULT
```

*Example:*

```
alter table Trees alter Girth drop default
```

An error is raised if you use `DROP DEFAULT` on a column that doesn't have a default or whose effective default is domain-based.

## ALTER COLUMN: SET DEFAULT

Available in: DSQL

Added in: 2.0

*Description:* Firebird 2 adds the possibility to set/alter defaults on existing columns. If the column already had a default, the new default will replace it. Column-level defaults always override domain-level defaults.

*Syntax:*

```
ALTER TABLE tablename ALTER [COLUMN] colname SET DEFAULT <default>
<default> ::= literal-value | context-variable | NULL
```

*Example:*

```
alter table Customers alter EnteredBy set default current_user
```

**Tip**

If you want to switch off a domain-based default on a column, set the column default to NULL.

**ALTER COLUMN: POSITION now 1-based**

*Changed in:* 1.0

*Description:* When changing a column's position, the engine now interprets the new position as 1-based. This is in accordance with the SQL standard and the InterBase documentation, but in practice InterBase interpreted the position as 0-based.

*Syntax:*

```
ALTER TABLE tablename ALTER [COLUMN] colname POSITION <newpos>
```

```
<newpos> ::= an integer between 1 and the number of columns
```

*Example:*

```
alter table Stock alter Quantity position 3
```

**Note**

Don't confuse this with the POSITION in CREATE/ALTER TRIGGER. Trigger positions are and will remain 0-based.

**CHECK accepts NULL outcome**

*Changed in:* 2.0

*Description:* If a CHECK constraint resolves to NULL, Firebird versions before 2.0 reject the input. Following the SQL standard to the letter, Firebird 2.0 and above let NULLs pass and only consider the check failed if the outcome is false. For more information see under *CREATE TABLE*.

**FOREIGN KEY without target column references PK**

*Changed in:* IB

*Description:* If you create a foreign key without specifying a target column, it will reference the **primary key** of the target table. This was already the case in InterBase 6, but the IB Language Reference wrongly states that in such cases, the engine scans the target table for a column with the same name as the referencing column.

*Example:*

```
create table eik (
  a int not null primary key,
  b int not null unique
);
```

```
create table beuk (
  b int
);
```



```
alter table beuk
  add constraint fk_beuk
  foreign key (b) references eik;

-- beuk.b now references eik.a, not eik.b !
```

## FOREIGN KEY creation no longer requires exclusive access

*Changed in: 2.0*

*Description:* In Firebird 2.0 and above, adding a foreign key constraint no longer requires exclusive access to the database.

## GENERATED ALWAYS AS

*Added in: 2.1*

*Description:* Instead of COMPUTED [BY], you may also use the SQL-2003-compliant equivalent GENERATED ALWAYS AS for computed fields.

*Syntax:*

```
colname [coltype] GENERATED ALWAYS AS (expression)
```

*Example:*

```
alter table Friends
  add fullname varchar(74)
  generated always as
  (firstname || coalesce(' ' || middlename, '') || ' ' || lastname)
```

## UNIQUE constraints now allow NULLS

*Changed in: 1.5*

*Description:* In compliance with the SQL-99 standard, NULLS – even multiple – are now allowed in columns with a UNIQUE constraint. For a full discussion, see [CREATE TABLE :: UNIQUE constraints now allow NULLS](#).

## USING INDEX subclause

*Available in: DSQL*

*Added in: 1.5*

*Description:* A USING INDEX subclause can be placed at the end of a primary, unique or foreign key definition. Its purpose is to

- provide a user-defined name for the automatically created index that enforces the constraint, and
- optionally define the index to be ascending or descending (the default being ascending).

*Syntax:*

```
[ADD] [CONSTRAINT constraint-name]
  <constraint-type> <constraint-definition>
  [USING [ASC[ENDING] | DESC[ENDING]] INDEX index_name]
```

For a full discussion and examples, see [CREATE TABLE :: USING INDEX subclause](#).

## RECREATE TABLE

Available in: DSQL

Added in: 1.0

*Description:* Creates or recreates a table. If a table with the same name already exists, RECREATE TABLE will try to drop it (destroying all its data in the process!) and create a new table. RECREATE TABLE will fail if the existing table is in use.

*Syntax:* Exactly the same as [CREATE TABLE](#).

# TRIGGER

## CREATE TRIGGER

Available in: DSQL, ESQL

*Description:* Creates a trigger, a block of PSQL code that is executed automatically upon certain database events or mutations to a table or view.

*Syntax:*

```
CREATE TRIGGER name
  {<relation_trigger_legacy>
   | <relation_trigger_sql2003>
   | <database_trigger> }
AS
  [<declarations>]
BEGIN
  [<statements>]
END

<relation_trigger_legacy> ::= FOR {tablename | viewname}
                             [ACTIVE | INACTIVE]
                             {BEFORE | AFTER} <mutation_list>
                             [POSITION number]

<relation_trigger_sql2003> ::= [ACTIVE | INACTIVE]
                              {BEFORE | AFTER} <mutation_list>
                              [POSITION number]
                              ON {tablename | viewname}

<database_trigger> ::= [ACTIVE | INACTIVE]
                      ON db_event
                      [POSITION number]

<mutation_list> ::= mutation [OR mutation [OR mutation]]
mutation ::= INSERT | UPDATE | DELETE
```

```

db_event          ::= CONNECT | DISCONNECT | TRANSACTION START
                  | TRANSACTION COMMIT | TRANSACTION ROLLBACK

number           ::= 0..32767 (default is 0)

<declarations>   ::= See PSQL::DECLARE for the exact syntax

```

- “Legacy” and “sql2003” relation triggers are exactly the same. The only thing that differs is the creation syntax.
- Triggers with lower position numbers fire first. Position numbers need not be unique, but if two or more triggers have the same position, the firing order between them is undefined.
- When defining relation triggers, each mutation type (INSERT, UPDATE or DELETE) may occur at most once in the mutation list.

## SQL-2003-compliant syntax for relation triggers

*Added in: 2.1*

*Description:* Since Firebird 2.1, an alternative, SQL-2003-compliant syntax can be used for triggers on tables and views. Instead of specifying “FOR *relationname*” before the event type and the optional directives surrounding it, you can now put “ON *relationname*” after it, as shown in the syntax earlier in this chapter.

*Example:*

```

create trigger biu_books
  active before insert or update position 3
  on books
as
begin
  if (new.id is null)
    then new.id = next value for gen_bookids;
end

```

## Database triggers

*Added in: 2.1*

*Description:* Since Firebird 2.1, triggers can be defined to fire upon the database events CONNECT, DISCONNECT, TRANSACTION START, TRANSACTION COMMIT and TRANSACTION ROLLBACK. Only the database owner and SYSDBA can create, alter and drop these triggers.

*Syntax:*

```

CREATE TRIGGER name
  [ACTIVE | INACTIVE]
  ON db_event
  [POSITION number]
  AS
    [<declarations>]
  BEGIN
    [<statements>]
  END

db_event          ::= CONNECT | DISCONNECT | TRANSACTION START

```

	TRANSACTION COMMIT   TRANSACTION ROLLBACK
<code>number</code>	::= 0..32767 (default is 0)
<code>&lt;declarations&gt;</code>	::= See <a href="#">PSQL::DECLARE</a> for the exact syntax

*Example:*

```
create trigger tr_connect
  on connect
as
begin
  insert into dblog (wie, wannear, wat)
    values (current_user, current_timestamp, 'verbind');
end
```

*Execution of database triggers and handling of exceptions:*

- CONNECT and DISCONNECT triggers are executed in a transaction created specifically for this purpose. If all goes well, the transaction is committed. Uncaught exceptions roll back the transaction, and:
  - In the case of a CONNECT trigger, the connection is then broken and the exception returned to the client.
  - With a DISCONNECT trigger, exceptions are not reported and the connection is broken as foreseen.
- TRANSACTION triggers are executed within the transaction whose opening, committing or rolling-back evokes them. The actions taken after an uncaught exception depend on the type:
  - In a START trigger, the exception is reported to the client and the transaction is rolled back.
  - In a COMMIT trigger, the exception is reported, the trigger's actions so far are undone and the commit is canceled.
  - In a ROLLBACK trigger, the exception is not reported and the transaction is rolled back as foreseen.
- It follows from the above that there is no direct way of knowing if a DISCONNECT or TRANSACTION ROLLBACK trigger caused an exception.
- It also follows that you can't connect to a database if a CONNECT trigger causes an exception, and that you can't start a transaction if a TRANSACTION START trigger does so. Both phenomena effectively lock you out of your database while you need to get in there to fix the problem. See the note below for a way around this Catch-22 situation.
- In the case of a two-phase commit, TRANSACTION COMMIT triggers fire in the prepare, not the commit phase.

#### Note

Some Firebird command-line tools have been supplied with new switches to suppress the automatic firing of database triggers:

```
gbak -nodbtriggers
isql -nodbtriggers
nbackup -T
```

These switches can only be used by the database owner and SYSDBA.

## TYPE OF COLUMN in variable declarations

*Added in: 2.5*

*Description:* Analogous to the “TYPE OF *domain*” syntax supported since version 2.1, it is now also possible to declare variables as having the type of an existing table or view column. See [PSQL::DECLARE](#) for syntax and details.

## Domains instead of data types

*Changed in: 2.1*

*Description:* Firebird 2.1 and up allow the use of domains instead of SQL data types when declaring local trigger variables. See [PSQL::DECLARE](#) for the exact syntax and details.

## COLLATE in variable declarations

*Changed in: 2.1*

*Description:* Firebird 2.1 and up allow COLLATE clauses in local variable declarations. See [PSQL::DECLARE](#) for syntax and details.

## NOT NULL in variable declarations

*Changed in: 2.1*

*Description:* Firebird 2.1 and up allow NOT NULL constraints in local variable declarations. See [PSQL::DECLARE](#) for syntax and details.

## Multi-action triggers

*Added in: 1.5*

*Description:* Relation triggers can be defined to fire upon multiple operations (INSERT and/or UPDATE and/or DELETE). Three new boolean context variables (INSERTING, UPDATING and DELETING) have been added so you can execute code conditionally within the trigger body depending on the type of operation.

*Example:*

```
create trigger biu_parts for parts
  before insert or update
as
begin
  /* conditional code when inserting: */
  if (inserting and new.id is null)
    then new.id = gen_id(gen_partrec_id, 1);

  /* common code: */
  new.partname_upper = upper(new.partname);
end
```

**Note**

In multi-action triggers, both context variables OLD and NEW are always available. If you use them in the wrong situation (i.e. OLD while inserting or NEW while deleting), the following happens:

- If you try to read their field values, NULL is returned.
- If you try to assign values to them, a runtime exception is thrown.

**BEGIN ... END blocks may be empty**

*Changed in:* 1.5

*Description:* BEGIN ... END blocks may be empty in Firebird 1.5 and up, allowing you to write stub code without having to resort to dummy statements.

*Example:*

```
create trigger bi_atable for atable
active before insert position 0
as
begin
end
```

**CREATE TRIGGER no longer increments table change count**

*Changed in:* 1.0

*Description:* In contrast to InterBase, Firebird does not increment the metadata change counter of the associated table when CREATE, ALTER or DROP TRIGGER is used. For a full discussion, see *ALTER TRIGGER no longer increments table change count*.

**PLAN allowed in trigger code**

*Changed in:* 1.5

*Description:* Before Firebird 1.5, a trigger containing a PLAN statement would be rejected by the compiler. Now a valid plan can be included and will be used.

**ALTER TRIGGER**

*Available in:* DSQL, ESQL

*Description:* Alters an existing trigger. Relation triggers cannot be changed into database triggers or vice versa. The associated table or view of a relation trigger cannot be changed.

*Syntax:*

```
ALTER TRIGGER name
[ACTIVE | INACTIVE]
[ {BEFORE | AFTER} <mutation_list> | ON db_event ]
[POSITION number]
[AS
  [<declarations>]
```

```
BEGIN
  [<statements>]
END      ]
```

- See [CREATE TRIGGER](#) for the meaning of `<mutation_list>` etc.

## Database triggers

*Added in:* 2.1

*Description:* The ALTER TRIGGER syntax (see above) has been extended to support database triggers. For a full discussion of this feature, see [CREATE TRIGGER :: Database triggers](#).

## TYPE OF COLUMN in variable declarations

*Added in:* 2.5

*Description:* Analogous to the “TYPE OF *domain*” syntax supported since version 2.1, it is now also possible to declare variables as having the type of an existing table or view column. See [PSQL::DECLARE](#) for syntax and details.

## Domains instead of data types

*Changed in:* 2.1

*Description:* Firebird 2.1 and up allow the use of domains instead of SQL data types when declaring local trigger variables. See [PSQL::DECLARE](#) for the exact syntax and details.

## COLLATE in variable declarations

*Changed in:* 2.1

*Description:* Firebird 2.1 and up allow COLLATE clauses in local variable declarations. See [PSQL::DECLARE](#) for syntax and details.

## NOT NULL in variable declarations

*Changed in:* 2.1

*Description:* Firebird 2.1 and up allow NOT NULL constraints in local variable declarations. See [PSQL::DECLARE](#) for syntax and details.

## Multi-action triggers

*Added in:* 1.5

*Description:* The ALTER TRIGGER syntax (see above) has been extended to support multi-action triggers. For a full discussion of this feature, see [CREATE TRIGGER :: Multi-action triggers](#).

## Restriction on altering used triggers

*Changed in:* 2.0, 2.0.1

*Description:* In Firebird 2.0 only, a restriction is in place which prevents anyone from dropping, altering or recreating a trigger or stored procedure if it has been used since the database was opened. This restriction has been removed again in version 2.0.1. Still, performing these operations on a live database is potentially risky and should only be done with the utmost care.

## **PLAN allowed in trigger code**

*Changed in:* 1.5

*Description:* Before Firebird 1.5, a trigger containing a PLAN statement would be rejected by the compiler. Now a valid plan can be included and will be used.

## **ALTER TRIGGER no longer increments table change count**

*Changed in:* 1.0

*Description:* Each time you use CREATE, ALTER or DROP TRIGGER, InterBase increments the metadata change counter of the associated table. Once that counter reaches 255, no more metadata changes are possible on the table (you can still work with the data though). A backup-restore cycle is needed to reset the counter and perform metadata operations again.

While this obligatory cleanup after many metadata changes is in itself a useful feature, it also means that users who regularly use ALTER TRIGGER to deactivate triggers during e.g. bulk import operations are forced to backup and restore much more often than needed.

Since changes to triggers don't imply structural changes to the table itself, Firebird no longer increments the table change counter when CREATE, ALTER or DROP TRIGGER is used. One thing has remained though: once the counter is at 255, you can no longer create, alter or drop triggers for that table.

## **CREATE OR ALTER TRIGGER**

*Available in:* DSQL

*Added in:* 1.5

*Description:* If the trigger does not yet exist, it is created just as if CREATE TRIGGER were used. If it already exists, it is altered and recompiled. Existing permissions and dependencies are preserved.

*Syntax:* Exactly the same as for CREATE TRIGGER.

## **DROP TRIGGER**

*Available in:* DSQL, ESQL

## **Restriction on dropping used triggers**

*Changed in:* 2.0, 2.0.1

*Description:* In Firebird 2.0 only, a restriction is in place which prevents anyone from dropping, altering or recreating a trigger or stored procedure if it has been used since the database was opened. This restriction has been removed again in version 2.0.1. Still, performing these operations on a live database is potentially risky and should only be done with the utmost care.



## DROP TRIGGER no longer increments table change count

*Changed in:* 1.0

*Description:* In contrast to InterBase, Firebird does not increment the metadata change counter of the associated table when CREATE, ALTER or DROP TRIGGER is used. For a full discussion, see [ALTER TRIGGER no longer increments table change count](#).

## RECREATE TRIGGER

*Available in:* DSQL

*Added in:* 2.0

*Description:* Creates or recreates a trigger. If a trigger with the same name already exists, RECREATE TRIGGER will try to drop it and create a new trigger. RECREATE TRIGGER will fail if the existing trigger is in use.

*Syntax:* Exactly the same as [CREATE TRIGGER](#).

## Restriction on recreating used triggers

*Changed in:* 2.0, 2.0.1

*Description:* In Firebird 2.0 only, a restriction is in place which prevents anyone from dropping, altering or recreating a trigger or stored procedure if it has been used since the database was opened. This restriction has been removed again in version 2.0.1. Still, performing these operations on a live database is potentially risky and should only be done with the utmost care.

# VIEW

## CREATE VIEW

*Available in:* DSQL, ESQL

*Syntax:*

```
CREATE VIEW viewname [<full_column_list>]
  AS
  <select_statement>
  [WITH CHECK OPTION]

<full_column_list> ::= (colname [, colname ...])
```

## Views can select from stored procedures

*Changed in:* 2.5

*Description:* In Firebird 2.5 and up, views can select from selectable stored procedures.

*Example:*

```
create view low_bones as
  select id, name, description from them_bones('human')
  where name in ('leg_bone', 'foot_bone', 'toe_bone')
```

## Views can infer column names from derived tables or GROUP BY

*Changed in: 2.5*

*Description:* In Firebird 2.5 and up, views can infer the names of columns from a derived table or involved in a GROUP BY clause. Previously it was necessary to specify explicit aliases for these columns (either per column or in a full list).

*Examples:*

```
create view tickle as
  select t from (select t from tackle)
```

```
create view vstocks as
  select kind, sum(stock) s from stocks
  group by kind
```

In the second example, notice that it is still necessary to alias the SUM column. Previous Firebird versions also required an explicit alias for the KIND column.

## Per-column aliases supported in view definition

*Changed in: 2.1*

*Description:* Firebird 2.1 and up allow the use of column aliases in the SELECT statement. You can alias none, some or all of the columns; each alias used becomes the name of the corresponding view column.

*Syntax (partial):*

```
CREATE VIEW viewname [<full_column_list>]
  AS
  SELECT <column_def> [, <column_def> ...]
  ...

<full_column_list> ::= (colname [, colname ...])

<column_def>      ::= {source_col | expr} [[AS] colalias]
```

*Notes:*

- If the full column list is also present, specifying column aliases is futile as they will be overridden by the names in the column list.
- The full column list used to be mandatory for views whose SELECT statement contains expression-based columns or identical column names. Now you can omit the full column list, provided that you alias such columns in the SELECT clause.

## Full SELECT syntax supported

*Changed in: 2.0, 2.5*

*Description:* From Firebird 2.0 onward view definitions are considered full-fledged SELECT statements. Consequently, the following elements are (re)allowed in view definitions: FIRST, SKIP, ROWS, ORDER BY, PLAN and UNION.

**Note**

In Firebird 2.5 and up, it is no longer necessary to supply a view column list if the view is based on a UNION:

```
create view vplanes as
  select make, model from jets
  union
  select make, model from props
  union
  select make, model from gliders
```

The column names will be taken from the union. Of course you can still override them with a view column list.

## PLAN subclause disallowed in 1.5, reallowed in 2.0

*Changed in:* 1.5, 2.0

*Description:* Firebird versions 1.5.x forbid the use of a PLAN subclause in a view definition. From 2.0 onward a PLAN is allowed again.

## Triggers on updatable views block auto-writethrough

*Changed in:* 2.0

*Description:* In versions prior to 2.0, Firebird often did not block the automatic writethrough to the underlying table if one or more triggers were defined on a naturally updatable view. This could cause mutations to be performed twice unintentionally, sometimes leading to data corruption and other mishaps. Starting at Firebird 2.0, this misbehaviour has been corrected: now if you define a trigger on a naturally updatable view, no mutations to the view will be automatically passed on to the table; either your trigger takes care of that, or nothing will. This is in accordance with the description in the InterBase 6 *Data Definition Guide* under *Updating views with triggers*.

**Warning**

Some people have developed code that counts on or takes advantage of the prior behaviour. Such code should be corrected for Firebird 2.0 and higher, or mutations may not reach the table at all.

## View with non-participating NOT NULL columns in base table can be made insertable

*Changed in:* 2.0

*Description:* Any view whose base table contains one or more non-participating NOT NULL columns is read-only by nature. It can be made updatable by the use of triggers, but even with those, all INSERT attempts into such views used to fail because the NOT NULL constraint on the base table was checked before the view trigger got a chance to put things right. In Firebird 2.0 and up this is no longer the case: provided the right trigger is in place, such views are now insertable.

*Example:*

The view below would give validation errors for any insert attempts in Firebird 1.5 and earlier. In Firebird 2.0 and up it is insertable:

```
create table base (x int not null, y int not null);

create view vbase as select x from base;

set term #;
create trigger bi_base for vbase before insert
as
begin
  if (new.x is null) then new.x = 33;
  insert into base values (new.x, 0);
end#
set term ;#
```

*Notes:*

- Please notice that the problem described above only occurred for NOT NULL columns that were left *outside* the view.
- Oddly enough, the problem would be gone if the base table itself had a trigger converting NULL input to something valid. But then there was a risk that the insert would take place twice, due to the [auto-writethrough bug](#) that has also been fixed in Firebird 2.

## **ALTER VIEW**

*Available in:* DSQL

*Added in:* 2.5

*Description:* Firebird 2.5 and up support ALTER VIEW, allowing you to change a view's definition without having to drop it first. Existing dependencies are preserved.

*Syntax:* Exactly the same as [CREATE VIEW](#).

## **CREATE OR ALTER VIEW**

*Available in:* DSQL

*Added in:* 2.5

*Description:* CREATE OR ALTER VIEW will create the view if it doesn't exist. Otherwise, it will alter the existing view, preserving existing dependencies.

*Syntax:* Exactly the same as [CREATE VIEW](#).

## **RECREATE VIEW**

*Available in:* DSQL

*Added in:* 1.5

*Description:* Creates or recreates a view. If a view with the same name already exists, RECREATE VIEW will try to drop it and create a new view. RECREATE VIEW will fail if the existing view is in use.

*Syntax:* Exactly the same as [CREATE VIEW](#).

# DML statements

## DELETE

Available in: DSQL, ESQL, PSQL

*Description:* Deletes rows from a database table (or from one or more tables underlying a view), depending on the WHERE and ROWS clauses.

*Syntax:*

```
DELETE
  [TRANSACTION name]
  FROM {tablename | viewname} [[AS] alias]
  [WHERE {search-conditions | CURRENT OF cursorname}]
  [PLAN plan_items]
  [ORDER BY sort_items]
  [ROWS <m> [TO <n>]]
  [RETURNING <values> [INTO <variables>]]

<m>, <n>      ::= Any expression evaluating to an integer.
<values>       ::= value_expression [, value_expression ...]
<variables>    ::= :varname [, :varname ...]
```

### Restrictions

- The TRANSACTION directive is only available in ESQL.
- In a pure DSQL session, WHERE CURRENT OF isn't of much use, since there exists no DSQL statement to create a cursor.
- The PLAN, ORDER BY and ROWS clauses are not available in ESQL.
- The RETURNING clause is not available in ESQL.
- The “INTO <*variables*>” subclause is only available in PSQL.
- When returning values into the context variable NEW, this name must not be preceded by a colon (“:”).

## COLLATE subclause for text BLOB columns

Added in: 2.0

*Description:* COLLATE subclauses are now also supported for text BLOBs.

*Example:*

```
delete from MyTable
  where NameBlob collate pt_br = 'João'
```

## ORDER BY

Available in: DSQL, PSQL

Added in: 2.0

*Description:* DELETE now allows an ORDER BY clause. This only makes sense in combination with ROWS, but is also valid without it.

## PLAN

Available in: DSQL, PSQL

Added in: 2.0

*Description:* DELETE now allows a PLAN clause, so users can optimize the operation manually.

## Relation alias makes real name unavailable

Changed in: 2.0

*Description:* If you give a table or view an alias in a Firebird 2.0 or above statement, you *must* use the alias, not the table name, if you want to qualify fields from that relation.

*Examples:*

Correct usage:

```
delete from Cities where name starting 'Alex'
```

```
delete from Cities where Cities.name starting 'Alex'
```

```
delete from Cities C where name starting 'Alex'
```

```
delete from Cities C where C.name starting 'Alex'
```

No longer possible:

```
delete from Cities C where Cities.name starting 'Alex'
```

## RETURNING

Available in: DSQL, PSQL

Added in: 2.1

*Description:* A DELETE statement removing *at most one row* may optionally include a RETURNING clause in order to return values from the deleted row. The clause, if present, need not contain all of the relation's columns and may also contain other columns or expressions.

*Examples:*

```
delete from Scholars
```

```
where firstname = 'Henry' and lastname = 'Higgins'
returning lastname, fullname, id
```

```
delete from Dumbbells
order by iq desc
rows 1
returning lastname, iq into :lname, :iq;
```

*Notes:*

- In DSQL, a statement with a RETURNING clause *always* returns exactly one row. If no record was actually deleted, the fields in this row are all NULL. This behaviour may change in a later version of Firebird. In PSQL, if no row was deleted, nothing is returned, and the receiving variables keep their existing values.

## ROWS

*Available in:* DSQL, PSQL*Added in:* 2.0*Description:* Limits the amount of rows deleted to a specified number or range.*Syntax:*

```
ROWS <m> [TO <n>]
<m>, <n> ::= Any expression evaluating to an integer.
```

With a single argument  $m$ , the deletion is limited to the first  $m$  rows of the dataset defined by the table or view and the optional WHERE and ORDER BY clauses.

*Points to note:*

- If  $m >$  the total number of rows in the dataset, the entire set is deleted.
- If  $m = 0$ , no rows are deleted.
- If  $m < 0$ , an error is raised.

With two arguments  $m$  and  $n$ , the deletion is limited to rows  $m$  to  $n$  inclusively. Row numbers are 1-based.

*Points to note when using two arguments:*

- If  $m >$  the total number of rows in the dataset, no rows are deleted.
- If  $m$  lies within the set but  $n$  doesn't, the rows from  $m$  to the end of the set are deleted.
- If  $m < 1$  or  $n < 1$ , an error is raised.
- If  $n = m-1$ , no rows are deleted.
- If  $n < m-1$ , an error is raised.

ROWS can also be used with the [SELECT](#) and [UPDATE](#) statements.

## EXECUTE BLOCK

*Available in:* DSQL



*Added in:* 2.0

*Changed in:* 2.1, 2.5

*Description:* Executes a block of PSQL code as if it were a stored procedure, optionally with input and output parameters and variable declarations. This allows the user to perform “on-the-fly” PSQL within a DSQL context.

*Syntax:*

```
EXECUTE BLOCK [(<inparams>)]
    [RETURNS (<outparams>)]
AS
    [<declarations>]
BEGIN
    [<PSQL statements>]
END

<inparams>      ::= <param_decl> = ? [, <inparams> ]
<outparams>     ::= <param_decl>      [, <outparams>]
<param_decl>    ::= paramname <type> [NOT NULL] [COLLATE collation]
<type>          ::= sql_datatype | [TYPE OF] domain | TYPE OF COLUMN rel.col
<declarations> ::= See PSQL::DECLARE for the exact syntax
```

*Examples:*

This example injects the numbers 0 through 127 and their corresponding ASCII characters into the table ASCIITABLE:

```
execute block
as
declare i int = 0;
begin
    while (i < 128) do
        begin
            insert into AsciiTable values (:i, ascii_char(:i));
            i = i + 1;
        end
    end
end
```

The next example calculates the geometric mean of two numbers and returns it to the user:

```
execute block (x double precision = ?, y double precision = ?)
returns (gmean double precision)
as
begin
    gmean = sqrt(x*y);
    suspend;
end
```

Because this block has input parameters, it has to be prepared first. Then the parameters can be set and the block executed. It depends on the client software how this must be done and even if it is possible at all – see the notes below.

Our last example takes two integer values, *smallest* and *largest*. For all the numbers in the range *smallest* .. *largest*, the block outputs the number itself, its square, its cube and its fourth power.

```
execute block (smallest int = ?, largest int = ?)
```

```

returns (number int, square bigint, cube bigint, fourth bigint)
as
begin
  number = smallest;
  while (number <= largest) do
  begin
    square = number * number;
    cube   = number * square;
    fourth = number * cube;
    suspend;
    number = number + 1;
  end
end

```

Again, it depends on the client software if and how you can set the parameter values.

#### Notes:

- Some clients, especially those allowing the user to submit several statements at once, may require you to surround the EXECUTE BLOCK statement with SET TERM lines, like this:

```

set term #;
execute block (...)
as
begin
  statement1;
  statement2;
end
#
set term ;#

```

In Firebird's isql client you must set the terminator to something other than “;” before you type in the EXECUTE BLOCK statement. Otherwise isql, being line-oriented, will try to execute the part you have entered as soon as it encounters the first semicolon.

- Executing a block without input parameters should be possible with every Firebird client that allows the user to enter his or her own DSQL statements. If there are input parameters, things get trickier: these parameters must get their values after the statement is prepared but before it is executed. This requires special provisions, which not every client application offers. (Firebird's own isql, for one, doesn't.)
- The server only accepts question marks (“?”) as placeholders for the input values, not “:a”, “:MyParam” etc., or literal values. Client software may support the “:xxx” form though, which it will preprocess before sending it to the server.
- If the block has output parameters, you *must* use SUSPEND or nothing will be returned.
- Output is always returned in the form of a result set, just as with a SELECT statement. You can't use RETURNING\_VALUES or execute the block INTO some variables, even if there's only one result row.

## ***COLLATE in variable and parameter declarations***

*Changed in: 2.1*

*Description:* Firebird 2.1 and up allow COLLATE clauses in declarations of input/output parameters and local variables.

*Example:*

```
execute block
  (es_1 varchar(20) character set iso8859_1 collate es_es = ?)
returns
  (nl_1 varchar(20) character set iso8859_1 collate du_nl)
as
  declare s_temp varchar(100) character set utf8 collate unicode;
begin
  ...
  ...
end
```

## ***NOT NULL in variable and parameter declarations***

*Changed in: 2.1*

*Description:* Firebird 2.1 and up allow NOT NULL constraints in declarations of input/output parameters and local variables.

*Example:*

```
execute block (a int not null = ?, b int not null = ?)
returns (product bigint not null, message varchar(20) not null)
as
  declare useless_dummy timestamp not null;
begin
  product = a*b;
  if (product < 0) then message = 'This is below zero.';
  else if (product > 0) then message = 'This is above zero.';
  else message = 'This must be zero.';
  suspend;
end
```

## ***Domains instead of data types***

*Changed in: 2.1*

*Description:* Firebird 2.1 and up allow the use of domains instead of SQL data types when declaring input/output parameters and local variables. With the “TYPE OF” modifier only the domain's type is used, not its NOT NULL setting, CHECK constraint and/or default value. If the domain is of a text type, its character set and collation are always included.

*Example:*

```
execute block (a my_domain = ?, b type of my_other_domain = ?)
returns (p my_third_domain)
as
  declare s_temp type of my_third_domain;
begin
  ...
  ...
end
```

**Warning**

For input parameters, the collation that comes with the domain is not taken into consideration when comparisons (e.g. equality tests) are made. This is caused by a bug that has been fixed for Firebird 3.

**TYPE OF COLUMN in parameter and variable declarations**

*Added in: 2.5*

*Description:* Analogous to the “TYPE OF *domain*” syntax supported since version 2.1, it is now also possible to declare variables and parameters as having the type of an existing table or view column. Only the type itself is used; in the case of string types, this includes the character set and the collation. Constraints and default values are never copied from the source column.

*Example:*

```
create table numbers (
  bignum   numeric(18),
  smallnum numeric(9)
)

execute block (dividend  type of column numbers.bignum = ?,
              divisor   type of column numbers.smallnum = ?)
  returns (quotient  type of column numbers.bignum,
          remainder type of column numbers.smallnum)

as
begin
  quotient = dividend / divisor;
  remainder = mod (dividend, divisor);
  suspend;
end
```

**Warning**

For input parameters, the collation that comes with the column's type is not taken into consideration when comparisons (e.g. equality tests) are made. For local variables, the behaviour varies. This is caused by a bug that has been fixed for Firebird 3.

**EXECUTE PROCEDURE**

*Available in:* DSQL, ESQL, PSQL

*Changed in:* 1.5

*Description:* Executes a stored procedure. In Firebird 1.0.x as well as in InterBase, any input parameters for the SP must be supplied as literals, host language variables (in ESQL) or local variables (in PSQL). In Firebird 1.5 and above, input parameters may also be (compound) expressions, except in static ESQL.

*Syntax:*

```
EXECUTE PROCEDURE procname
  [TRANSACTION transaction]
```

```

[<in_item> [, <in_item> ...]]
[RETURNING_VALUES <out_item> [, <out_item> ...]]

<in_item>      ::= <inparam> [<nullind>]
<out_item>     ::= <outvar>  [<nullind>]
<inparam>     ::= an expression evaluating to the declared parameter type
<outvar>      ::= a host language or PSQL variable to receive the return value
<nullind>     ::= [INDICATOR]:host_lang_intvar

```

**Notes**

- TRANSACTION clauses are not supported in PSQL.
- Expression parameters are not supported in static ESQL, and not in Firebird versions below 1.5.
- NULL indicators are only valid in ESQL code. They must be host language variables of type integer.
- In ESQL, variable names used as parameters or outvars must be preceded by a colon (“:”). In PSQL the colon is generally optional, but forbidden for the trigger context variables OLD and NEW.

*Examples:*

In PSQL (with optional colons):

```

execute procedure MakeFullName
  :FirstName, :MiddleName, :LastName
returning_values :FullName;

```

The same call in ESQL (with obligatory colons):

```

exec sql
  execute procedure MakeFullName
    :FirstName, :MiddleName, :LastName
  returning_values :FullName;

```

...and in Firebird's command-line utility isql (with literal parameters):

```

execute procedure MakeFullName
  'J', 'Edgar', 'Hoover';

```

**Note:** In isql, don't use RETURNING\_VALUES. Any output values are shown automatically.

Finally, a PSQL example with expression parameters, only possible in Firebird 1.5 and up:

```

execute procedure MakeFullName
  'Mr./Mrs. ' || FirstName, MiddleName, upper(LastName)
returning_values FullName;

```

## INSERT

*Available in:* DSQL, ESQL, PSQL

*Description:* Adds rows to a database table, or to one or more tables underlying a view. Field values can be given in the VALUES clause, they can be totally absent (in both cases, exactly one row is inserted), or they can come from a SELECT statement (0 to many rows inserted).

Syntax:

```
INSERT [TRANSACTION name]
  INTO {tablename | viewname}
  {DEFAULT VALUES | [(column_list)] value_source}
  [RETURNING value_list [INTO variables]]

<column_list> ::= colname [, colname ...]
<value_source> ::= VALUES (<value_list>) | <select_stmt>
<value_list> ::= value_expression [, value_expression ...]
<variables> ::= :varname [, :varname ...]
<select_stmt> ::= a SELECT whose result set fits the target columns
```

### Restrictions

- The TRANSACTION directive is only available in ESQL.
- The RETURNING clause is not available in ESQL.
- The “INTO *variables*” subclause is only available in PSQL.
- When returning values into the context variable NEW, this name must not be preceded by a colon (“:”).
- Since v. 2.0, no column may appear more than once in the insert list.

## INSERT ... DEFAULT VALUES

Available in: DSQL, PSQL

Added in: 2.1

*Description:* The DEFAULT VALUES clause allows insertion of a record without providing any values at all, neither directly nor from a SELECT statement. This is only possible if every NOT NULL or CHECKED column in the table either has a valid default declared or gets such a value from a BEFORE INSERT trigger. Furthermore, triggers providing required field values must not depend on the presence of input values.

*Example:*

```
insert into journal default values
  returning entry_id
```

## RETURNING clause

Available in: DSQL, PSQL

Added in: 2.0

Changed in: 2.1

*Description:* An INSERT statement adding *at most one row* may optionally include a RETURNING clause in order to return values from the inserted row. The clause, if present, need not contain all of the insert columns and may also contain other columns or expressions. The returned values reflect any changes that may have been made in BEFORE triggers, but not those in AFTER triggers.

*Examples:*

```
insert into Scholars (firstname, lastname, address, phone, email)
  values ('Henry', 'Higgins', '27A Wimpole Street', '3231212', null)
```

```
returning lastname, fullname, id
```

```
insert into Dumbbells (firstname, lastname, iq)
select fname, lname, iq from Friends order by iq rows 1
returning id, firstname, iq into :id, :fname, :iq;
```

Notes:

- RETURNING is only supported for VALUES inserts and – since version 2.1 – singleton SELECT inserts.
- In DSQL, a statement with a RETURNING clause *always* returns exactly one row. If no record was actually inserted, the fields in this row are all NULL. This behaviour may change in a later version of Firebird. In PSQL, if no row was inserted, nothing is returned, and the receiving variables keep their existing values.

## UNION allowed in feeding SELECT

Changed in: 2.0

Description: A SELECT query used in an INSERT statement may now be a UNION.

Example:

```
insert into Members (number, name)
select number, name from NewMembers where Accepted = 1
union
select number, name from SuspendedMembers where Vindicated = 1
```

## MERGE

Available in: DSQL, PSQL

Added in: 2.1

Description: Merges data into a table or view. The source may be a table, view or [derived table](#) (i.e. a parenthesized SELECT statement or [CTE](#)). Each source record will be used to update one or more target records, insert a new record in the target table, or neither. The action taken depends on the provided condition and the WHEN clause(s). The condition will typically contain a comparison of fields in the source and target relations.

Syntax:

```
MERGE INTO {tablename | viewname} [[AS] alias]
USING {tablename | viewname | (select_stmt)} [[AS] alias]
ON condition
WHEN MATCHED THEN UPDATE SET colname = value [, colname = value ...]
WHEN NOT MATCHED THEN INSERT [(<columns>)] VALUES (<values>)

<columns> ::= colname [, colname ...]
<values> ::= value [, value ...]
```

**Note:** It is allowed to provide only one of the WHEN clauses

Examples:

```
merge into books b
```

```

using purchases p
on p.title = b.title and p.type = 'bk'
when matched then
  update set b.desc = b.desc || ';' || p.desc
when not matched then
  insert (title, desc, bought) values (p.title, p.desc, p.bought)

```

```

merge into customers c
using (select * from customers_delta where id > 10) cd
on (c.id = cd.id)
when matched then update set name = cd.name
when not matched then insert (id, name) values (cd.id, cd.name)

```

**Note**

WHEN NOT MATCHED should be interpreted from the point of view of the *source* (the relation in the USING clause). That is: if a source record doesn't have a match in the target table, the INSERT clause is executed. Conversely, records in the target table without a matching source record don't trigger any action.

**Warning**

If the WHEN MATCHED clause is present and multiple source records match the same record in the target table, the UPDATE clause is executed for all the matching source records, each update overwriting the previous one. This is non-standard behaviour: SQL-2003 specifies that in such a case an exception must be raised.

## SELECT

Available in: DSQL, ESQL, PSQL

### Aggregate functions: Extended functionality

Changed in: 1.5

*Description:* Several types of mixing and nesting aggregate functions are supported since Firebird 1.5. They will be discussed in the following subsections. To get the complete picture, also look at the SELECT :: GROUP BY sections.

#### Mixing aggregate functions from different contexts

Firebird 1.5 and up allow the use of aggregate functions from different contexts inside a single expression.

*Example:*

```

select
  r.rdb$relation_name as "Table name",
  ( select max(i.rdb$statistics) || ' (' || count(*) || ')'
    from rdb$relation_fields rf
    where rf.rdb$relation_name = r.rdb$relation_name
  ) as "Max. IndexSel (# fields)"
from
  rdb$relations r

```



```

join rdb$indices i on (i.rdb$relation_name = r.rdb$relation_name)
group by r.rdb$relation_name
having max(i.rdb$statistics) > 0
order by 2

```

This admittedly rather contrived query shows, in the second column, the maximum index selectivity of any index defined on a table, followed by the table's field count between parentheses. Of course you would normally display the field count in a separate column, or in the column with the table name, but the purpose here is to demonstrate that you can combine aggregates from different contexts in a single expression.

### Warning

Firebird 1.0 also executes this type of query, but gives the wrong results!

## Aggregate functions and GROUP BY items inside subqueries

Since Firebird 1.5 it is possible to use aggregate functions and/or expressions contained in the GROUP BY clause inside a subquery.

*Examples:*

This query returns each table's ID and field count. The subquery refers to `flds.rdb$relation_name`, which is also a GROUP BY item:

```

select
  flds.rdb$relation_name as "Relation name",
  ( select rels.rdb$relation_id
    from rdb$relations rels
    where rels.rdb$relation_name = flds.rdb$relation_name
  ) as "ID",
  count(*) as "Fields"
from rdb$relation_fields flds
group by flds.rdb$relation_name

```

The next query shows the last field from each table and its 1-based position. It uses the aggregate function MAX in a subquery.

```

select
  flds.rdb$relation_name as "Table",
  ( select flds2.rdb$field_name
    from rdb$relation_fields flds2
    where
      flds2.rdb$relation_name = flds.rdb$relation_name
      and flds2.rdb$field_position = max(flds.rdb$field_position)
  ) as "Last field",
  max(flds.rdb$field_position) + 1 as "Last fieldpos"
from rdb$relation_fields flds
group by 1

```

The subquery also contains the GROUP BY item `flds.rdb$relation_name`, but that's not immediately obvious because in this case the GROUP BY clause uses the column number.

## Subqueries inside aggregate functions

Using a singleton subselect inside (or as) an aggregate function argument is supported in Firebird 1.5 and up.

*Example:*

```
select
  r.rdb$relation_name as "Table",
  sum( (select count(*)
        from rdb$relation_fields rf
        where rf.rdb$relation_name = r.rdb$relation_name)
    ) as "Ind. x Fields"
from
  rdb$relations r
  join rdb$indices i
    on (i.rdb$relation_name = r.rdb$relation_name)
group by
  r.rdb$relation_name
```

## Nesting aggregate function calls

Firebird 1.5 allows the indirect nesting of aggregate functions, provided that the inner function is from a lower SQL context. Direct nesting of aggregate function calls, as in “COUNT( MAX( price ) )”, is still forbidden and punishable by exception.

*Example:* See under *Subqueries inside aggregate functions*, where COUNT() is used inside a SUM().

## Aggregate statements: Stricter HAVING and ORDER BY

Firebird 1.5 and above are stricter than previous versions about what can be included in the HAVING and ORDER BY clauses. If, in the context of an aggregate statement, an operand in a HAVING or ORDER BY item contains a column name, it is only accepted if one of the following is true:

- The column name appears in an aggregate function call (e.g. “HAVING MAX( SALARY ) > 10000”).
- The operand equals or is based upon a non-aggregate column that appears in the GROUP BY list (by name or position).

“Is based upon” means that the operand need not be exactly the same as the column name. Suppose there's a non-aggregate column “STR” in the select list. Then it's OK to use expressions like “UPPER(STR)”, “STR || '!'” or “SUBSTRING(STR FROM 4 FOR 2)” in the HAVING clause – even if these expressions don't appear as such in the SELECT or GROUP BY list.

## [AS] before relation alias

*Added in:* IB

*Description:* The keyword AS can optionally be placed before a relation alias, just as it can be placed before a column alias. This feature dates back to InterBase times, but wasn't documented in the IB Language Reference.

*Syntax:*

```
SELECT ... FROM <relation> [AS] alias
<relation> ::= A table, view, or selectable SP
```

*Examples:*

```
select order_no, total, fullname
```

```
from orders as o join customers as c on o.cust_id = c.cust_id
```

```
select order_no, total, fullname  
from orders o join customers c on o.cust_id = c.cust_id
```

The two queries are fully equivalent.

## ***COLLATE subclause for text BLOB columns***

*Added in:* 2.0

*Description:* COLLATE subclauses are now also supported for text BLOBs.

*Example:*

```
select NameBlob from MyTable  
where NameBlob collate pt_br = 'João'
```

## ***Common Table Expressions (“WITH ... AS ... SELECT”)***

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* A common table expression or CTE can be described as a virtual table or view, defined in a preamble to a main query, and going out of scope after the main query's execution. The main query can reference any CTEs defined in the preamble as if they were regular tables or views. CTEs can be recursive, i.e. self-referencing, but they cannot be nested.

*Syntax:*

```
<cte-construct> ::= <cte-defs>  
                  <main-query>  
  
<cte-defs>      ::= WITH [RECURSIVE] <cte> [, <cte> ...]  
  
<cte>           ::= name [( <column-list> )] AS ( <cte-stmt> )  
  
<column-list>  ::= column-alias [, column-alias ...]  
  
<cte-stmt>     ::= any SELECT statement or UNION  
  
<main-query>   ::= the main SELECT statement, which can refer to the  
                  CTEs defined in the preamble
```

*Example:*

```
with dept_year_budget as (  
  select fiscal_year,  
         dept_no,  
         sum(projected_budget) as budget  
  from proj_dept_budget  
  group by fiscal_year, dept_no  
)  
select d.dept_no,
```

```

        d.department,
        dyb_2008.budget as budget_08,
        dyb_2009.budget as budget_09
from department d
  left join dept_year_budget dyb_2008
    on d.dept_no = dyb_2008.dept_no
    and dyb_2008.fiscal_year = 2008
  left join dept_year_budget dyb_2009
    on d.dept_no = dyb_2009.dept_no
    and dyb_2009.fiscal_year = 2009
where exists (
  select * from proj_dept_budget b
  where d.dept_no = b.dept_no
)

```

*Notes:*

- A CTE definition can contain any legal SELECT statement, as long as it doesn't have a “WITH...” preamble of its own (no nesting).
- CTEs defined for the same main query can reference each other, but care should be taken to avoid loops.
- CTEs can be referenced from anywhere in the main query.
- Each CTE can be referenced multiple times in the main query, possibly with different aliases.
- When enclosed in parentheses, CTE constructs can be used as subqueries in SELECT statements, but also in UPDATES, MERGES etc.
- In PSQL, CTEs are also supported in FOR loop headers:

```

for with my_rivers as (select * from rivers where owner = 'me')
  select name, length from my_rivers into :rname, :rlen
do
begin
  ..
end

```

## Recursive CTEs

A recursive (self-referencing) CTE is a UNION which must have at least one non-recursive member, called the *anchor*. The non-recursive member(s) must be placed before the recursive member(s). Recursive members are linked to each other and to their non-recursive neighbour by UNION ALL operators. The unions between non-recursive members may be of any type.

Recursive CTEs require the RECURSIVE keyword to be present right after WITH. Each recursive union member may reference itself only once, and it must do so in a FROM clause.

A great benefit of recursive CTEs is that they use far less memory and CPU cycles than an equivalent recursive stored procedure.

The execution pattern of a recursive CTE is as follows:

- The engine begins execution from a non-recursive member.
- For each row evaluated, it starts executing each recursive member one by one, using the current values from the outer row as parameters.

- If the currently executing instance of a recursive member produces no rows, execution loops back one level and gets the next row from the outer result set.

*Example with a recursive CTE:*

```
with recursive
  dept_year_budget as (
    select fiscal_year,
           dept_no,
           sum(projected_budget) as budget
    from proj_dept_budget
    group by fiscal_year, dept_no
  ),
  dept_tree as (
    select dept_no,
           head_dept,
           department,
           cast('' as varchar(255)) as indent
    from department
    where head_dept is null
    union all
    select d.dept_no,
           d.head_dept,
           d.department,
           h.indent || ' '
    from department d
         join dept_tree h on d.head_dept = h.dept_no
  )
select d.dept_no,
       d.indent || d.department as department,
       dyb_2008.budget as budget_08,
       dyb_2009.budget as budget_09
from dept_tree d
  left join dept_year_budget dyb_2008
    on d.dept_no = dyb_2008.dept_no
   and dyb_2008.fiscal_year = 2008
  left join dept_year_budget dyb_2009
    on d.dept_no = dyb_2009.dept_no
   and dyb_2009.fiscal_year = 2009
```

*Notes on recursive CTEs:*

- Aggregates (DISTINCT, GROUP BY, HAVING) and aggregate functions (SUM, COUNT, MAX etc) are not allowed in recursive union members.
- A recursive reference cannot participate in an outer join.
- The maximum recursion depth is 1024.

## ***Derived tables (“SELECT FROM SELECT”)***

*Added in:* 2.0

*Description:* A derived table is the result set of a SELECT query, used in an outer SELECT as if it were an ordinary table. Put otherwise, it is a subquery in the FROM clause.

*Syntax:*

```
(select-query)
  [[AS] derived-table-alias]
  [(derived-column-aliases)]

derived-column-aliases := column-alias [, column-alias ...]
```

*Examples:*

The derived table in the query below (shown in boldface) contains all the relation names in the database followed by their field count. The outer SELECT produces, for each existing field count, the number of relations having that field count.

```
select fieldcount,
       count(relation) as num_tables
from   (select r.rdb$relation_name as relation,
             count(*) as fieldcount
        from   rdb$relations r
             join rdb$relation_fields rf
                 on rf.rdb$relation_name = r.rdb$relation_name
        group by relation)
group by fieldcount
```

A trivial example demonstrating the use of a derived table alias and column aliases list (both are optional):

```
select dbinfo.descr,
       dbinfo.def_charset
from   (select * from rdb$database) dbinfo
       (descr, rel_id, sec_class, def_charset)
```

*Notes:*

- Derived tables can be nested.
- Derived tables can be unions and can be used in unions. They can contain aggregate functions, subselects and joins, and can themselves be used in aggregate functions, subselects and joins. They can also be or contain queries on selectable stored procedures. They can have WHERE, ORDER BY and GROUP BY clauses, FIRST, SKIP or ROWS directives, etc. etc.
- Every column in a derived table *must* have a name. If it doesn't have one by nature (e.g. because it's a constant) it must either be given an alias in the usual way, or a column aliases list must be added to the derived table specification.
- The column aliases list is optional, but if it is used it must be complete. That is: it must contain an alias for every column in the derived table.
- The optimizer can handle a derived table very efficiently. However, if the derived table is involved in an inner join and contains a subquery, then no join order can be made.

## ***FIRST and SKIP***

*Available in:* DSQL, PSQL

*Added in:* 1.0

Changed in: 1.5

Better alternative: [ROWS](#)

*Description:* FIRST limits the output of a query to the first so-many rows. SKIP will suppress the given number of rows before starting to return output.

**Tip**

In Firebird 2.0 and up, use the SQL-compliant [ROWS](#) syntax instead.

*Syntax:*

```
SELECT [FIRST (<int-expr>)] [SKIP (<int-expr>)] <columns> FROM ...
```

```
<int-expr> ::= Any expression evaluating to an integer.
<columns>  ::= The usual output column specifications.
```

**Note**

If *<int-expr>* is an integer literal or a query parameter, the “( )” may be omitted. Subselects on the other hand require an extra pair of parentheses.

FIRST and SKIP are both optional. When used together as in “FIRST *m* SKIP *n*”, the *n* topmost rows of the output set are discarded and the first *m* rows of the remainder are returned.

SKIP 0 is allowed, but of course rather pointless. FIRST 0 is allowed in version 1.5 and up, where it returns an empty set. In 1.0.x, FIRST 0 causes an error. Negative SKIP and/or FIRST values always result in an error.

If a SKIP lands past the end of the dataset, an empty set is returned. If the number of rows in the dataset (or the remainder after a SKIP) is less than the value given after FIRST, that smaller number of rows is returned. These are valid results, not error situations.

*Examples:*

The following query will return the first 10 names from the People table:

```
select first 10 id, name from People
order by name asc
```

The following query will return everything *but* the first 10 names:

```
select skip 10 id, name from People
order by name asc
```

And this one returns the last 10 rows. Notice the double parentheses:

```
select skip ((select count(*) - 10 from People))
id, name from People
order by name asc
```

This query returns rows 81–100 of the People table:

```
select first 20 skip 80 id, name from People
order by name asc
```

**Two Gotchas with FIRST in subselects**

- This:

```
delete from MyTable where ID in (select first 10 ID from MyTable)
```

will delete all of the rows in the table. Ouch! The sub-select is evaluating each 10 candidate rows for deletion, deleting them, slipping forward 10 more... ad infinitum, until there are no rows left. Beware! Or better: use the ROWS syntax, available since Firebird 2.0.

- Queries like:

```
...where F1 in (select first 5 F2 from Table2 order by 1 desc)
```

won't work as expected, because the optimization performed by the engine transforms the IN predicate to the correlated EXISTS predicate shown below. It's obvious that in this case FIRST *N* doesn't make any sense:

```
...where exists
( select first 5 F2 from Table2
  where Table2.F2 = Table1.F1
  order by 1 desc )
```

**GROUP BY**

*Description:* GROUP BY merges rows that have the same combination of values and/or NULLs in the item list into a single row. Any aggregate functions in the select list are applied to each group individually instead of to the dataset as a whole.

*Syntax:*

```
SELECT ... FROM ...
  GROUP BY <item> [, <item> ...]
  ...

<item> ::= column-name [COLLATE collation-name]
         | column-alias
         | column-position
         | expression
```

- Only non-negative integer *literals* will be interpreted as column positions. If they are outside the range from 1 to the number of columns, an error is raised. Integer values resulting from expressions or parameter substitutions are simply invariables and will be used as such in the grouping. They will have no effect though, as their value is the same for each row.
- A GROUP BY item cannot be a reference to an aggregate function (including one that is buried inside an expression) from the same context.
- The select list may not contain expressions that can have different values within a group. To avoid this, the rule of thumb is to include each non-aggregate item from the select list in the GROUP BY list (whether by copying, alias or position).

*Note:* If you group by a column position, the expression at that position is copied internally from the select list. If it concerns a subquery, that subquery will be executed at least twice.

**Grouping by alias, position and expressions**

*Changed in:* 1.0, 1.5, 2.0



*Description:* In addition to column names, Firebird 2 allows column aliases, column positions and arbitrary valid expressions as GROUP BY items.

*Examples:*

These three queries all achieve the same result:

```
select strlen(lastname) as len_name, count(*)
  from people
  group by len_name
```

```
select strlen(lastname) as len_name, count(*)
  from people
  group by 1
```

```
select strlen(lastname) as len_name, count(*)
  from people
  group by strlen(lastname)
```

*History:* Grouping by UDF results was added in Firebird 1. Grouping by column positions, CASE outcomes and a limited number of internal functions in Firebird 1.5. Firebird 2 added column aliases and expressions in general as valid GROUP BY items (“expressions in general” absorbing the UDF, CASE and internal functions lot).

## **HAVING: Stricter rules**

*Changed in:* 1.5

*Description:* See [Aggregate statements: Stricter HAVING and ORDER BY](#).

## **JOIN**

### **Ambiguous field names rejected**

*Changed in:* 1.0

*Description:* InterBase 6 accepts and executes statements like the one below, which refers to an unqualified column name even though that name exists in both tables participating in the JOIN:

```
select buses.name, garages.name
  from buses join garages on buses.garage_id = garage.id
  where name = 'Phideaux III'
```

The results of such a query are unpredictable. Firebird Dialect 3 returns an error if there are ambiguous field names in JOIN statements. Dialect 1 gives a warning but will execute the query anyway.

## **CROSS JOIN**

*Added in:* 2.0

*Description:* Firebird 2.0 and up support CROSS JOIN, which performs a full set multiplication on the tables involved. Previously you had to achieve this by joining on a tautology (a condition that is always true) or by using the comma syntax, now deprecated.

*Syntax:*

```
SELECT ...
  FROM <relation> CROSS JOIN <relation>
  ...

<relation> ::= {table | view | cte | (select_stmt)} [[AS] alias]
```

**Note:** If you use CROSS JOIN, you can't use ON.

*Example:*

```
select * from Men cross join Women
order by Men.age, Women.age

-- old syntax:
-- select * from Men join Women on 1 = 1
-- order by Men.age, Women.age

-- comma syntax:
-- select * from Men, Women
-- order by Men.age, Women.age
```

## Named columns JOIN

*Added in:* 2.1

*Description:* A named columns join is an equi-join on the columns named in the USING clause. These columns must exist in both relations.

*Syntax:*

```
SELECT ...
  FROM <relation> [<join_type>] JOIN <relation>
  USING (colname [, colname ...])
  ...

<relation> ::= {table | view | cte | (select_stmt)} [[AS] alias]
<join_type> ::= INNER | {LEFT | RIGHT | FULL} [OUTER]
```

*Example:*

```
select *
  from books join shelves
  using (shelf, bookcase)
```

The equivalent in traditional syntax:

```
select *
  from books b join shelves s
  on b.shelf = s.shelf and b.bookcase = s.bookcase
```

*Notes:*

- The columns in the USING clause can be selected without qualifier. Be aware, however, that doing so in outer joins doesn't always give the same result as selecting *left.colname* or *right.colname*. One of the latter may be NULL while the other isn't; plain *colname* always returns the non-NULL alternative in such cases.

- `SELECT *` from a named columns join returns each `USING` column only once. In outer joins, such a column always contains the non-NULL alternative except for rows where the field is NULL in both tables.

## Natural JOIN

Added in: 2.1

*Description:* A natural join is an automatic equi-join on all the columns that exist in both relations. If there are no common column names, a `CROSS JOIN` is produced.

*Syntax:*

```
SELECT ...
  FROM <relation> NATURAL [<join_type>] JOIN <relation>
  ...

<relation> ::= {table | view | cte | (select_stmt)} [[AS] alias]
<join_type> ::= INNER | {LEFT | RIGHT | FULL} [OUTER]
```

*Example:*

```
select * from Pupils natural left join Tutors
```

Assuming that the Pupils and Tutors tables have two field names in common: TUTOR and CLASS, the equivalent traditional syntax is:

```
select * from Pupils p left join Tutors t
  on p.tutor = t.tutor and p.class = t.class
```

*Notes:*

- Common columns can be selected from a natural join without qualifier. Beware, however, that doing so in outer joins doesn't always gives the same result as selecting `left.colname` or `right.colname`. One of the latter may be NULL while the other isn't; plain `colname` always returns the non-NULL alternative in such cases.
- `SELECT *` from a natural join returns each common column only once. In outer joins, such a column always contains the non-NULL alternative except for rows where the field is NULL in both tables.

## ORDER BY

*Syntax:*

```
SELECT ... FROM ...
  ...
  ORDER BY <ordering-item> [, <ordering-item> ...]

<ordering-item> ::= {col-name | col-alias | col-position | expression}
                  [COLLATE collation-name]
                  [ASC[ENDING] | DESC[ENDING]]
                  [NULLS {FIRST|LAST}]
```

### Order by column alias

Added in: 2.0

*Description:* Firebird 2.0 and above support ordering by column alias.

*Example:*

```
select rdb$character_set_id as charset_id,  
       rdb$collation_id as coll_id,  
       rdb$collation_name as name  
from rdb$collations  
order by charset_id, coll_id
```

## Ordering by column position causes \* expansion

*Changed in:* 2.0

*Description:* If you order by column position in a “SELECT \*” query, the engine will now expand the \* to determine the sort column(s).

*Examples:*

The following wasn't possible in pre-2.0 versions:

```
select * from rdb$collations  
order by 3, 2
```

The following would sort the output set on `Films.Director` in previous versions. In Firebird 2 and up, it will sort on the second column of `Books`:

```
select Books.*, Films.Director from Books, Films  
order by 2
```

## Ordering by expressions

*Added in:* 1.5

*Description:* Firebird 1.5 introduced the possibility to use expressions as ordering items. Please note that expressions consisting of a single non-negative whole number will be interpreted as column positions and cause an exception if they're not in the range from 1 to the number of columns.

*Example:*

```
select x, y, note from Pairs  
order by x+y desc
```

### Note

The number of function or procedure invocations resulting from a sort based on a UDF or stored procedure is unpredictable, regardless whether the ordering is specified by the expression itself or by the column position number.

*Notes:*

- The number of function or procedure invocations resulting from a sort based on a UDF or stored procedure is unpredictable, regardless whether the ordering is specified by the expression itself or by the column position number.

- Only non-negative whole number *literals* are interpreted as column positions. A whole number resulting from an expression evaluation or parameter substitution is seen as an integer invariable and will lead to a dummy sort, since its value is the same for each row.

## NULLS placement

*Changed in:* 1.5, 2.0

*Description:* Firebird 1.5 has introduced the per-column NULLS FIRST and NULLS LAST directives to specify where NULLs appear in the sorted column. Firebird 2.0 has changed the default placement of NULLs.

Unless overridden by NULLS FIRST or NULLS LAST, NULLs in ordered columns are placed as follows:

- In Firebird 1.0 and 1.5: at the end of the sort, regardless whether the order is ascending or descending.
- In Firebird 2.0 and up: at the *start* of ascending orderings and at the *end* of descending orderings.

See also the table below for an overview of the different versions.

**Table 7.1. NULLs placement in ordered columns**

Ordering	NULLs placement		
	Firebird 1	Firebird 1.5	Firebird 2
order by Field [asc]	bottom	bottom	top
order by Field desc	bottom	bottom	bottom
order by Field [asc   desc] nulls first	—	top	top
order by Field [asc   desc] nulls last	—	bottom	bottom

### Notes

- Pre-existing databases may need a backup-restore cycle before they show the correct NULL ordering behaviour under Firebird 2.0 and up.
- No index will be used on columns for which a non-default NULLS placement is chosen. In Firebird 1.5, that is the case with NULLS FIRST. In 2.0 and higher, with NULLS LAST on ascending and NULLS FIRST on descending sorts.

*Examples:*

```
select * from msg
order by process_time desc nulls first
```

```
select * from document
order by strlen(description) desc
rows 10
```

```
select doc_number, doc_date from payorder
union all
select doc_number, doc_date from budgorder
order by 2 desc nulls last, 1 asc nulls first
```

## Stricter ordering rules with aggregate statements

Changed in: 1.5

Description: See *Aggregate statements: Stricter HAVING and ORDER BY*.

## PLAN

Available in: DSQL, ESQL, PSQL

Description: Specifies a user plan for the data retrieval, overriding the plan that the optimizer would have generated automatically.

Syntax:

```

PLAN <plan_expr>

<plan_expr> ::= [JOIN | [SORT] [MERGE]] (<plan_item> [, <plan_item> ...])

<plan_item> ::= <basic_item> | <plan_expr>

<basic_item> ::= {table | alias}
                {NATURAL
                 | INDEX (<indexlist>))
                 | ORDER index [INDEX (<indexlist>)]}

<indexlist> ::= index [, index ...]

```

## Handling of user PLANS improved

Changed in: 2.0

Description: Firebird 2 has implemented the following improvements in the handling of user-specified PLANS:

- Plan fragments are propagated to nested levels of joins, enabling manual optimization of complex outer joins.
- User-supplied plans will be checked for correctness in outer joins.
- Short-circuit optimization for user-supplied plans has been added.
- A user-specified access path can be supplied for any SELECT-based statement or clause.

## ORDER with INDEX

Changed in: 2.0

Description: A single plan item can now contain both an ORDER and an INDEX directive (in that order).

Example:

```

plan (MyTable order ix_myfield index (ix_this, ix_that))

```

## PLAN must include all tables

Changed in: 2.0

*Description:* In Firebird 2 and up, a PLAN clause must handle all the tables in the query. Previous versions sometimes accepted incomplete plans, but this is no longer the case.

## Relation alias makes real name unavailable

*Changed in:* 2.0

*Description:* If you give a table or view an alias in a Firebird 2.0 or above statement, you *must* use the alias, not the table name, if you want to qualify fields from that relation.

*Examples:*

Correct usage:

```
select pears from Fruit
```

```
select Fruit.pears from Fruit
```

```
select pears from Fruit F
```

```
select F.pears from Fruit F
```

No longer possible:

```
select Fruit.pears from Fruit F
```

## ROWS

*Available in:* DSQL, PSQL

*Added in:* 2.0

*Description:* Limits the amount of rows returned by the SELECT statement to a specified number or range.

*Syntax:*

With a single SELECT:

```
SELECT <columns> FROM ...  
  [WHERE ...]  
  [ORDER BY ...]  
  ROWS <m> [TO <n>]
```

<columns> ::= The usual output column specifications.

<m>, <n> ::= Any expression evaluating to an integer.

With a UNION:

```
SELECT [FIRST p] [SKIP q] <columns> FROM ...  
  [WHERE ...]  
  [ORDER BY ...]
```

```
UNION [ALL | DISTINCT]
```

```
SELECT [FIRST r] [SKIP s] <columns> FROM ...
```

```
[WHERE ...]  
[ORDER BY ...]  
  
ROWS <m> [TO <n>]
```

With a single argument  $m$ , the first  $m$  rows of the dataset are returned.

Points to note:

- If  $m >$  the total number of rows in the dataset, the entire set is returned.
- If  $m = 0$ , an empty set is returned.
- If  $m < 0$ , an error is raised.

With two arguments  $m$  and  $n$ , rows  $m$  to  $n$  of the dataset are returned, inclusively. Row numbers are 1-based.

Points to note when using two arguments:

- If  $m >$  the total number of rows in the dataset, an empty set is returned.
- If  $m$  lies within the set but  $n$  doesn't, the rows from  $m$  to the end of the set are returned.
- If  $m < 1$  or  $n < 1$ , an error is raised.
- If  $n = m-1$ , an empty set is returned.
- If  $n < m-1$ , an error is raised.

The SQL-compliant ROWS syntax obviates the need for [FIRST](#) and [SKIP](#), except in one case: a SKIP without FIRST, which returns the entire remainder of the set after skipping a given number of rows. (You can often “fake it” though, by supplying a second argument that you know to be bigger than the number of rows in the set.)

You cannot use ROWS together with FIRST and/or SKIP in a single SELECT statement, but is it valid to use one form in the top-level statement and the other in subselects, or to use the two syntaxes in different subselects.

When used with a UNION, the ROWS subclause applies to the UNION as a whole and must be placed after the last SELECT. If you want to limit the output of one or more individual SELECTs within the UNION, you have two options: either use FIRST/SKIP on those SELECT statements, or convert them to [derived tables](#) with ROWS clauses.

ROWS can also be used with the [UPDATE](#) and [DELETE](#) statements.

## UNION

*Available in:* DSQL, ESQL, PSQL

### UNIONS in subqueries

*Changed in:* 2.0

*Description:* UNIONS are now allowed in subqueries. This applies not only to column-level subqueries in a SELECT list, but also to subqueries in ANY|SOME, ALL and IN predicates, as well as the optional SELECT expression that feeds an INSERT.

*Example:*

```
select name, phone, hourly_rate from clowns  
where hourly_rate < all  
  (select hourly_rate from jugglers  
   union
```



```
select hourly_rate from acrobats)
order by hourly_rate
```

## UNION DISTINCT

*Added in:* 2.0

*Description:* You can now use the optional DISTINCT keyword when defining a UNION. This will show duplicate rows only once instead of every time they occur in one of the tables. Since DISTINCT, being the opposite of ALL, is the default mode anyway, this doesn't add any new functionality.

*Syntax:*

```
SELECT (...) FROM (...)
UNION [DISTINCT | ALL]
SELECT (...) FROM (...)
```

*Example:*

```
select name, phone from translators
union distinct
select name, phone from proofreaders
```

Translators who also work as proofreaders (a not uncommon combination) will show up only once in the result set, provided their phone number is the same in both tables. The same result would have been obtained without DISTINCT. With ALL, they would appear twice.

## WITH LOCK

*Available in:* DSQL, PSQL

*Added in:* 1.5

*Description:* WITH LOCK provides a limited explicit pessimistic locking capability for cautious use in conditions where the affected row set is:

- a. extremely small (ideally, a singleton), *and*
- b. precisely controlled by the application code.

### **This is for experts only!**

The need for a pessimistic lock in Firebird is very rare indeed and should be well understood before use of this extension is considered.

It is essential to understand the effects of transaction isolation and other transaction attributes before attempting to implement explicit locking in your application.

*Syntax:*

```
SELECT ... FROM single_table
[WHERE ...]
[FOR UPDATE [OF ...]]
WITH LOCK
```

If the WITH LOCK clause succeeds, it will secure a lock on the selected rows and prevent any other transaction from obtaining write access to any of those rows, or their dependants, until your transaction ends.

If the FOR UPDATE clause is included, the lock will be applied to each row, one by one, as it is fetched into the server-side row cache. It becomes possible, then, that a lock which appeared to succeed when requested will nevertheless *fail subsequently*, when an attempt is made to fetch a row which becomes locked by another transaction.

WITH LOCK can only be used with a top-level, single-table SELECT statement. It is *not* available:

- in a subquery specification;
- for joined sets;
- with the DISTINCT operator, a GROUP BY clause or any other aggregating operation;
- with a view;
- with the output of a selectable stored procedure;
- with an external table.

A lengthier, more in-depth discussion of “SELECT ... WITH LOCK” is included in the [Notes](#). It is a must-read for everybody who considers using this feature.

## UPDATE

*Available in:* DSQL, ESQL, PSQL

*Description:* Changes values in a table (or in one or more tables underlying a view). The columns affected are specified in the SET clause; the rows affected may be limited by the WHERE and ROWS clauses.

*Syntax:*

```
UPDATE [TRANSACTION name] {tablename | viewname} [[AS] alias]
  SET col = newval [, col = newval ...]
  [WHERE {search-conditions | CURRENT OF cursorname}]
  [PLAN plan_items]
  [ORDER BY sort_items]
  [ROWS <m> [TO <n>]]
  [RETURNING <values> [INTO <variables>]]
```

```
<m>, <n>      ::= Any expression evaluating to an integer.
<values>     ::= value_expression [, value_expression ...]
<variables> ::= :varname [, :varname ...]
```

### Restrictions

- The TRANSACTION directive is only available in ESQL.
- In a pure DSQL session, WHERE CURRENT OF isn't of much use, since there exists no DSQL statement to create a cursor.
- The PLAN, ORDER BY and ROWS clauses are not available in ESQL.
- Since v. 2.0, no column may be SET more than once in the same UPDATE statement.
- The RETURNING clause is not available in ESQL.
- The “INTO <variables>” subclause is only available in PSQL.
- When returning values into the context variable NEW, this name must not be preceded by a colon (“:”).

## Changed SET semantics

*Changed in:* 2.5

*Description:* In previous Firebird versions, if multiple assignments were done in the SET clause, the new column values would become immediately available to subsequent assignments in the same clause. That is, in a clause like “set a=3, b=a”, *b* would be set to 3, not to *a*'s old value. This non-standard behaviour has now been corrected. In Firebird 2.5 and up, any assignments in the SET clause will use the old column values.

*Example:*

Given table TSET:

```
A  B
----
1  0
2  0
```

the following statement:

```
update tset set a=5, b=a
```

will change its state to

```
A  B
----
5  1
5  2
```

In versions prior to Firebird 2.5, this would have been:

```
A  B
----
5  5
5  5
```

*Retaining the old behaviour:* For a limited time, you can keep the old, non-standard behaviour by setting the `OldSetClauseSemantics` parameter in `firebird.conf` to 1. This parameter will be deprecated and removed in the future. If set, it will be used for all database connections made through the server.

## **COLLATE subclause for text BLOB columns**

*Added in:* 2.0

*Description:* COLLATE subclauses are now also supported for text BLOBs.

*Example:*

```
update MyTable
  set NameBlobSp = 'Juan'
  where NameBlobBr collate pt_br = 'João'
```

## **ORDER BY**

*Available in:* DSQL, PSQL

*Added in:* 2.0

*Description:* UPDATE now allows an ORDER BY clause. This only makes sense in combination with ROWS, but is also valid without it.

## PLAN

*Available in:* DSQL, PSQL

*Added in:* 2.0

*Description:* UPDATE now allows a PLAN clause, so users can optimize the operation manually.

## Relation alias makes real name unavailable

*Changed in:* 2.0

*Description:* If you give a table or view an alias in a Firebird 2.0 or above statement, you *must* use the alias, not the table name, if you want to qualify fields from that relation.

*Examples:*

Correct usage:

```
update Fruit set soort = 'pisang' where ...
```

```
update Fruit set Fruit.soort = 'pisang' where ...
```

```
update Fruit F set soort = 'pisang' where ...
```

```
update Fruit F set F.soort = 'pisang' where ...
```

No longer possible:

```
update Fruit F set Fruit.soort = 'pisang' where ...
```

## RETURNING

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* An UPDATE statement modifying *at most one row* may optionally include a RETURNING clause in order to return values from the updated row. The clause, if present, need not contain all the modified columns and may also contain other columns or expressions. The returned values reflect any changes that may have been made in BEFORE triggers, but not those in AFTER triggers. *OLD.fieldname* and *NEW.fieldname* may both be used in the list of columns to return; for field names not preceded by either of these, the new value is returned.

*Example:*

```
update Scholars
  set firstname = 'Hugh', lastname = 'Pickering'
  where firstname = 'Henry' and lastname = 'Higgins'
  returning id, old.lastname, new.lastname
```

Notes:

- In DSQL, a statement with a RETURNING clause *always* returns exactly one row. If no record was actually updated, the fields in this row are all NULL. This behaviour may change in a later version of Firebird. In PSQL, if no row was updated, nothing is returned, and the receiving variables keep their existing values.

## ROWS

Available in: DSQL, PSQL

Added in: 2.0

Description: Limits the amount of rows updated to a specified number or range.

Syntax:

```
ROWS <m> [TO <n>]
<m>, <n> ::= Any expression evaluating to an integer.
```

With a single argument *m*, the update is limited to the first *m* rows of the dataset defined by the table or view and the optional WHERE and ORDER BY clauses.

Points to note:

- If  $m >$  the total number of rows in the dataset, the entire set is updated.
- If  $m = 0$ , no rows are updated.
- If  $m < 0$ , an error is raised.

With two arguments *m* and *n*, the update is limited to rows *m* to *n* inclusively. Row numbers are 1-based.

Points to note when using two arguments:

- If  $m >$  the total number of rows in the dataset, no rows are updated.
- If *m* lies within the set but *n* doesn't, the rows from *m* to the end of the set are updated.
- If  $m < 1$  or  $n < 1$ , an error is raised.
- If  $n = m - 1$ , no rows are updated.
- If  $n < m - 1$ , an error is raised.

ROWS can also be used with the [SELECT](#) and [DELETE](#) statements.

## UPDATE OR INSERT

Available in: DSQL, PSQL

Added in: 2.1

Description: UPDATE OR INSERT checks if any existing records already contain the new values supplied for the MATCHING columns. If so, those records are updated. If not, a new record is inserted. In the absence of a MATCHING clause, matching is done against the primary key. If a RETURNING clause is present and more than one matching record is found, an error is raised.

*Syntax:*

```

UPDATE OR INSERT INTO
  {tablename | viewname} [(<columns>)]
VALUES (<values>)
[MATCHING (<columns>)]
[RETURNING <values> [INTO <variables>]]

<columns>      ::= colname [, colname ...]
<values>       ::= value  [, value  ...]
<variables>   ::= :varname [, :varname ...]

```

**Restrictions**

- No column may appear more than once in the update/insert column list.
- If the table has no PK, the MATCHING clause becomes mandatory.
- The “INTO *<variables>*” subclause is only available in PSQL.
- When values are returned into the context variable NEW, this name must not be preceded by a colon (“:”).

*Example:*

```

update or insert into Cows (Name, Number, Location)
values ('Suzy Creamcheese', 3278823, 'Green Pastures')
matching (Number)
returning rec_id into :id;

```

*Notes:*

- Matches are determined with **IS NOT DISTINCT**, not with the “=” operator. This means that one NULL matches another.
- The optional RETURNING clause:
  - ...may contain any or all columns of the target table, regardless if they were mentioned earlier in the statement, but also other expressions.
  - ...may contain OLD and NEW qualifiers for field names; by default, the new field value is returned.
  - ...returns field values as they are after the BEFORE triggers have run, but before any AFTER triggers.

---

## Chapter 8

# Transaction control statements

## RELEASE SAVEPOINT

*Available in:* DSQL

*Added in:* 1.5

*Description:* Deletes a named savepoint, freeing up all the resources it binds.

*Syntax:*

```
RELEASE SAVEPOINT name [ONLY]
```

Unless ONLY is added, all the savepoints created after the named savepoint are released as well.

For a full discussion of savepoints, see [SAVEPOINT](#).

## ROLLBACK

*Available in:* DSQL, ESQL

*Syntax:*

```
ROLLBACK [WORK]  
  [TRANSACTION tr_name]  
  [RETAIN [SNAPSHOT] | TO [SAVEPOINT] sp_name | RELEASE]
```

- The TRANSACTION clause is only available in ESQL.
- The RELEASE clause is only available in ESQL, and is discouraged.
- RETAIN and TO are only available in DSQL.

## ROLLBACK RETAIN

*Available in:* DSQL

*Added in:* 2.0

*Description:* Undoes all the database changes carried out in the transaction without closing it. User variables set with `RDB$SET_CONTEXT()` remain unchanged.

*Syntax:*

```
ROLLBACK [WORK] RETAIN [SNAPSHOT]
```

**Note**

The functionality provided by `ROLLBACK RETAIN` has been present since InterBase 6, but the only way to access it was through the API call `isc_rollback_retaining()`.

## **ROLLBACK TO SAVEPOINT**

*Available in:* DSQL

*Added in:* 1.5

*Description:* Undoes everything that happened in a transaction since the creation of the savepoint.

*Syntax:*

```
ROLLBACK [WORK] TO [SAVEPOINT] name
```

`ROLLBACK TO SAVEPOINT` performs the following operations:

- All the database mutations performed within the transaction since the savepoint was created are undone. User variables set with `RDB$SET_CONTEXT()` remain unchanged.
- All savepoints created after the one named are destroyed. All earlier savepoints are preserved, as is the savepoint itself. This means that you can rollback to the same savepoint several times.
- All implicit and explicit record locks acquired since the savepoint are released. Other transactions that have requested access to rows locked after the savepoint must continue to wait until the transaction is committed or rolled back. Other transactions that have not already requested the rows can request and access the unlocked rows immediately.

For a full discussion of savepoints, see [SAVEPOINT](#).

## **SAVEPOINT**

*Available in:* DSQL

*Added in:* 1.5

*Description:* Creates an SQL-99 compliant savepoint, to which you can later rollback your work without rolling back the entire transaction. Savepoint mechanisms are also known as “nested transactions”.

*Syntax:*

```
SAVEPOINT <name>
```



```
<name> ::= a user-chosen identifier, unique within the transaction
```

If the supplied name exists already within the same transaction, the existing savepoint is deleted and a new one is created with the same name.

If you later want to rollback your work to the point where the savepoint was created, use:

```
ROLLBACK [WORK] TO [SAVEPOINT] name
```

ROLLBACK TO SAVEPOINT performs the following operations:

- All the database mutations performed within the transaction since the savepoint was created are undone. User variables set with `RDB$SET_CONTEXT()` remain unchanged.
- All savepoints created after the one named are destroyed. All earlier savepoints are preserved, as is the savepoint itself. This means that you can rollback to the same savepoint several times.
- All implicit and explicit record locks acquired since the savepoint are released. Other transactions that have requested access to rows locked after the savepoint must continue to wait until the transaction is committed or rolled back. Other transactions that have not already requested the rows can request and access the unlocked rows immediately.

The internal savepoint bookkeeping can consume huge amounts of memory, especially if you update the same records multiple times in one transaction. If you don't need a savepoint anymore but you're not yet ready to end the transaction, you can delete the savepoint and free the resources it uses with:

```
RELEASE SAVEPOINT name [ONLY]
```

With ONLY, the named savepoint is the only one that gets released. Without it, all savepoints created after it are released as well.

*Example DSQL session using a savepoint:*

```
create table test (id integer);
commit;
insert into test values (1);
commit;
insert into test values (2);
savepoint y;
delete from test;
select * from test; -- returns no rows
rollback to y;
select * from test; -- returns two rows
rollback;
select * from test; -- returns one row
```

## Internal savepoints

By default, the engine uses an automatic transaction-level system savepoint to perform transaction rollback. When you issue a ROLLBACK statement, all changes performed in this transaction are backed out via a transaction-level savepoint and the transaction is then committed. This logic reduces the amount of garbage collection caused by rolled back transactions.

When the volume of changes performed under a transaction-level savepoint is getting large ( $10^4$ – $10^6$  records affected), the engine releases the transaction-level savepoint and uses the TIP mechanism to roll back the transaction if needed.

### Tip

If you expect the volume of changes in your transaction to be large, you can specify the NO AUTO UNDO option in your SET TRANSACTION statement, or – if you use the API – set the TPB flag `isc_tpb_no_auto_undo`. Both prevent the creation of the transaction-level savepoint.

## Savepoints and PSQL

Transaction control statements are not allowed in PSQL, as that would break the atomicity of the statement that calls the procedure. But Firebird does support the raising and handling of exceptions in PSQL, so that actions performed in stored procedures and triggers can be selectively undone without the entire procedure failing. Internally, automatic savepoints are used to:

- undo all actions in a BEGIN...END block where an exception occurs;
- undo all actions performed by the SP/trigger (or, in the case of a selectable SP, all actions performed since the last SUSPEND) when it terminates prematurely due to an uncaught error or exception.

Each PSQL exception handling block is also bounded by automatic system savepoints.

## SET TRANSACTION

Available in: DSQL, ESQL

Changed in: 2.0

Description: Starts and optionally configures a transaction.

Syntax:

```

SET TRANSACTION
  [NAME hostvar]
  [READ WRITE | READ ONLY]
  [ [ISOLATION LEVEL] { SNAPSHOT [TABLE STABILITY]
                          | READ COMMITTED [[NO] RECORD_VERSION] } ]
  [WAIT | NO WAIT]
  [LOCK TIMEOUT seconds]
  [NO AUTO UNDO]
  [IGNORE LIMBO]
  [RESERVING <tables> | USING <dbhandles>]

<tables>      ::= <table_spec> [, <table_spec> ...]

<table_spec> ::= tablename [, tablename ...]
               [FOR [SHARED | PROTECTED] {READ | WRITE}]

<dbhandles>  ::= dbhandle [, dbhandle ...]

```

- The NAME option is only available in ESQL. It must be followed by a previously declared and initialized host-language variable. Without NAME, SET TRANSACTION applies to the default transaction.
- The USING option is also ESQL-only. It limits the databases that the transaction can access to the ones mentioned here.
- IGNORE LIMBO and LOCK TIMEOUT are not supported in ESQL.
- LOCK TIMEOUT and NO WAIT are mutually exclusive.
- Default option settings are: READ WRITE + WAIT + SNAPSHOT.

## IGNORE LIMBO

*Available in:* DSQL

*Added in:* 2.0

*Description:* With this option, records created by limbo transactions are ignored. Transactions are in limbo if the second stage of a two-phase commit fails.

### Note

IGNORE LIMBO surfaces the `isc_tpb_ignore_limbo` TPB parameter, available in the API since InterBase times and mainly used by gfix.

## LOCK TIMEOUT

*Available in:* DSQL

*Added in:* 2.0

*Description:* This option is only available for WAIT transactions. It takes a non-negative integer as argument, prescribing the maximum number of seconds that the transaction should wait when a lock conflict occurs. If the waiting time has passed and the lock has still not been released, an error is generated.

### Note

This is a brand new feature in Firebird 2. Its API equivalent is the new `isc_tpb_lock_timeout` TPB parameter.

## NO AUTO UNDO

*Available in:* DSQL, ESQL

*Added in:* 2.0

*Description:* With NO AUTO UNDO, the transaction refrains from keeping the log that is normally used to undo changes in the event of a rollback. Should the transaction be rolled back after all, other transactions will pick up the garbage (eventually). This option can be useful for massive insertions that don't need to be rolled back. For transactions that don't perform any mutations, NO AUTO UNDO makes no difference at all.

**Note**

NO AUTO UNDO is the SQL equivalent of the `isc_tpb_no_auto_undo` TPB parameter, available in the API since InterBase times.

---

## Chapter 9

# PSQL statements

PSQL – Procedural SQL – is the Firebird programming language used in stored procedures, triggers and executable blocks.

## BEGIN ... END blocks may be empty

*Available in:* PSQL

*Changed in:* 1.5

*Description:* BEGIN ... END blocks may be empty in Firebird 1.5 and up, allowing you to write stub code without having to resort to dummy statements.

*Example:*

```
create trigger bi_atable for atable
active before insert position 0
as
begin
end
```

## BREAK

*Available in:* PSQL

*Added in:* 1.0

*Better alternative:* [LEAVE](#)

*Description:* BREAK immediately terminates a WHILE or FOR loop and continues with the first statement after the loop.

*Example:*

```
create procedure selphrase(num int)
returns (phrase varchar(40))
as
begin
  for select Phr from Phrases into phrase do
  begin
    if (num < 1) then break;
    suspend;
    num = num - 1;
  end
```

```
phrase = '*** Ready! ***';
suspend;
end
```

This selectable SP returns at most *num* rows from the table Phrases. The variable *num* is decremented in each iteration; once it is smaller than 1, the loop is terminated with BREAK. The program then continues at the line “phrase = '\*\*\* Ready! \*\*\*';”.

### Important

Since Firebird 1.5, use of the SQL-99 compliant alternative [LEAVE](#) is preferred.

## CLOSE cursor

Available in: PSQL

Added in: 2.0

*Description:* Closes an open cursor. Any cursors still open when the trigger, stored procedure or EXECUTE BLOCK statement they belong to is exited, will be closed automatically.

*Syntax:*

```
CLOSE cursorname;
```

*Example:* See [DECLARE ... CURSOR](#).

## DECLARE

Available in: PSQL

*Description:* Declares a PSQL local variable.

*Syntax:*

```
DECLARE [VARIABLE] varname <var_spec>;

<var_spec> ::= <type> [NOT NULL] [<coll>] [<default>]
              | CURSOR FOR (select-statement)
<type>      ::= sql_datatype | [TYPE OF] domain | TYPE OF COLUMN rel.col
<coll>      ::= COLLATE collation
<default>   ::= {= | DEFAULT} value
```

- If *sql\_datatype* is a text type, it may include a character set.
- Obviously, a COLLATE clause is only allowed with text types.

## DECLARE ... CURSOR

Added in: 2.0

*Description:* Declares a named cursor and binds it to its own SELECT statement. The cursor can later be opened, used to walk the result set, and closed again. Positioned updates and deletes (using [WHERE CURRENT OF](#)) are also supported. PSQL cursors are available in triggers, stored procedures and [EXECUTE BLOCK](#) statements.

*Example:*

```
execute block
returns (relation char(31), sysflag int)
as
declare cur cursor for
  (select rdb$relation_name, rdb$system_flag from rdb$relations);
begin
  open cur;
  while (1=1) do
  begin
    fetch cur into relation, sysflag;
    if (row_count = 0) then leave;
    suspend;
  end
  close cur;
end
```

*Notes:*

- A “FOR UPDATE” clause is allowed in the SELECT statement, but not required for a positioned update or delete to succeed.
- Make sure that declared cursor names do not clash with any names defined later on in [AS CURSOR](#) clauses.
- If you need a cursor to loop through an output set, it is almost always easier – and less error-prone – to use a FOR SELECT statement with an AS CURSOR clause. Declared cursors must be explicitly opened, fetched from, and closed. Furthermore, you need to check `row_count` after every fetch and break out of the loop if it is zero. AS CURSOR takes care of all of that automatically. However, declared cursors give you more control over the sequence of events, and allow you to operate several cursors in parallel.
- The SELECT statement may contain named SQL parameters, like in “select name || :sfx from names where number = :num”. Each parameter must be a PSQL variable that has been declared previously (this includes any in/out params of the PSQL module). When the cursor is opened, the parameter is assigned the current value of the variable.
- Caution! If the value of a PSQL variable that is used in the SELECT statement changes during execution of the loop, the statement *may* (but will not always) be re-evaluated for the remaining rows. In general, this situation should be avoided. If you really need this behaviour, test your code thoroughly and make sure you know how variable changes affect the outcome. Also be advised that the behaviour may depend on the query plan, in particular the use of indices. As it is currently not strictly defined, it may change in some future version of Firebird.

*See also:* [OPEN cursor](#), [FETCH cursor](#), [CLOSE cursor](#)

## ***DECLARE [VARIABLE] with initialization***

*Changed in:* 1.5

*Description:* In Firebird 1.5 and above, a PSQL local variable can be initialized upon declaration. The VARIABLE keyword has become optional.

*Example:*

```
create procedure proccie (a int)
returns (b int)
as
  declare p int;
  declare q int = 8;
  declare r int default 9;
  declare variable s int;
  declare variable t int = 10;
  declare variable u int default 11;
begin
  <intelligent code here>
end
```

## **DECLARE with DOMAIN instead of datatype**

*Added in:* 2.1

*Description:* In Firebird 2.1 and above, PSQL local variables and input/output parameters can be declared with a domain instead of a datatype. The TYPE OF modifier allows using only the domain's datatype and not its NOT NULL setting, CHECK constraint and/or default value. If the domain is of a text type, its character set and collation are always included.

*Example:*

```
create procedure MyProc (a int, f ternbool)
  returns (b int, x type of bigfloat)
as
  declare p int;
  declare q int = 8;
  declare y stocknum default -1;
begin
  <very intelligent code here>
end
```

(This example presupposes that TERNBOOL, BIGFLOAT and STOCKNUM are domains already defined in the database.)

### **Warning**

If you change a domain's definition, existing PSQL code using that domain may become invalid. For information on how to detect this, please read the note *The RDB\$VALID\_BLR field*, near the end of this document.

## **TYPE OF COLUMN in variable declaration**

*Added in:* 2.5

*Description:* Analogous to the “TYPE OF *domain*” syntax supported since version 2.1, it is now also possible to declare variables and parameters as having the type of an existing table or view column. Only the type itself is used; in the case of string types, this includes the character set and the collation. Constraints and default values are never copied from the source column.



*Example:*

```
create table cars (
  make varchar(20),
  model varchar(20),
  weight numeric(4),
  topspeed numeric(3),
  constraint uk_make_model unique (make, model)
)

create procedure max_kinetic_energy
  (make type of column cars.make,
   model type of column cars.model)
  returns (max_e_kin double precision)
as
  declare mass type of column cars.weight;
  declare velocity type of column cars.topspeed;
begin
  select weight, topspeed from cars
    where make = :make and model = :model
    into mass, velocity;
  max_e_kin = 0.5 * mass * velocity * velocity;
end
```

#### Warnings

- The collation of the source column is not always taken into consideration when comparisons (e.g. equality tests) are made, even though it should. This is due to a bug that has been fixed for Firebird 3.
- PSQL code using TYPE OF COLUMN may become invalid if the column's type is changed at a later time. For information on how to detect this, please read the note *The RDB\$VALID\_BLR field*, near the end of this document.

## COLLATE in variable declaration

*Added in:* 2.1

*Description:* In Firebird 2.1 and above, a COLLATE clause is allowed in the declaration of text-type PSQL local variables and input/output parameters.

*Example:*

```
create procedure GimmeText
  returns (txt char(32) character set utf8 collate unicode)
as
  declare simounao mytextdomain collate pt_br default 'não';
begin
  <stunningly intelligent code here>
end
```

## NOT NULL in variable declaration

*Added in:* 2.1

*Description:* In Firebird 2.1 and above, a NOT NULL constraint is allowed in the declaration of PSQL local variables and input/output parameters.

*Example:*

```
create procedure Compute(a int not null, b int not null)
  returns (outcome bigint not null)
as
  declare temp bigint not null;
begin
  <slightly disappointing code here>
end
```

## EXCEPTION

*Available in:* PSQL

*Changed in:* 1.5

*Description:* The EXCEPTION syntax has been extended so that the user can

- a. Rethrow a caught exception or error.
- b. Provide a custom message when throwing a user-defined exception.

*Syntax:*

```
EXCEPTION [<exception-name> [custom-message]]

<exception-name> ::= A previously defined exception name
```

### ***Rethrowing a caught exception***

Within the exception handling block only, you can rethrow the caught exception or error by giving the EXCEPTION command without any arguments. Outside such blocks, this “bare” command has no effect.

*Example:*

```
when any do
begin
  insert into error_log (...) values (sqlcode, ...);
  exception;
end
```

This example first logs some information about the exception or error, and then rethrows it.

### ***Providing a custom error message***

Firebird 1.5 and up allow you to override an exception's default error message by supplying an alternative one when throwing the exception.

*Examples:*

```
exception ex_data_error 'You just lost some valuable data';
```

```
exception ex_bad_type 'Wrong type for record with id ' || new.id;
```

**Note**

Starting at version 2.0, the maximum message length is 1021 instead of 78 characters.

## EXECUTE PROCEDURE

Available in: DSQL, PSQL

Changed in: 1.5

*Description:* In Firebird 1.5 and above, (compound) expressions are allowed as input parameters for stored procedures called with EXECUTE PROCEDURE. See *DML statements :: EXECUTE PROCEDURE* for full info and examples.

## EXECUTE STATEMENT

Available in: PSQL

Added in: 1.5

Changed in: 2.5

*Description:* EXECUTE STATEMENT takes a string argument and executes it as if it had been submitted as a DSQL statement. If the statement returns data, the INTO clause assigns these to local variables. If the statement may return more than one row of data, the “FOR ... DO” form must be used to create a loop.

*Syntax (full):*

```
<execute-statement> ::= EXECUTE STATEMENT <argument>
                        [<option> ...]
                        [INTO <variables>]

<looped-version>     ::= FOR <execute-statement> DO <psql-statement>

<argument>           ::= paramless-stmt
                        | (paramless-stmt)
                        | (<stmt-with-params>) (<param-values>)

<stmt-with-params>  ::= A statement containing one or more parameters,
                        in one of these forms:
                        - named: ':' + paramname, e.g. :a, :b, :size
                        - positional: each param is designated by '?'
                        Named and positional parameters may not be mixed.

<param-values>      ::= <named-values> | <positional-values>
<named-values>      ::= paramname := value-expr [, paramname := value-expr ...]
<positional-values> ::= value-expr [, value-expr ...]

<option>             ::= WITH {AUTONOMOUS|COMMON} TRANSACTION
```

```

        | WITH CALLER PRIVILEGES
        | AS USER user
        | PASSWORD password
        | ROLE role
        | ON EXTERNAL [DATA SOURCE] <connect-string>

<connect-string> ::= [<hostspec>]path-or-alias
<hostspec> ::= <tcpip-hostspec> | <netbeui-hostspec>
<tcpip-hostspec> ::= hostname:
<netbeui-hostspec> ::= \\hostname\

<variables> ::= [:]varname [, [:]varname ...]

<psql-statement> ::= A simple or compound PSQL statement.

```

NOTICE:  
*paramless-stmt*, *<stmt-with-params>*, *user*, *password*, *role* and *<connect-string>* are string expressions. When given directly, i.e. as literal strings, they must be enclosed in single-quote characters.

The following paragraphs first explain the basic usage of EXECUTE STATEMENT as it has been since Firebird 1.5. After that, the new features in 2.5 are introduced.

## No data returned

This form is used with INSERT, UPDATE, DELETE and EXECUTE PROCEDURE statements that return no data.

*Syntax (partial):*

```

EXECUTE STATEMENT <statement>

<statement> ::= An SQL statement returning no data.

```

*Example:*

```

create procedure DynamicSampleOne (ProcName varchar(100))
as
declare variable stmt varchar(1024);
declare variable param int;
begin
    select min(SomeField) from SomeTable into param;
    stmt = 'execute procedure '
        || ProcName
        || '('
        || cast(param as varchar(20))
        || ')';
    execute statement stmt;
end

```

### Warning

Although this form of EXECUTE STATEMENT can also be used with all kinds of DDL strings (except CREATE/DROP DATABASE), it is generally very, very unwise to use this trick in order to circumvent the no-DDL rule in PSQL.

## One row of data returned

This form is used with singleton SELECT statements.

*Syntax (partial):*

```
EXECUTE STATEMENT <select-statement> INTO <var> [, <var> ...]

<select-statement> ::= An SQL statement returning at most one row of data.
<var>                ::= A PSQL variable, optionally preceded by ":"
```

*Example:*

```
create procedure DynamicSampleTwo (TableName varchar(100))
as
declare variable param int;
begin
  execute statement
    'select max(CheckField) from ' || TableName into :param;
  if (param > 100) then
    exception Ex_Overflow 'Overflow in ' || TableName;
end
```

## Any number of data rows returned

This form – analogous to “FOR SELECT ... DO” – is used with SELECT statements that may return a multi-row dataset.

*Syntax (partial):*

```
FOR EXECUTE STATEMENT <select-statement> INTO <var> [, <var> ...]
DO <psql-statement>

<select-statement> ::= Any SELECT statement.
<var>                ::= A PSQL variable, optionally preceded by ":"
<psql-statement>    ::= A simple or compound PSQL statement.
```

*Example:*

```
create procedure DynamicSampleThree
  (TextField varchar(100),
   TableName varchar(100))
returns
  (LongLine varchar(32000))
as
declare variable Chunk varchar(100);
begin
  Chunk = '';
  for execute statement
    'select ' || TextField || ' from ' || TableName into :Chunk
  do
    if (Chunk is not null) then
      LongLine = LongLine || Chunk || ' ';
    suspend;
```

end

## Improved performance

*Changed in: 2.5*

*Description:* In previous versions, if EXECUTE STATEMENT occurred in a loop, the SQL statement would be prepared, executed and released upon every iteration. In Firebird 2.5 and above, such a statement is only prepared once, giving a huge performance benefit.

## WITH {AUTONOMOUS|COMMON} TRANSACTION

*Added in: 2.5*

*Description:* Traditionally, the executed SQL statement always ran within the current transaction, and this is still the default. WITH AUTONOMOUS TRANSACTION causes a separate transaction to be started, with the same parameters as the current transaction. It will be committed if the statement runs to completion without errors and rolled back otherwise. WITH COMMON TRANSACTION uses the current transaction if possible. If the statement must run in a separate connection, an already started transaction within that connection is used, if available. Otherwise, a new transaction is started with the same parameters as the current transaction. Any new transactions started under the “COMMON” regime are committed or rolled back with the current transaction.

*Syntax (partial):*

```
[FOR]
EXECUTE STATEMENT sql-statement
WITH {AUTONOMOUS|COMMON} TRANSACTION
[...other options...]
[INTO <variables>]
[DO psql-statement]
```

## WITH CALLER PRIVILEGES

*Added in: 2.5*

*Description:* By default, the SQL statement is executed with the privileges of the current user. Specifying WITH CALLER PRIVILEGES adds to this the privileges of the calling SP or trigger, just as if the statement were executed directly by the routine. WITH CALLER PRIVILEGES has no effect if the ON EXTERNAL clause is also present.

*Syntax (partial):*

```
[FOR]
EXECUTE STATEMENT sql-statement
WITH CALLER PRIVILEGES
[...other options...]
[INTO <variables>]
[DO psql-statement]
```

## ON EXTERNAL [DATA SOURCE]

*Added in: 2.5*

*Description:* With ON EXTERNAL DATA SOURCE, the SQL statement is executed in a separate connection to the same or another database, possibly even on another server. If the connect string is NULL or ' ' (empty string), the entire ON EXTERNAL clause is considered absent and the statement is executed against the current database.

*Syntax (partial):*

```
[FOR]
EXECUTE STATEMENT sql-statement
ON EXTERNAL [DATA SOURCE] <connect-string>
[AS USER user]
[PASSWORD password]
[ROLE role]
[...other options...]
[INTO <variables>]
[DO psql-statement]

<connect-string>      ::= [<hostspec>]path-or-alias
<hostspec>           ::= <tcpip-hostspec> | <netbeui-hostspec>
<tcpip-hostspec>    ::= hostname:
<netbeui-hostspec> ::= \\hostname\

NOTICE:
sql-statement, user, password, role and <connect-string> are string
expressions. When given directly, i.e. as literal strings, they must
be enclosed in single-quote characters.
```

*Connection pooling:*

- External connections made by statements WITH COMMON TRANSACTION (the default) will remain open until the current transaction ends. They can be reused by subsequent calls to EXECUTE STATEMENT, but only if the connect string is *exactly* the same, including case.
- External connections made by statements WITH AUTONOMOUS TRANSACTION are closed as soon as the statement has been executed.
- Notice that statements WITH AUTONOMOUS TRANSACTION can and will reuse connections that were opened earlier by statements WITH COMMON TRANSACTION. If this happens, the reused connection will be left open after the statement has been executed. (It must be, because it has at least one uncommitted transaction!)

*Transaction pooling:*

- If WITH COMMON TRANSACTION is in effect, transactions will be reused as much as possible. They will be committed or rolled back together with the current transaction.
- If WITH AUTONOMOUS TRANSACTION is specified, a fresh transaction will always be started for the statement. This transaction will be committed or rolled back immediately after the statement's execution.

*Exception handling:* When ON EXTERNAL is used, the extra connection is always made via a so-called external provider, even if the connection is to the current database. One of the consequences is that you can't catch exceptions the way you are used to. Every exception caused by the statement is wrapped in either an eds\_connection or an eds\_statement error. In order to catch them in your PSQL code, you have to use WHEN GDSCODE eds\_connection, WHEN GDSCODE eds\_statement or WHEN ANY. (Without ON EXTERNAL, exceptions are caught in the usual way, even if an extra connection is made to the current database.)

*Miscellaneous notes:*

- The character set used for the external connection is the same as that for the current connection.
- Two-phase commits are not supported.
- For authentication details, please look under *AS USER, PASSWORD and ROLE :: Authentication*, below.

## ***AS USER, PASSWORD and ROLE***

*Added in: 2.5*

*Description:* Optionally, a user name, password and/or role can be specified under which the statement must be executed.

*Syntax (partial):*

```
[FOR]
EXECUTE STATEMENT sql-statement
AS USER user
PASSWORD password
ROLE role
[...other options...]
[INTO <variables>]
[DO psql-statement]
```

**NOTICE:**  
*sql-statement*, *user*, *password* and *role* are string expressions.  
 When given directly, i.e. as literal strings, they must be enclosed in single-quote characters.

*Authentication:* How a user is authenticated and whether a separate connection is opened depends on the presence and values of the parameters ON EXTERNAL [DATA SOURCE], AS USER, PASSWORD and ROLE.

- If ON EXTERNAL is present, a new connection is always opened, and:
  - If at least one of AS USER, PASSWORD and ROLE is present, native authentication is attempted with the given parameter values (locally or remotely, depending on the connect string). No defaults are used for missing parameters.
  - If all three are absent and the connect string contains no host name, then the new connection is established on the local host with the same user and role as the current connection. The term 'local' means 'on the same machine as the *server*' here. This is not necessarily the location of the client.
  - If all three are absent and the connect string contains a host name, then trusted authentication is attempted on the remote host (again, remote from the POV of the server). If this succeeds, the remote OS will provide the user name (usually the OS account under which the Firebird process runs).
- If ON EXTERNAL is absent:
  - If at least one of AS USER, PASSWORD and ROLE is present, a new connection to the current database is opened with the given parameter values. No defaults are used for missing parameters.
  - If all three are absent, the statement is executed within the current connection.

*Notice:* If a parameter value is NULL or '' (empty string), the entire parameter is considered absent. Additionally, AS USER is considered absent if its value is equal to CURRENT\_USER, and ROLE if it's equal to



CURRENT\_ROLE. The comparison is made case-sensitively; in most cases this means that only user and role names given in all-caps can be equal tot CURRENT\_USER or CURRENT\_ROLE.

## Parameterized statements

Added in: 2.5

*Description:* Since Firebird 2.5, the SQL statement to be executed may contain parameters. When [FOR] EXECUTE STATEMENT is called, a value must be provided for each parameter.

*Syntax (partial):*

```
[FOR]
EXECUTE STATEMENT (<parameterized-statement>) (<param-assignments>)
[...options...]
[INTO <variables>]
[DO psql-statement]

<parameterized-statement> ::= An SQL statement containing
                             <named-param>s or <positional-param>s

<named-param>                ::= :paramname
<positional-param>           ::= ?

<param-assignments>         ::= <named-assignments> | <positional-assignments>
<named-assignments>         ::= paramname := value [, paramname := value ...]
<positional-assignments>    ::= value [, value ...]

NOTICE:
<parameterized-statement> is a string expression. When given directly,
i.e. as a literal string, it must be enclosed in single-quote characters.
```

*Examples:*

With named parameters:

```
...
declare license_num varchar(15);
declare connect_string varchar(100);
declare stmt varchar(100) =
  'select license from cars where driver = :driver and location = :loc';
begin
  ...
  select connstr from databases where cust_id = :id into connect_string;
  ...
  for select id from drivers into current_driver do
  begin
    for select location from driver_locations
      where driver_id = :current_driver
      into current_location do
    begin
      ...
      execute statement (stmt) (driver := current_driver,
                                loc := current_location)
      on external connect_string
      into license_num;
    end
  end
end
...
```

The same code with positional parameters:

```

...
declare license_num varchar(15);
declare connect_string varchar(100);
declare stmt varchar(100) =
  'select license from cars where driver = ? and location = ?';
begin
  ...
  select connstr from databases where cust_id = :id into connect_string;
  ...
  for select id from drivers into current_driver do
  begin
    for select location from driver_locations
      where driver_id = :current_driver
      into current_location do
    begin
      ...
      execute statement (stmt) (current_driver, current_location)
        on external connect_string
        into license_num;
      ...
    end
  end
end

```

*Notes:* Some things to be aware of:

- When a statement has parameters, it must be placed in parentheses when EXECUTE STATEMENT is called, regardless whether it is given directly as a string, as a variable name, or by another expression.
- Named parameters must be preceded by a colon (“:”) in the statement itself, but not in the parameter assignments.
- Each named parameter may occur several times in the statement, but only once in the assignments.
- Each named parameter must be assigned a value when EXECUTE STATEMENT is called; the assignments can be placed in any order.
- The assignment operator for named parameters is “:=”, not “=” like in SQL.
- With positional parameters, the number of values supplied must exactly equal the number of parameters (question marks) in the statement.

## ***Caveats with EXECUTE STATEMENT***

1. There is no way to validate the syntax of the enclosed statement.
2. There are no dependency checks to discover whether tables or columns have been dropped.
3. Even though the performance in loops has been significantly improved in Firebird 2.5, execution is still considerably slower than that of statements given directly.
4. Return values are strictly checked for data type in order to avoid unpredictable type-casting exceptions. For example, the string '1234' would convert to an integer, 1234, but 'abc' would give a conversion error.

All in all, this feature is meant to be used very cautiously and you should always take the above factors into account. If you can achieve the same result with PSQL and/or DSQL, then this is nearly always preferable.

## EXIT

*Available in:* PSQL

*Changed in:* 1.5

*Description:* In Firebird 1.5 and up, EXIT can be used in all PSQL. In earlier versions it is only supported in stored procedures, not in triggers.

## FETCH cursor

*Available in:* PSQL

*Added in:* 2.0

*Description:* Fetches the next data row from a cursor's result set and stores the column values in PSQL variables.

*Syntax:*

```
FETCH cursorname INTO [:]varname [, [:]varname ...];
```

*Notes:*

- The `ROW_COUNT` context variable will be 1 if the fetch returned a data row and 0 if the end of the set has been reached.
- You can do a positioned `UPDATE` or `DELETE` on the fetched row with the `WHERE CURRENT OF` clause.

*Example:* See `DECLARE ... CURSOR`.

## FOR EXECUTE STATEMENT ... DO

*Available in:* PSQL

*Added in:* 1.5

*Description:* See `EXECUTE STATEMENT :: Any number of data rows returned`.

## FOR SELECT ... INTO ... DO

*Available in:* PSQL

*Description:* Executes a `SELECT` statement and retrieves the result set. In each iteration of the loop, the field values of the current row are copied into local variables. Adding an `AS CURSOR` clause enables positioned deletes and updates. `FOR SELECT` statements may be nested.

*Syntax:*

```

FOR <select-stmt>
  INTO <var> [, <var> ...]
  [AS CURSOR name]
DO
  <psql-stmt>

<select-stmt> ::= A valid SELECT statement.
<var> ::= A PSQL variable name, optionally preceded by ":"
<psql-stmt> ::= A single statement or a block of PSQL code.

```

- The SELECT statement may contain named SQL parameters, like in “select name || :sfx from names where number = :num”. Each parameter must be a PSQL variable that has been declared previously (this includes any in/out params of the PSQL module).
- Caution! If the value of a PSQL variable that is used in the SELECT statement changes during execution of the loop, the statement *may* (but will not always) be re-evaluated for the remaining rows. In general, this situation should be avoided. If you really need this behaviour, test your code thoroughly and make sure you know how variable changes affect the outcome. Also be advised that the behaviour may depend on the query plan, in particular the use of indices. And as it is currently not strictly defined, it may also change in some future version of Firebird.

*Examples:*

```

create procedure shownums
  returns (aa int, bb int, sm int, df int)
as
begin
  for select distinct a, b from numbers order by a, b
    into :aa, :bb
  do
    begin
      sm = aa + bb;
      df = aa - bb;
      suspend;
    end
  end
end

```

```

create procedure relfields
  returns (relation char(32), pos int, field char(32))
as
begin
  for select rdb$relation_name from rdb$relations
    into :relation
  do
    begin
      for select rdb$field_position + 1, rdb$field_name
        from rdb$relation_fields
        where rdb$relation_name = :relation
        order by rdb$field_position
        into :pos, :field
      do
        begin
          if (pos = 2) then relation = '  '; -- for nicer output
          suspend;
        end
      end
    end
  end
end

```

```
end
end
```

## AS CURSOR clause

Available in: PSQL

Added in: IB

*Description:* The optional AS CURSOR clause creates a named cursor that can be referenced (after [WHERE CURRENT OF](#)) within the FOR SELECT loop in order to update or delete the current row. This feature was already added in InterBase, but not mentioned in the *Language Reference*.

*Example:*

```
create procedure deltown (towntodelete varchar(24))
  returns (town varchar(24), pop int)
as
begin
  for select town, pop from towns into :town, :pop as cursor tcur do
  begin
    if (town = towntodelete)
      then delete from towns where current of tcur;
      else suspend;
    end
  end
end
```

*Notes:*

- A “FOR UPDATE” clause is allowed in the SELECT statement., but not required for a positioned update or delete to succeed.
- Make sure that cursor names defined here do not clash with any names created earlier on in [DECLARE CURSOR](#) statements.
- AS CURSOR is not supported in FOR EXECUTE STATEMENT loops, even if the statement to execute is a suitable SELECT query.

## IN AUTONOMOUS TRANSACTION

Available in: PSQL

Added in: 2.5

*Description:* Code running in an autonomous transaction will be committed immediately upon successful completion, regardless of how the parent transaction finishes. This is useful if you want to make sure that certain actions will not be rolled back, even if an error is raised later.

*Syntax:*

```
IN AUTONOMOUS TRANSACTION DO <psql-statement>
```

*Example:*

```
create trigger tr_connect on connect
as
begin
  -- make sure log message is always preserved:
  in autonomous transaction do
    insert into log (msg) values ('User ' || current_user || ' connects.');
```

```
  if (current_user in (select username from blocked_users)) then
    begin
      -- again, log message must be preserved and event posted, so:
      in autonomous transaction do
        begin
          insert into log (msg) values ('User ' || current_user || ' refused.');
```

```
          post_event 'Connection attempt by blocked user.';
        end
      -- now we can safely except:
      exception ex_baduser;
    end
  end
end
```

*Notes:*

- Autonomous transactions have the same isolation level as their parent transaction.
- Because the autonomous transaction is completely independent of its parent, care must be taken to avoid deadlocks.
- If an exception occurs *within* the autonomous transaction, the work will be rolled back.

## LEAVE

*Available in:* PSQL

*Added in:* 1.5

*Changed in:* 2.0

*Description:* LEAVE immediately terminates the innermost WHILE or FOR loop. With the optional *label* argument introduced in Firebird 2.0, LEAVE can break out of surrounding loops as well. Execution continues with the first statement after the outermost terminated loop.

*Syntax:*

```
[label:]
{FOR | WHILE} ... DO
  ...
  (possibly nested loops, with or without labels)
  ...
  LEAVE [label];
```

*Example:*

If an error occurs during the insert in the example below, the event is logged and the loop terminated. The program continues at the line of code reading “c = 0;”

```

while (b < 10) do
begin
  insert into Numbers(B) values (:b);
  b = b + 1;
  when any do
  begin
    execute procedure log_error (current_timestamp, 'Error in B loop');
    leave;
  end
end
end
c = 0;

```

The next example uses labels. “Leave LoopA” terminates the outer loop, “leave LoopB” the inner loop. Notice that a plain “leave” would also suffice to terminate the inner loop.

```

stmt1 = 'select Name from Farms';
LoopA:
for execute statement :stmt1 into :farm do
begin
  stmt2 = 'select Name from Animals where Farm = ''';
  LoopB:
  for execute statement :stmt2 || :farm || '' into :animal do
  begin
    if (animal = 'Fluffy') then leave LoopB;
    else if (animal = farm) then leave LoopA;
    else suspend;
  end
end
end

```

## OPEN cursor

*Available in:* PSQL

*Added in:* 2.0

*Description:* Opens a previously declared cursor, executing its SELECT statement and enabling it to fetch records from the result set.

*Syntax:*

```
OPEN cursorname;
```

*Example:* See [DECLARE ... CURSOR](#).

## PLAN allowed in trigger code

*Changed in:* 1.5

*Description:* Before Firebird 1.5, a trigger containing a PLAN statement would be rejected by the compiler. Now a valid plan can be included and will be used.

## Subqueries as PSQL expressions

*Changed in: 2.5*

*Description:* Previously, subqueries could not be used as value expressions in PSQL, even if they returned a single value. This made it necessary to use `SELECT ... INTO`, often assigning the result to a variable that wouldn't have been necessary otherwise. Firebird 2.5 and up support the direct use of scalar subqueries as if they were simple value expressions.

*Examples:*

Constructions like the following are now valid PSQL:

```
var = (select ... from ...);

if ((select ... from ...) = 1) then ...

if (1 = any (select ... from ...)) then ...

if (1 in (select ... from ...)) then ...
```

Of course, in the first two examples you have to be sure that the `SELECT` doesn't return multiple rows!

## UDFs callable as void functions

*Changed in: 2.0*

*Description:* In Firebird 2.0 and above, PSQL code may call UDFs without assigning the result value, i.e. like a Pascal procedure or C void function. In most cases this is senseless, because the main purpose of almost every UDF is to produce the result value. Some functions however perform a specific task, and if you're not interested in the result value you can now spare yourself the trouble of assigning it to a dummy variable.

### Note

`RDB$GET_CONTEXT` and `RDB$SET_CONTEXT`, though classified in this guide under internal functions, are actually a kind of auto-declared UDFs. You may therefore call them without catching the result. Of course this only makes sense for `RDB$SET_CONTEXT`.

## WHERE CURRENT OF valid again for view cursors

*Changed in: 2.0, 2.1*

*Description:* Because of possible reliability issues, Firebird 2.0 disallowed `WHERE CURRENT OF` for view cursors. In Firebird 2.1, with its improved view validation logic, this restriction has been lifted.



---

## Chapter 10

# Security and access control

## ALTER ROLE

*Available in:* DSQL

*Added in:* 2.5

*Description:* Currently, ALTER ROLE's only purpose is to control the automatic mapping of the RDB\$ADMIN role to Windows administrators. For a full discussion, see [RDB\\$ADMIN](#) and [AUTO ADMIN MAPPING](#).

*Syntax:*

```
ALTER ROLE RDB$ADMIN {SET|DROP} AUTO ADMIN MAPPING
```

## GRANT and REVOKE

### GRANTED BY

*Available in:* DSQL

*Added in:* 2.5

*Description:* When a privilege is granted, it is normally stored in the database with the current user as the grantor. With the GRANTED BY clause, the user who grants the privilege can have someone else registered as the grantor. When GRANTED BY is used with REVOKE, the privilege (registered as) granted by the named user will be removed. To make migration from certain other RDBMSes easier, the non-standard AS is supported as a synonym of GRANTED BY.

*Access:* Use of the GRANTED BY clause is reserved to:

- The database owner;
- SYSDBA;
- anybody who has the [RDB\\$ADMIN](#) role in the database and specified it while connecting;
- if [AUTO ADMIN MAPPING](#) is on for the database: any Windows administrator who connected to the database using trusted authentication without specifying a role.

Even the owner of the role can't use GRANTED BY if he isn't in the above list.

*Syntax:*

```
GRANT
```

```
{<privileges> ON <object> | role}
TO <grantees>
[WITH {GRANT|ADMIN} OPTION]
[{{GRANTED BY | AS} [USER] grantor]
```

```
REVOKE
[{{GRANT|ADMIN} OPTION FOR]
{<privileges> ON <object> | role}
FROM <grantees>
[{{GRANTED BY | AS} [USER] grantor]
```

(These are not the complete GRANT and REVOKE syntaxes, but they are complete as far as GRANTED BY is concerned.)

*Example:*

```
-- connected as database owner BOB:

create role digger;
grant digger to francis;
grant digger to fred;
grant digger to frank with admin option granted by fritz;
commit;

revoke digger from fred;
-- OK
revoke admin option for digger from frank;
-- error: "BOB is not grantor of Role on DIGGER to FRANK."
revoke admin option for digger from frank granted by fritz;
-- OK
revoke digger from frank
-- error: "BOB is not grantor of Role on DIGGER to FRANK."
commit;

-- exit BOB, enter FRITZ:

revoke digger from frank;
-- OK
revoke digger from francis;
-- error: "FRITZ is not grantor of Role on DIGGER to FRANCIS."
revoke digger from francis granted by bob;
-- error: "Only SYSDBA or database owner can use GRANTED BY clause"
commit;
```

*Note:* Please notice that a GRANT or ADMIN option is just a flag in the privilege record; it does not have a separate grantor. So this line:

```
grant digger to frank with admin option granted by fritz
```

does not mean “Grant digger to Frank, and grant the admin option in Fritz's name”, but “Grant digger to Frank with admin option – all in Fritz's name”.

## REVOKE ALL ON ALL

*Available in:* DSQL

*Added in:* 2.5

*Description:* Revokes all privileges (including role memberships) on all objects from one or more users and/or roles. This is a quick way to “clean up” when a user has left the system or must be locked out of the database.

*Syntax:*

```
REVOKE ALL ON ALL FROM <grantee> [, <grantee> ...]
<grantee> ::= [USER] username | [ROLE] rolename
```

*Example:*

```
revoke all on all from buddy, peggy, sue
```

*Notes:*

- When invoked by a privileged user (the database owner, SYSDBA or anyone whose CURRENT\_ROLE is RDB\$ADMIN), all privileges are removed regardless of the grantor. Otherwise, only those privileges granted by the current user are removed.
- The GRANTED BY clause is not supported.
- This statement cannot be used to revoke privileges from stored procedure, trigger or view grantees. (Privileges ON such objects are removed, of course.)

## REVOKE ADMIN OPTION

*Available in:* DSQL

*Added in:* 2.0

*Description:* Revokes a previously granted admin option (the right to pass on a granted role to others) from the grantee, without revoking the role itself. Multiple roles and/or multiple grantees can be handled in one statement.

*Syntax:*

```
REVOKE ADMIN OPTION FOR <role-list> FROM <grantee-list>
<role-list> ::= role [, role ...]
<grantee-list> ::= [USER] <grantee> [, [USER] <grantee> ...]
<grantee> ::= username | PUBLIC
```

*Example:*

```
revoke admin option for manager from john, paul, george, ringo
```

If a user has received the admin option from several grantors, each of those grantors must revoke it or the user will still be able to grant the role(s) in question to others.

## The RDB\$ADMIN role

*Added in:* 2.5

*Description:* Firebird 2.5 introduces the RDB\$ADMIN system role, which is predefined in every database. Granting someone the RDB\$ADMIN role in a database gives him or her SYSDBA rights *in that database only*. In a normal database, this means full control over all objects. In the security database, it means the ability to create, alter and drop user accounts. In both cases, the grantee can always pass the role on to others. In other words, “WITH ADMIN OPTION” is built in and need not be specified.

## In normal databases

### Granting the RDB\$ADMIN role in a normal database

In a regular database, the RDB\$ADMIN role can be granted and revoked with the usual syntax:

```
GRANT RDB$ADMIN TO username
REVOKE RDB$ADMIN FROM username
```

Grantors can be:

- The database owner;
- SYSDBA;
- anybody who has the RDB\$ADMIN role in the database and specified it while connecting;
- if **AUTO ADMIN MAPPING** is on for the database: any Windows administrator who connected to the database using trusted authentication without specifying a role.

### Using the RDB\$ADMIN role in a normal database

To make use of his RDB\$ADMIN privileges, the grantee simply specifies the role when connecting to the database.

## In the security database

### Granting the RDB\$ADMIN role in the security database

Since nobody can connect to the security database, the GRANT and REVOKE statements cannot be used here. Instead, the RDB\$ADMIN role is granted and revoked with the new [SQL user management commands](#):

```
CREATE USER newuser PASSWORD 'password' GRANT ADMIN ROLE
ALTER USER existinguser GRANT ADMIN ROLE
ALTER USER existinguser REVOKE ADMIN ROLE
```

Please notice that GRANT ADMIN ROLE and REVOKE ADMIN ROLE are not GRANT and REVOKE statements. They are three-word parameters to CREATE and ALTER USER.

Alternatively, gsec can be used with the *-admin* parameter:

```
gsec -add newuser -pw password -admin yes
gsec -mo existinguser -admin yes
gsec -mo existinguser -admin no
```

Depending on the situation, more parameters may be needed when invoking gsec, e.g. *-user* and *-pass*, or *-trusted*.

Grantors can be:

- SYSDBA;
- anybody who has the RDB\$ADMIN role in the security database and specified it while connecting (or while invoking gsec);
- if **AUTO ADMIN MAPPING** is on for the security database: any Windows administrator who connected (or invoked gsec) using trusted authentication without specifying a role.

## Using the RDB\$ADMIN role in the security database

To manage user accounts through SQL, the grantee must specify the RDB\$ADMIN role when connecting. But this poses a problem, because nobody can connect to the security database. The solution is that the user connects to another – regular – database where he also has RDB\$ADMIN rights. He specifies the role when connecting to the regular database, and can then give any SQL user management command. It's not the most elegant of solutions, but it is the only way. If there isn't a regular database where the grantee has the RDB\$ADMIN role, the SQL route is blocked.

To perform user management with gsec, the grantee must provide the extra parameter `-role rdb$admin`.

## AUTO ADMIN MAPPING

*Platform:* Windows only

*Added in:* 2.5

*Description:* In Firebird 2.1, Windows administrators would automatically receive SYSDBA privileges if they used trusted authentication to connect to the server. In Firebird 2.5, this is no longer the case. Whether administrators have automatic SYSDBA rights now depends on the setting of AUTO ADMIN MAPPING. This is a per-database switch which is off by default. If AUTO ADMIN MAPPING is on, it will take effect whenever a Windows administrator: a) connects using trusted authentication, and b) does *not* specify any role when connecting. After a successful “auto admin” connect, the current role is set to **RDB\$ADMIN**.

## In normal databases

To turn the automatic mapping on and off in a regular database:

```
ALTER ROLE RDB$ADMIN SET AUTO ADMIN MAPPING
ALTER ROLE RDB$ADMIN DROP AUTO ADMIN MAPPING
```

These statements must be issued by a user with sufficient rights, that is:

- The database owner;
- SYSDBA;
- anybody who has the RDB\$ADMIN role in the database and specified it while connecting;
- if **AUTO ADMIN MAPPING** is on for the database: any Windows administrator who connected to the database using trusted authentication without specifying a role.

In normal databases, the status of AUTO ADMIN MAPPING is checked at connect time only. If an administrator has the RDB\$ADMIN role because the mapping was on when he connected, he will keep that role for the duration of the connection, even if he or someone else turns off the mapping in the meantime. Likewise, setting AUTO ADMIN MAPPING on will not change the current role to RDB\$ADMIN for administrators who were already connected.

## In the security database

There are no SQL statements to turn the automatic mapping on and off in the security database. Instead, `gsec` must be used:

```
gsec -mapping set
gsec -mapping drop
```

Depending on the situation, more parameters may be needed when invoking `gsec`, e.g. `-user` and `-pass`, or `-trusted`.

These commands can be given by:

- SYSDBA;
- if AUTO ADMIN MAPPING is on for the security database: any Windows administrator who invokes `gsec` using trusted authentication without specifying a role.

Unlike the case with regular databases, users connecting with the RDB\$ADMIN role cannot turn AUTO ADMIN MAPPING on or off in the security database. Also notice that the Windows administrator in the second listitem can only turn the mapping *off*. In doing so, he shuts off the very mechanism that gave him access in the first place, so he won't be able to turn it back on again. (Even in an interactive `gsec` session, the new setting takes effect immediately.)

## SQL user management commands

Available in: DSQL

Added in: 2.5

*Description:* Firebird 2.5 and up provide SQL statements for user account management. Except in one case, they are only available to the following privileged users:

- SYSDBA;
- Any user who has been granted the [RDB\\$ADMIN](#) role in the security database and at least one other database. The user must specify the role when connecting to the database.
- If [AUTO ADMIN MAPPING](#) is on for the security database: any Windows administrator connected to any database using trusted authentication without specifying a role. Whether AUTO ADMIN MAPPING is on in the connection database is unimportant.

Non-privileged users can only use ALTER USER, to change their own account details.

### CREATE USER

*Description:* Creates a Firebird user account.

*Syntax:*

```
CREATE USER username PASSWORD 'password'
  [FIRSTNAME 'firstname']
  [MIDDLENAME 'middlename']
```

```
[LASTNAME 'lastname']  
[GRANT ADMIN ROLE]
```

GRANT ADMIN ROLE gives the new user the RDB\$ADMIN role in the security database. This allows him to manage user accounts, but doesn't give him any special privileges in regular databases. For more information, see *The RDB\$ADMIN role*.

*Examples:*

```
create user bigshot password 'buckshot'  
create user john password 'fYe_3Ksw' firstname 'John' lastname 'Doe'  
create user mary password 'lamb_chop' firstname 'Mary' grant admin role
```

## ALTER USER

*Description:* Alters details of a Firebird user account. This is the only account management statement that can also be used by non-privileged users, in order to change their own account details.

*Syntax:*

```
ALTER USER username  
  [PASSWORD 'password']  
  [FIRSTNAME 'firstname']  
  [MIDDLENAME 'middlename']  
  [LASTNAME 'lastname']  
  [{GRANT|REVOKE} ADMIN ROLE]  
  
-- At least one of the optional parameters must be present.  
-- GRANT/REVOKE ADMIN ROLE is reserved to privileged users.
```

*Examples:*

```
alter user bobby password '67-UiT_G8' grant admin role  
alter user dan firstname 'No_Jack' lastname 'Kennedy'  
alter user dumbbell revoke admin role
```

## DROP USER

*Description:* Removes a Firebird user account.

*Syntax:*

```
DROP USER username
```

*Example:*

```
drop user timmy
```

# Context variables

## CURRENT\_CONNECTION

*Available in:* DSQL, PSQL

*Added in:* 1.5

*Changed in:* 2.1

*Description:* CURRENT\_CONNECTION contains the unique identifier of the current connection.

*Type:* INTEGER

*Examples:*

```
select current_connection from rdb$database
```

```
execute procedure P_Login(current_connection)
```

The value of CURRENT\_CONNECTION is stored on the database header page and reset to 0 upon restore. Since version 2.1, it is incremented upon every new connection. (In previous versions, it was only incremented if the client read it during a session.) As a result, CURRENT\_CONNECTION now indicates the number of connections since the creation – or most recent restoration – of the database.

## CURRENT\_ROLE

*Available in:* DSQL, PSQL

*Added in:* 1.0

*Description:* CURRENT\_ROLE is a context variable containing the role of the currently connected user. If there is no active role, CURRENT\_ROLE is NONE.

*Type:* VARCHAR(31)

*Example:*

```
if (current_role <> 'MANAGER')
  then exception only_managers_may_delete;
else
  delete from Customers where custno = :custno;
```

CURRENT\_ROLE always represents a valid role or NONE. If a user connects with a non-existing role, the engine silently resets it to NONE without returning an error.



## CURRENT\_TIME

Available in: DSQL, PSQL, ESQL

Changed in: 2.0

*Description:* CURRENT\_TIME returns the current server time. In versions prior to 2.0, the fractional part used to be always “.0000”, giving an effective precision of 0 decimals. From Firebird 2.0 onward you can specify a precision when polling this variable. The default is still 0 decimals, i.e. seconds precision.

*Type:* TIME

*Syntax:*

```
CURRENT_TIME [(precision)]  
  
precision ::= 0 | 1 | 2 | 3
```

The optional *precision* argument is not supported in ESQL.

*Examples:*

```
select current_time from rdb$database  
-- returns e.g. 14:20:19.6170
```

```
select current_time(2) from rdb$database  
-- returns e.g. 14:20:23.1200
```

*Notes:*

- Unlike CURRENT\_TIME, the default precision of CURRENT\_TIMESTAMP has changed to 3 decimals. As a result, CURRENT\_TIMESTAMP is no longer the exact sum of CURRENT\_DATE and CURRENT\_TIME, unless you explicitly specify a precision.
- Within a PSQL module (procedure, trigger or executable block), the value of CURRENT\_TIME will remain constant every time it is read. If multiple modules call or trigger each other, the value will remain constant throughout the duration of the outermost module. If you need a progressing value in PSQL – e.g. to measure time intervals – use 'NOW' with a full cast (not shorthand syntax).

## CURRENT\_TIMESTAMP

Available in: DSQL, PSQL, ESQL

Changed in: 2.0

*Description:* CURRENT\_TIMESTAMP returns the current server date and time. In versions prior to 2.0, the fractional part used to be always “.0000”, giving an effective precision of 0 decimals. From Firebird 2.0 onward you can specify a precision when polling this variable. The default is 3 decimals, i.e. milliseconds precision.

*Type:* TIMESTAMP

*Syntax:*

```
CURRENT_TIMESTAMP [(precision)]  
  
precision ::= 0 | 1 | 2 | 3
```

The optional *precision* argument is not supported in ESQL.

*Examples:*

```
select current_timestamp from rdb$database  
-- returns e.g. 2008-08-13 14:20:19.6170
```

```
select current_timestamp(2) from rdb$database  
-- returns e.g. 2008-08-13 14:20:23.1200
```

*Notes:*

- The default precision of `CURRENT_TIME` is still 0 decimals, so in Firebird 2.0 and up `CURRENT_TIMESTAMP` is no longer the exact sum of `CURRENT_DATE` and `CURRENT_TIME`, unless you explicitly specify a precision.
- Within a PSQL module (procedure, trigger or executable block), the value of `CURRENT_TIMESTAMP` will remain constant every time it is read. If multiple modules call or trigger each other, the value will remain constant throughout the duration of the outermost module. If you need a progressing value in PSQL – e.g. to measure time intervals – use `'NOW'` with a full cast (not shorthand syntax).

## CURRENT\_TRANSACTION

*Available in:* DSQL, PSQL

*Added in:* 1.5

*Description:* `CURRENT_TRANSACTION` contains the unique identifier of the current transaction.

*Type:* INTEGER

*Examples:*

```
select current_transaction from rdb$database  
  
New.Txn_ID = current_transaction;
```

The value of `CURRENT_TRANSACTION` is stored on the database header page and reset to 0 upon restore. It is incremented with every new transaction.

## CURRENT\_USER

*Available in:* DSQL, PSQL

*Added in:* 1.0

*Description:* CURRENT\_USER is a context variable containing the name of the currently connected user. It is fully equivalent to USER.

*Type:* VARCHAR(31)

*Example:*

```
create trigger bi_customers for customers before insert as
begin
  New.added_by = CURRENT_USER;
  New.purchases = 0;
end
```

## DELETING

*Available in:* PSQL

*Added in:* 1.5

*Description:* Available in triggers only, DELETING indicates if the trigger fired because of a DELETE operation. Intended for use in [multi-action triggers](#).

*Type:* boolean

*Example:*

```
if (deleting) then
begin
  insert into Removed_Cars (id, make, model, removed)
    values (old.id, old.make, old.model, current_timestamp);
end
```

## GDSCODE

*Available in:* PSQL

*Added in:* 1.5

*Changed in:* 2.0

*Description:* In a “WHEN ... DO” error handling block, the GDSCODE context variable contains the numerical representation of the current Firebird error code. Prior to Firebird 2.0, GDSCODE was only set in WHEN GDSCODE handlers. Now it may also be non-zero in WHEN ANY, WHEN SQLCODE and WHEN EXCEPTION blocks, provided that the condition raising the error corresponds with a Firebird error code. Outside error handlers, GDSCODE is always 0. Outside PSQL it doesn't exist at all.

*Type:* INTEGER

*Example:*

```
when gdscode grant_obj_notfound, gdscode grant_fld_notfound,
  gdscode grant_nopriv, gdscode grant_nopriv_on_base
```

```
do
begin
  execute procedure log_grant_error(gdscode);
  exit;
end
```

Please notice: After WHEN GDSCODE, you must use symbolic names like grant\_obj\_notfound etc. But the GDSCODE context variable is an INTEGER. If you want to compare it against a certain error, you have to use the numeric value, e.g. 335544551 for grant\_obj\_notfound.

## INSERTING

*Available in:* PSQL

*Added in:* 1.5

*Description:* Available in triggers only, INSERTING indicates if the trigger fired because of an INSERT operation. Intended for use in [multi-action triggers](#).

*Type:* boolean

*Example:*

```
if (inserting or updating) then
begin
  if (new.serial_num is null) then
    new.serial_num = gen_id(gen_serials, 1);
end
```

## NEW

*Available in:* PSQL, triggers only

*Changed in:* 1.5, 2.0

*Description:* NEW contains the new version of a database record that has just been inserted or updated. Starting with Firebird 2.0 it is read-only in AFTER triggers.

*Type:* Data row

### Note

In multi-action triggers – introduced in Firebird 1.5 – NEW is always available. But if the trigger is fired by a DELETE, there will be no new version of the record. In that situation, reading from NEW will always return NULL; writing to it will cause a runtime exception.

## 'NOW'

*Available in:* DSQL, PSQL, ESQL

*Changed in:* 2.0

*Description:* 'NOW' is not a variable but a string literal. It is, however, special in the sense that when you CAST() it to a date/time type, you will get the current date and/or time. The fractional part of the time used to be always “.0000”, giving an effective seconds precision. Since Firebird 2.0 the precision is 3 decimals, i.e. milliseconds. 'NOW' is case-insensitive, and the engine ignores leading or trailing spaces when casting.

*Type:* CHAR(3)

*Examples:*

```
select 'Now' from rdb$database
-- returns 'Now'
```

```
select cast('Now' as date) from rdb$database
-- returns e.g. 2008-08-13
```

```
select cast('now' as time) from rdb$database
-- returns e.g. 14:20:19.6170
```

```
select cast('NOW' as timestamp) from rdb$database
-- returns e.g. 2008-08-13 14:20:19.6170
```

**Shorthand syntax** for the last three statements:

```
select date 'Now' from rdb$database
select time 'now' from rdb$database
select timestamp 'NOW' from rdb$database
```

*Notes:*

- When used with CAST(), 'NOW' always returns the actual date/time, even in PSQL modules, where CURRENT\_DATE, CURRENT\_TIME and CURRENT\_TIMESTAMP return the same value throughout the duration of the outermost routine. This makes 'NOW' useful for measuring time intervals in triggers, procedures and executable blocks.
- When used with the shorthand syntax, 'NOW' is evaluated at parse time and the value is frozen for as long as the statement stays prepared – even across multiple executions of the prepared statement! This is something to be aware of.
- Unless you really need progressing values in PSQL, or frozen values during multiple executions, reading CURRENT\_DATE, CURRENT\_TIME and CURRENT\_TIMESTAMP is generally preferable to using 'NOW'. Be aware though that CURRENT\_TIME defaults to seconds precision; to get milliseconds precision, use CURRENT\_TIME(3).

## OLD

*Available in:* PSQL, triggers only

*Changed in:* 1.5, 2.0

*Description:* OLD contains the existing version of a database record just before a deletion or update. Starting with Firebird 2.0 it is read-only.

Type: Data row

**Note**

In multi-action triggers – introduced in Firebird 1.5 – OLD is always available. But if the trigger is fired by an INSERT, there is obviously no pre-existing version of the record. In that situation, reading from OLD will always return NULL; writing to it will cause a runtime exception.

## ROW\_COUNT

Available in: PSQL

Added in: 1.5

Changed in: 2.0

*Description:* The ROW\_COUNT context variable contains the number of rows affected by the most recent DML statement (INSERT, UPDATE, DELETE, SELECT or FETCH) in the current trigger, stored procedure or executable block.

Type: INTEGER

Example:

```
update Figures set Number = 0 where id = :id;
if (row_count = 0) then
  insert into Figures (id, Number) values (:id, 0);
```

*Behaviour with SELECT and FETCH:*

- After a singleton SELECT, ROW\_COUNT is 1 if a data row was retrieved and 0 otherwise.
- In a FOR SELECT loop, ROW\_COUNT is incremented with every iteration (starting at 0 before the first).
- After a FETCH from a cursor, ROW\_COUNT is 1 if a data row was retrieved and 0 otherwise. Fetching more records from the same cursor does *not* increment ROW\_COUNT beyond 1.
- In Firebird 1.5.x, ROW\_COUNT is 0 after any type of SELECT statement.

**Note**

ROW\_COUNT cannot be used to determine the number of rows affected by an EXECUTE STATEMENT or EXECUTE PROCEDURE command.

## SQLCODE

Available in: PSQL

Added in: 1.5

Changed in: 2.0

*Deprecated in: 2.5.1*

*Description:* In a “WHEN ... DO” error handling block, the `SQLCODE` context variable contains the current SQL error code. Prior to Firebird 2.0, `SQLCODE` was only set in `WHEN SQLCODE` and `WHEN ANY` handlers. Now it may also be non-zero in `WHEN GDSCODE` and `WHEN EXCEPTION` blocks, provided that the condition raising the error corresponds with an SQL error code. Outside error handlers, `SQLCODE` is always 0. Outside PSQL it doesn't exist at all.

*Type:* INTEGER

*Example:*

```
when any
do
begin
  if (sqlcode <> 0) then
    Msg = 'An SQL error occurred!';
  else
    Msg = 'Something bad happened!';
  exception ex_custom Msg;
end
```

*Important notice:* `SQLCODE` is now deprecated in favour of the SQL-2003-compliant `SQLSTATE` status code. Support for `SQLCODE` and `WHEN SQLCODE` will be discontinued in some future version of Firebird.

## SQLSTATE

*Available in:* PSQL

*Added in:* 2.5.1

*Description:* In a “WHEN ... DO” error handler, the `SQLSTATE` context variable contains the 5-character, SQL-2003-compliant status code resulting from the statement that raised the error. Outside error handlers, `SQLSTATE` is always '00000'. Outside PSQL it is not available at all.

*Type:* CHAR(5)

*Example:*

```
when any
do
begin
  Msg = case sqlstate
    when '22003' then 'Numeric value out of range.'
    when '22012' then 'Division by zero.'
    when '23000' then 'Integrity constraint violation.'
    else 'Something bad happened! SQLSTATE = ' || sqlstate
  end;
  exception ex_custom Msg;
end
```

*Notes:*

- `SQLSTATE` is destined to replace `SQLCODE`. The latter is now deprecated in Firebird and will disappear in some future version.

- Firebird does not (yet) support the syntax “WHEN SQLSTATE ... DO”. You have to use WHEN ANY and test the SQLSTATE variable within the handler.
- Each SQLSTATE code is the concatenation of a 2-character class and a 3-character subclass. Classes 00 (successful completion), 01 (warning) and 02 (no data) represent *completion conditions*. Every status code outside these classes is an *exception*. Because classes 00, 01 and 02 don't raise an error, they won't ever show up in the SQLSTATE variable.
- For a complete listing of SQLSTATE codes, consult the [Appendix to the Firebird 2.5 Release Notes](#).

## UPDATING

*Available in:* PSQL

*Added in:* 1.5

*Description:* Available in triggers only, UPDATING indicates if the trigger fired because of an UPDATE operation. Intended for use in [multi-action triggers](#).

*Type:* boolean

*Example:*

```
if (inserting or updating) then
begin
  if (new.serial_num is null) then
    new.serial_num = gen_id(gen_serials, 1);
end
```



# Operators and predicates

## NULL literals allowed as operands

*Changed in: 2.0*

*Description:* Before Firebird 2.0, most operators and predicates did not allow NULL literals as operands. Tests or operations like “A <> NULL”, “B + NULL” or “NULL < ANY( . . . )” would be rejected by the parser. Now they are allowed almost everywhere, but please be aware of the following:

*The vast majority of these newly allowed expressions return NULL regardless of the state or value of the other operand, and are therefore worthless for any practical purpose whatsoever.*

In particular, don't try to determine (non-)nullness of a field or variable by testing with “= NULL” or “<> NULL”. Always use “IS [NOT] NULL”.

*Predicates:* The IN, ANY/SOME and ALL predicates now also allow NULL literals where they were previously taboo. Here too, there is no practical benefit to enjoy, but the situation is a little more complicated in that predicates with NULLs do not always return a NULL result. For details, see the *Firebird Null Guide*, section [Predicates](#).

## || (string concatenator)

*Available in:* DSQL, ESQL, PSQL

### **Text BLOB concatenation**

*Changed in: 2.1*

*Description:* Since Firebird 2.1 the concatenation operator supports BLOBs of any length and any character set. If a mixture of BLOBs and non-BLOBs is involved, the result is a BLOB. If both text and binary BLOBs are involved, the result is a binary BLOB.

### **Result type VARCHAR or BLOB**

*Changed in: 2.0, 2.1*

*Description:* Before Firebird 2.0, the result type of string concatenations used to be CHAR(*n*). In Firebird 2.0 this was changed to VARCHAR(*n*). As a result, the maximum length of a concatenation outcome became 32765 instead of 32767. In Firebird 2.1 and up, if at least one of the operands is a BLOB, the result is also a BLOB

and the maximum doesn't apply. For non-BLOB concatenations the result is still `VARCHAR(n)` with a maximum of 32765 bytes.

## Overflow checking

*Changed in:* 1.0, 2.0

*Description:* In Firebird versions 1.x, an error would be raised if the sum of the *declared* string lengths in a concatenation exceeded 65535 bytes, even if the *actual* result lay within the maximum string length of 32767 bytes. In Firebird 2.0 and up, the declared string lengths will never cause an error. Only if the actual outcome exceeds 32765 bytes (the new limit for concatenation results) will an error be raised.

## ALL

*Available in:* DSQL, ESQL, PSQL

### **NULL literals allowed**

*Changed in:* 2.0

*Description:* The ALL predicate now allows a NULL as the test value. Notice that this brings no practical benefits. In particular, a NULL test value will not be considered equal to NULLs in the subquery result set. Even if the entire set is filled with NULLs and the operator chosen is "=", the predicate will not return `true`, but `NULL`.

### **UNION as subselect**

*Changed in:* 2.0

*Description:* The subselect in an ALL predicate may now also be a UNION.

## ANY / SOME

*Available in:* DSQL, ESQL, PSQL

### **NULL literals allowed**

*Changed in:* 2.0

*Description:* The ANY (or SOME) predicate now allows a NULL as the test value. Notice that this brings no practical benefits. In particular, a NULL test value will not be considered equal to a NULL in the subquery result set.

### **UNION as subselect**

*Changed in:* 2.0

*Description:* The subselect in an ANY (or SOME) predicate may now also be a UNION.

## IN

*Available in:* DSQL, ESQL, PSQL

### **NULL literals allowed**

*Changed in:* 2.0

*Description:* The IN predicate now allows NULL literals, both as the test value and in the list. Notice that this brings no practical benefits. In particular, “NULL IN (... , NULL, ..., ...)” will not return true and “NULL NOT IN (... , NULL, ..., ...)” will not return false.

### **UNION as subselect**

*Changed in:* 2.0

*Description:* A subselect in an IN predicate may now also be a UNION.

## IS [NOT] DISTINCT FROM

*Available in:* DSQL, PSQL

*Added in:* 2.0

*Description:* Two operands are considered DISTINCT if they have a different value or if one of them is NULL and the other isn't. They are NOT DISTINCT if they have the same value or if both of them are NULL.

*Result type:* Boolean

*Syntax:*

```
op1 IS [NOT] DISTINCT FROM op2
```

*Examples:*

```
select id, name, teacher from courses
where start_day is not distinct from end_day
```

```
if (New.Job is distinct from Old.Job)
then post_event 'job_changed';
```

IS [NOT] DISTINCT FROM always returns true or false, never NULL (unknown). The “=” and “<>” operators, by contrast, return NULL if one or both operands are NULL. See also the table below.

**Table 12.1. Comparison of [NOT] DISTINCT to “=” and “<>”**

Operand characteristics	Results with the different operators			
	=	NOT DISTINCT	<>	DISTINCT
Same value	true	true	false	false
Different values	false	false	true	true
Both NULL	NULL	true	NULL	false
One NULL	NULL	false	NULL	true

## NEXT VALUE FOR

Available in: DSQL, PSQL

Added in: 2.0

*Description:* Returns the next value in a sequence. SEQUENCE is the SQL-compliant term for what InterBase and Firebird have always called a generator. NEXT VALUE FOR is fully equivalent to GEN\_ID(..., 1) and is the recommended syntax from Firebird 2.0 onward.

*Syntax:*

```
NEXT VALUE FOR sequence-name
```

*Example:*

```
new.cust_id = next value for custseq;
```

NEXT VALUE FOR doesn't support increment values other than 1. If you absolutely need other step values, use the legacy GEN\_ID function.

See also: [CREATE SEQUENCE](#), [GEN\\_ID\(\)](#)

## SIMILAR TO

Available in: DSQL, PSQL

Added in: 2.5

*Description:* SIMILAR TO matches a string against an SQL regular expression pattern. Unlike in some other languages, the pattern must match the entire string in order to succeed – matching a substring is not enough. If any operand is NULL, the result is NULL. Otherwise, the result is TRUE or FALSE.

*Result type:* Boolean

*Syntax:* SIMILAR TO:

```
string-expression [NOT] SIMILAR TO <pattern> [ESCAPE <escape-char>]
```

```
<pattern> ::= an SQL regular expression
```

```
<escape-char> ::= a single character
```

*Syntax: SQL regular expressions:* The following syntax defines the SQL regular expression format. It is a complete and correct top-down definition. It is also highly formal, rather long and probably perfectly fit to discourage everybody who hasn't already some experience with regular expressions (or with highly formal, rather long top-down definitions). Feel free to skip it and read the next section, *Building regular expressions*, which uses a bottom-up approach, aimed at the rest of us.

```
<regular expression> ::= <regular term> ['|' <regular term> ...]
```

```
<regular term> ::= <regular factor> ...
```

```
<regular factor> ::= <regular primary> [<quantifier>]
```

```
<quantifier> ::= ?
                | *
                | +
                | '{' <m> [, [<n>]] }'
```

```
<m>, <n> ::= unsigned int, with <m> <= <n> if both present
```

```
<regular primary> ::= <character>
                | <character class>
                | %
                | (<regular expression>)
```

```
<character> ::= <escaped character>
                | <non-escaped character>
```

```
<escaped character> ::= <escape-char> <special character>
                | <escape-char> <escape-char>
```

```
<special character> ::= any of the characters []()|^-+*%_?{
```

```
<non-escaped character> ::= any character that is not a <special character>
                and not equal to <escape-char> (if defined)
```

```
<character class> ::= '_'
                | '[' <member> ... ']'
                | '[' '^' <non-member> ... ']'
                | '[' <member> ... '^' <non-member> ... ']'
```

```
<member>, <non-member> ::= <character>
                | <range>
                | <predefined class>
```

```
<range> ::= <character>-<character>
```

```
<predefined class> ::= '[' <predefined class name> ':'
```

```
<predefined class name> ::= ALPHA | UPPER | LOWER | DIGIT
```

---

```
| ALNUM | SPACE | WHITESPACE
```

## Building regular expressions

### Characters

Within regular expressions, most characters represent themselves. The only exceptions are the special characters below:

```
[ ] ( ) | ^ - + * % _ ? {
```

...and the escape character, if it is defined.

A regular expression that doesn't contain any special or escape characters only matches strings that are identical to itself (subject to the collation in use). That is, it functions just like the “=” operator:

```
'Apple' similar to 'Apple'      -- true
'Apples' similar to 'Apple'    -- false
'Apple' similar to 'Apples'    -- false
'APPLE' similar to 'Apple'     -- depends on collation
```

### Wildcards

The known SQL wildcards `_` and `%` match any single character and a string of any length, respectively:

```
'Birne' similar to 'B_rne'      -- true
'Birne' similar to 'B_ne'      -- false
'Birne' similar to 'B%ne'      -- true
'Birne' similar to 'Bir%ne%'    -- true
'Birne' similar to 'Birr%ne'    -- false
```

Notice how `%` also matches the empty string.

### Character classes

A bunch of characters enclosed in brackets define a character class. A character in the string matches a class in the pattern if the character is a member of the class:

```
'Citroen' similar to 'Cit[arju]oen' -- true
'Citroen' similar to 'Ci[tr]oen'    -- false
'Citroen' similar to 'Ci[tr][tr]oen' -- true
```

As can be seen from the second line, the class only matches a single character, not a sequence.

Within a class definition, two characters connected by a hyphen define a range. A range comprises the two endpoints and all the characters that lie between them in the active collation. Ranges can be placed anywhere in the class definition without special delimiters to keep them apart from the other elements.

```
'Datte' similar to 'Dat[q-u]e'      -- true
'Datte' similar to 'Dat[abq-uy]e'    -- true
'Datte' similar to 'Dat[bcg-km-pwz]e' -- false
```

The following predefined character classes can also be used in a class definition:

`[[:ALPHA:]]`

Latin letters a..z and A..Z. With an accent-insensitive collation, this class also matches accented forms of these characters.

`[[:DIGIT:]]`

Decimal digits 0..9.

`[[:ALNUM:]]`

Union of `[[:ALPHA:]]` and `[[:DIGIT:]]`.

`[[:UPPER:]]`

Uppercase Latin letters A..Z. Also matches lowercase with case-insensitive collation and accented forms with accent-insensitive collation.

`[[:LOWER:]]`

Lowercase Latin letters a..z. Also matches uppercase with case-insensitive collation and accented forms with accent-insensitive collation.

`[[:SPACE:]]`

Matches the space character (ASCII 32).

`[[:WHITESPACE:]]`

Matches vertical tab (ASCII 9), linefeed (ASCII 10), horizontal tab (ASCII 11), form feed (ASCII 12), carriage return (ASCII 13) and space (ASCII 32).

Including a predefined class has the same effect as including all its members. Predefined classes are only allowed *within* class definitions. If you need to match against a predefined class and nothing more, place an extra pair of brackets around it.

```
'Erdbeere' similar to 'Erd[[:ALNUM:]]eere'      -- true
'Erdbeere' similar to 'Erd[[:DIGIT:]]eere'      -- false
'Erdbeere' similar to 'Erd[a[:SPACE:]]beere'    -- true
'Erdbeere' similar to [[:ALPHA:]]              -- false
'E'        similar to [[:ALPHA:]]                -- true
```

If a class definition starts with a caret, everything that follows is excluded from the class. All other characters match:

```
'Framboise' similar to 'Fra[^ck-p]boise'        -- false
'Framboise' similar to 'Fr[^a][^a]boise'        -- false
'Framboise' similar to 'Fra^[[:DIGIT:]]boise'    -- true
```

If the caret is not placed at the start of the sequence, the class contains everything *before* the caret, except for the elements that also occur *after* the caret:

```
'Grapefruit' similar to 'Grap[a-m^f-i]fruit'    -- true
'Grapefruit' similar to 'Grap[abc^xyz]fruit'    -- false
'Grapefruit' similar to 'Grap[abc^de]fruit'     -- false
'Grapefruit' similar to 'Grap[abe^de]fruit'     -- false
```

```
'3' similar to '[[[:DIGIT:]]^4-8]'              -- true
'6' similar to '[[[:DIGIT:]]^4-8]'              -- false
```

Lastly, the already mentioned wildcard “`_`” is a character class of its own, matching any single character.

## Quantifiers

A question mark immediately following a character or class indicates that the preceding item may occur 0 or 1 times in order to match:

```
'Hallon' similar to 'Hal?on'           -- false
'Hallon' similar to 'Hal?lon'          -- true
'Hallon' similar to 'Hall?on'          -- true
'Hallon' similar to 'Hallll?on'        -- false
'Hallon' similar to 'Halx?lon'         -- true
'Hallon' similar to 'H[a-c]?llon[x-z]?' -- true
```

An asterisk immediately following a character or class indicates that the preceding item may occur 0 or more times in order to match:

```
'Icaque' similar to 'Ica*que'          -- true
'Icaque' similar to 'Icar*que'         -- true
'Icaque' similar to 'I[a-c]*que'       -- true
'Icaque' similar to '_*'                -- true
'Icaque' similar to '[:ALPHA:]*'       -- true
'Icaque' similar to 'Ica[xyz]*e'       -- false
```

A plus sign immediately following a character or class indicates that the preceding item must occur 1 or more times in order to match:

```
'Jujube' similar to 'Ju_+'            -- true
'Jujube' similar to 'Ju+jube'          -- true
'Jujube' similar to 'Jujuber+'         -- false
'Jujube' similar to 'J[jux]+be'        -- true
'Jujube' similar to 'J[:DIGIT:]+ujube' -- false
```

If a character or class is followed by a number enclosed in braces, it must be repeated *exactly* that number of times in order to match:

```
'Kiwi' similar to 'Ki{2}wi'           -- false
'Kiwi' similar to 'K[ipw]{2}i'        -- true
'Kiwi' similar to 'K[ipw]{2}'         -- false
'Kiwi' similar to 'K[ipw]{3}'         -- true
```

If the number is followed by a comma, the item must be repeated *at least* that number of times in order to match:

```
'Limone' similar to 'Li{2,}mone'      -- false
'Limone' similar to 'Li{1,}mone'      -- true
'Limone' similar to 'Li[nezom]{2,}'    -- true
```

If the braces contain two numbers separated by a comma, the second number not smaller than the first, then the item must be repeated *at least* the first number and *at most* the second number of times in order to match:

```
'Mandarijn' similar to 'M[a-p]{2,5}rijn' -- true
'Mandarijn' similar to 'M[a-p]{2,3}rijn' -- false
'Mandarijn' similar to 'M[a-p]{2,3}arijn' -- true
```

The quantifiers `?`, `*` and `+` are shorthand for  $\{0, 1\}$ ,  $\{0, \}$  and  $\{1, \}$ , respectively.



## OR-ing terms

Regular expression terms can be OR'ed with the `|` operator. A match is made when the argument string matches at least one of the terms:

```
'Nektarin' similar to 'Nek|tarin'           -- false
'Nektarin' similar to 'Nektarin|Persika'    -- true
'Nektarin' similar to 'M_+|N_+|P_+'        -- true
```

## Subexpressions

One or more parts of the regular expression can be grouped into subexpressions (also called subpatterns) by placing them between parentheses. A subexpression is a regular expression in its own right. It can contain all the elements allowed in a regular expression, and can also have quantifiers added to it.

```
'Orange' similar to 'O(ra|ri|ro)nge'       -- true
'Orange' similar to 'O(r[a-e])+nge'        -- true
'Orange' similar to 'O(ra){2,4}nge'        -- false
'Orange' similar to 'O(r(an|in)g|rong)?e'  -- true
```

## Escaping special characters

In order to match against a character that is special in regular expressions, that character has to be escaped. There is no default escape character; rather, the user specifies one when needed:

```
'Peer (Poire)' similar to 'P[^ ]+ \ (P[^ ]+\)' escape '\\' -- true
'Pera [Pear]' similar to 'P[^ ]+ # [P[^ ]+#]' escape '#' -- true
'Päron-Äppledryck' similar to 'P%$-Ä%' escape '$' -- true
'Pärondryck' similar to 'P%--Ä%' escape '-' -- false
```

The last line demonstrates that the escape character can also escape itself, if needed.

# SOME

See [ANY](#)

---

## Chapter 13

# Aggregate functions

Aggregate functions operate on groups of records, rather than on individual records or variables. They are often used in combination with a GROUP BY clause.

## LIST()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Changed in:* 2.5

*Description:* LIST returns a string consisting of the non-NULL argument values in the group, separated either by a comma or by a user-supplied delimiter. If there are no non-NULL values (this includes the case where the group is empty), NULL is returned.

*Result type:* BLOB

*Syntax:*

```
LIST ([ALL | DISTINCT] expression [, separator])
```

- ALL (the default) results in all non-NULL values to be listed. With DISTINCT, duplicates are removed, except if *expression* is a BLOB.
- In Firebird 2.5 and up, the optional *separator* argument may be any string expression. This makes it possible to specify e.g. `ascii_char(13)` as a separator. (This improvement has also been backported to 2.1.4.)
- The *expression* and *separator* arguments support BLOBs of any size and character set.
- Date/time and numerical arguments are implicitly converted to strings before concatenation.
- The result is a text BLOB, except when *expression* is a BLOB of another subtype.
- The ordering of the list values is undefined.

## MAX()

*Available in:* DSQL, ESQL, PSQL

*Added in:* IB

*Changed in:* 2.1

*Description:* MAX returns the maximum argument value in the group. If the argument is a string, this is the value that comes last when the active collation is applied.

*Result type:* Varies

*Syntax:*

```
MAX (expression)
```

- If the group is empty or contains only NULLs, the result is NULL.
- Since Firebird 2.1, this function fully supports text BLOBs of any size and character set.

## MIN()

*Available in:* DSQL, ESQL, PSQL

*Added in:* IB

*Changed in:* 2.1

*Description:* MIN returns the minimum argument value in the group. If the argument is a string, this is the value that comes first when the active collation is applied.

*Result type:* Varies

*Syntax:*

```
MIN (expression)
```

- If the group is empty or contains only NULLs, the result is NULL.
- Since Firebird 2.1, this function fully supports text BLOBs of any size and character set.

# Internal functions

## ABS()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the absolute value of the argument.

*Result type:* Numerical

*Syntax:*

```
ABS (number)
```

### Important

If the [external function ABS](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## ACOS()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the arc cosine of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
ACOS (number)
```

- The result is an angle in the range [0, #].
- If the argument is outside the range [-1, 1], NaN is returned.

### Important

If the [external function ACOS](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## ASCII\_CHAR()

Available in: DSQL, PSQL

Added in: 2.1

Description: Returns the ASCII character corresponding to the number passed in the argument.

Result type: [VAR]CHAR(1) CHARACTER SET NONE

Syntax:

```
ASCII_CHAR (<code>)  
  
<code> ::= an integer in the range [0..255]
```

### Important

- If the external function `ASCII_CHAR` is declared in your database, it will override the internal function. To make the internal function available, `DROP` or `ALTER` the external function (UDF).
- If you are used to the behaviour of the `ASCII_CHAR` UDF, which returns an empty string if the argument is 0, please notice that the internal function correctly returns a character with ASCII code 0 here.

## ASCII\_VAL()

Available in: DSQL, PSQL

Added in: 2.1

Description: Returns the ASCII code of the character passed in.

Result type: SMALLINT

Syntax:

```
ASCII_VAL (ch)  
  
ch ::= a [VAR]CHAR or text BLOB of max. 32767 bytes
```

- If the argument is a string with more than one character, the ASCII code of the first character is returned.
- If the argument is an empty string, 0 is returned.
- If the argument is NULL, NULL is returned.
- If the first character of the argument string is multi-byte, an error is raised. (A bug in Firebird 2.1–2.1.3 and 2.5 causes an error to be raised if *any* character in the string is multi-byte. This is fixed in versions 2.1.4 and 2.5.1.)

**Important**

If the [external function ASCII\\_VAL](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## ASIN()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the arc sine of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
ASIN ( number )
```

- The result is an angle in the range [-#/2, #/2].
- If the argument is outside the range [-1, 1], NaN is returned.

**Important**

If the [external function ASIN](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## ATAN()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the arc tangent of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
ATAN ( number )
```

- The result is an angle in the range <-#/2, #/2>.

**Important**

If the [external function ATAN](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## ATAN2()

Available in: DSQL, PSQL

Added in: 2.1

*Description:* Returns the angle whose sine-to-cosine *ratio* is given by the two arguments, and whose sine and cosine *signs* correspond to the signs of the arguments. This allows results across the entire circle, including the angles  $-\pi/2$  and  $\pi/2$ .

*Result type:* DOUBLE PRECISION

*Syntax:*

```
ATAN2 (y, x)
```

- The result is an angle in the range  $[-\pi, \pi]$ .
- If  $x$  is negative, the result is  $\pi$  if  $y$  is 0, and  $-\pi$  if  $y$  is  $-0$ .
- If both  $y$  and  $x$  are 0, the result is meaningless. Starting with Firebird 3, an error will be raised if both arguments are 0.

### Important

If the [external function ATAN2](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

*Notes:*

- A fully equivalent description of this function is the following:  $\text{ATAN2}(y, x)$  is the angle between the positive X-axis and the line from the origin to the point  $(x, y)$ . This also makes it obvious that  $\text{ATAN2}(0, 0)$  is undefined.
- If  $x$  is greater than 0,  $\text{ATAN2}(y, x)$  is the same as  $\text{ATAN}(y/x)$ .
- If both sine and cosine of the angle are already known,  $\text{ATAN2}(\sin, \cos)$  gives the angle.

## BIN\_AND()

Available in: DSQL, PSQL

Added in: 2.1

*Description:* Returns the result of the bitwise AND operation on the argument(s).

*Result type:* INTEGER or BIGINT

*Syntax:*

```
BIN_AND (number [, number ...])
```

**Important**

If the [external function BIN\\_AND](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## BIN\_OR()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the result of the bitwise OR operation on the argument(s).

*Result type:* INTEGER or BIGINT

*Syntax:*

```
BIN_OR (number [, number ...])
```

**Important**

If the [external function BIN\\_OR](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## BIN\_SHL()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the first argument bitwise left-shifted by the second argument, i.e.  $a \ll b$  or  $a \cdot 2^b$ .

*Result type:* BIGINT

*Syntax:*

```
BIN_SHL (number, shift)
```

## BIN\_SHR()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the first argument bitwise right-shifted by the second argument, i.e.  $a \gg b$  or  $a / 2^b$ .

*Result type:* BIGINT



*Syntax:*

```
BIN_SHR (number, shift)
```

- The operation performed is an arithmetic right shift (SAR), meaning that the sign of the first operand is always preserved.

## BIN\_XOR()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the result of the bitwise XOR operation on the argument(s).

*Result type:* INTEGER or BIGINT

*Syntax:*

```
BIN_XOR (number [, number ...])
```

### Important

If the [external function](#) `BIN_XOR` is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## BIT\_LENGTH()

*Available in:* DSQL, PSQL

*Added in:* 2.0

*Changed in:* 2.1

*Description:* Gives the length in bits of the input string. For multi-byte character sets, this may be less than the number of characters times 8 times the “formal” number of bytes per character as found in `RDB $CHARACTER_SETS`.

### Note

With arguments of type `CHAR`, this function takes the entire formal string length (e.g. the declared length of a field or variable) into account. If you want to obtain the “logical” bit length, not counting the trailing spaces, [right-TRIM](#) the argument before passing it to `BIT_LENGTH`.

*Result type:* INTEGER

*Syntax:*

```
BIT_LENGTH (str)
```

*BLOB support:* Since Firebird 2.1, this function fully supports text BLOBs of any length and character set.

*Examples:*

```
select bit_length('Hello!') from rdb$database
-- returns 48
```

```
select bit_length(_iso8859_1 'Grüß di!') from rdb$database
-- returns 64: ü and ß take up one byte each in ISO8859_1
```

```
select bit_length
  (cast (_iso8859_1 'Grüß di!' as varchar(24) character set utf8))
from rdb$database
-- returns 80: ü and ß take up two bytes each in UTF8
```

```
select bit_length
  (cast (_iso8859_1 'Grüß di!' as char(24) character set utf8))
from rdb$database
-- returns 208: all 24 CHAR positions count, and two of them are 16-bit
```

*See also:* [OCTET\\_LENGTH\(\)](#), [CHARACTER\\_LENGTH\(\)](#)

## CAST()

*Available in:* DSQL, ESQL, PSQL

*Added in:* IB

*Changed in:* 2.0, 2.1, 2.5

*Description:* CAST converts an expression to the desired datatype or domain. If the conversion is not possible, an error is raised.

*Result type:* User-chosen.

*Syntax:*

```
CAST (expression AS <target_type>)

<target_type> ::= sql_datatype
                | [TYPE OF] domain
                | TYPE OF COLUMN relname.colname
```

*Shorthand syntax:*

Alternative syntax, supported only when casting a string literal to a DATE, TIME or TIMESTAMP:

```
datatype 'date/timestring'
```

This syntax was already available in InterBase, but was never properly documented. *Please notice:* The shorthand syntax is evaluated immediately at parse time, causing the value to stay the same until the statement is unprepared. For datetime literals like '12-Oct-2012' this doesn't make any difference. But for the pseudo-variables 'NOW', 'YESTERDAY', 'TODAY' and 'TOMORROW' this may not be what you want. If you need the value to be evaluated at every call, use CAST().

*Examples:*

A full-syntax cast:

```
select cast ('12' || '-June-' || '1959' as date) from rdb$database
```

A shorthand string-to-date cast:

```
update People set AgeCat = 'Old'
  where BirthDate < date '1-Jan-1943'
```

Notice that you can drop even the shorthand cast from the example above, as the engine will understand from the context (comparison to a DATE field) how to interpret the string:

```
update People set AgeCat = 'Old'
  where BirthDate < '1-Jan-1943'
```

But this is not always possible. The cast below cannot be dropped, otherwise the engine would find itself with an integer to be subtracted from a string:

```
select date 'today' - 7 from rdb$database
```

The following table shows the type conversions possible with CAST.

**Table 14.1. Possible CASTs**

From	To
Numeric types	Numeric types [VAR]CHAR BLOB
[VAR]CHAR BLOB	[VAR]CHAR BLOB Numeric types DATE TIME TIMESTAMP
DATE TIME	[VAR]CHAR BLOB TIMESTAMP
TIMESTAMP	[VAR]CHAR BLOB DATE TIME

Keep in mind that sometimes information is lost, for instance when you cast a TIMESTAMP to a DATE. Also, the fact that types are CAST-compatible is in itself no guarantee that a conversion will succeed. “CAST(123456789 as SMALLINT)” will definitely result in an error, as will “CAST('Judgement Day' as DATE)”.

*Casting input fields:* Since Firebird 2.0, you can cast statement parameters to a datatype:

```
cast (? as integer)
```

This gives you control over the type of input field set up by the engine. Please notice that with statement parameters, you always need a full-syntax cast – shorthand casts are not supported.

*Casting to a domain or its type:* Firebird 2.1 and above support casting to a domain or its base type. When casting to a domain, any constraints (NOT NULL and/or CHECK) declared for the domain must be satisfied or the cast will fail. Please be aware that a CHECK passes if it evaluates to TRUE *or* NULL! So, given the following statements:

```
create domain quint as int check (value >= 5000)
select cast (2000 as quint) from rdb$database      -- (1)
select cast (8000 as quint) from rdb$database      -- (2)
select cast (null as quint) from rdb$database      -- (3)
```

only cast number (1) will result in an error.

When the TYPE OF modifier is used, the expression is cast to the base type of the domain, ignoring any constraints. With domain quint defined as above, the following two casts are equivalent and will both succeed:

```
select cast (2000 as type of quint) from rdb$database
select cast (2000 as int) from rdb$database
```

If TYPE OF is used with a (VAR)CHAR type, its character set and collation are retained:

```
create domain iso20 varchar(20) character set iso8859_1;
create domain dunl20 varchar(20) character set iso8859_1 collate du_nl;
create table zinnen (zin varchar(20));
commit;
insert into zinnen values ('Deze');
insert into zinnen values ('Die');
insert into zinnen values ('die');
insert into zinnen values ('deze');

select cast(zin as type of iso20) from zinnen order by 1;
-- returns Deze -> Die -> deze -> die

select cast(zin as type of dunl20) from zinnen order by 1;
-- returns deze -> Deze -> die -> Die
```

### Warning

If a domain's definition is changed, existing CASTs to that domain or its type may become invalid. If these CASTs occur in PSQL modules, their invalidation may be detected. See the note [The RDB\\$VALID\\_BLR field](#), near the end of this document.

*Casting to a column's type:* In Firebird 2.5 and above, it is possible to cast expressions to the type of an existing table or view column. Only the type itself is used; in the case of string types, this includes the character set but not the collation. Constraints and default values of the source column are not applied.

```
create table ttt (
  s varchar(40) character set utf8 collate unicode_ci_ai
);
commit;

select cast ('Jag har många vänner' as type of column ttt.s) from rdb$database;
```

**Warnings**

- For text types, character set and collation are preserved by the cast – just as when casting to a domain. However, due to a bug, the collation is not always taken into consideration when comparisons (e.g. equality tests) are made. In cases where the collation is of importance, test your code thoroughly before deploying! This bug is fixed for Firebird 3.
- If a column's definition is altered, existing CASTs to that column's type may become invalid. If these CASTs occur in PSQL modules, their invalidation may be detected. See the note *The RDB\$VALID\_BLR field*, near the end of this document.

*Casting BLOBs:* Successful casting to and from BLOBs is possible since Firebird 2.1.

## CEIL(), CEILING()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the smallest whole number greater than or equal to the argument.

*Result type:* BIGINT or DOUBLE PRECISION

*Syntax:*

```
CEIL[ING] (number)
```

**Important**

If the **external function** `CEILING` is declared in your database, it will override the internal function `CEILING` (but not `CEIL`). To make the internal function available, `DROP` or `ALTER` the external function (UDF).

*See also:* `FLOOR()`

## CHAR\_LENGTH(), CHARACTER\_LENGTH()

*Available in:* DSQL, PSQL

*Added in:* 2.0

*Changed in:* 2.1

*Description:* Gives the length in characters of the input string.

**Note**

With arguments of type `CHAR`, this function returns the formal string length (i.e. the declared length of a field or variable). If you want to obtain the “logical” length, not counting the trailing spaces, `right-TRIM` the argument before passing it to `CHAR[ACTER]_LENGTH`.

*Result type:* INTEGER

*Syntax:*

```
CHAR_LENGTH (str)
CHARACTER_LENGTH (str)
```

*BLOB support:* Since Firebird 2.1, this function fully supports text BLOBs of any length and character set.

*Examples:*

```
select char_length('Hello!') from rdb$database
-- returns 6
```

```
select char_length(_iso8859_1 'Grüß di!') from rdb$database
-- returns 8
```

```
select char_length
  (cast (_iso8859_1 'Grüß di!' as varchar(24) character set utf8))
from rdb$database
-- returns 8; the fact that ü and ß take up two bytes each is irrelevant
```

```
select char_length
  (cast (_iso8859_1 'Grüß di!' as char(24) character set utf8))
from rdb$database
-- returns 24: all 24 CHAR positions count
```

See also: [BIT\\_LENGTH\(\)](#), [OCTET\\_LENGTH\(\)](#)

## CHAR\_TO\_UUID()

Available in: DSQL, PSQL

Added in: 2.5

*Description:* Converts a human-readable 36-char UUID string to the corresponding 16-byte UUID.

*Result type:* CHAR(16) CHARACTER SET OCTETS

*Syntax:*

```
CHAR_TO_UUID (ascii_uuid)

ascii_uuid ::= a string of length 36 with:
                * '-' (hyphen) at positions 9, 14, 19 and 24;
                * valid hex digits at every other position.
```

*Examples:*

```
select char_to_uuid('A0bF4E45-3029-2a44-D493-4998c9b439A3') from rdb$database
-- returns A0BF4E4530292A44D4934998C9B439A3 (16-byte string)
```

```
select char_to_uuid('A0bF4E45-3029-2A44-X493-4998c9b439A3') from rdb$database
-- error: -Human readable UUID argument for CHAR_TO_UUID must
--         have hex digit at position 20 instead of "X (ASCII 88)"
```

See also: [UUID\\_TO\\_CHAR\(\)](#), [GEN\\_UUID\(\)](#)

## COALESCE()

Available in: DSQL, PSQL

Added in: 1.5

*Description:* The COALESCE function takes two or more arguments and returns the value of the first non-NULL argument. If all the arguments evaluate to NULL, the result is NULL.

*Result type:* Depends on input.

*Syntax:*

```
COALESCE (<exp1>, <exp2> [, <expN> ... ])
```

*Example:*

```
select
  coalesce (Nickname, FirstName, 'Mr./Mrs.') || ' ' || LastName
  as FullName
from Persons
```

This example picks the Nickname from the Persons table. If it happens to be NULL, it goes on to FirstName. If that too is NULL, “Mr./Mrs.” is used. Finally, it adds the family name. All in all, it tries to use the available data to compose a full name that is as informal as possible. Notice that this scheme only works if absent nicknames and first names are really NULL: if one of them is an empty string instead, COALESCE will happily return that to the caller.

### Note

In Firebird 1.0.x, where COALESCE is not available, you can accomplish the same with the `*nvl` external functions.

## COS()

Available in: DSQL, PSQL

Added in: 2.1

*Description:* Returns an angle's cosine. The argument must be given in radians.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
COS (angle)
```

- Any non-NULL result is – obviously – in the range [-1, 1].

**Important**

If the [external function COS](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## COSH()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the hyperbolic cosine of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
COSH (number)
```

- Any non-NULL result is in the range [1, INF].

**Important**

If the [external function COSH](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## COT()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns an angle's cotangent. The argument must be given in radians.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
COT (angle)
```

**Important**

If the [external function COT](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## DATEADD()

*Available in:* DSQL, PSQL



*Added in:* 2.1

*Changed in:* 2.5

*Description:* Adds the specified number of years, months, weeks, days, hours, minutes, seconds or milliseconds to a date/time value. (The WEEK unit is new in 2.5.)

*Result type:* DATE, TIME or TIMESTAMP

*Syntax:*

```
DATEADD (<args>)

<args>      ::= <amount> <unit> TO <datetime>
              | <unit>, <amount>, <datetime>

<amount>    ::= an integer expression (negative to subtract)
<unit>      ::= YEAR | MONTH | WEEK | DAY
              | HOUR | MINUTE | SECOND | MILLISECOND
<datetime>  ::= a DATE, TIME or TIMESTAMP expression
```

- The result type is determined by the third argument.
- With TIMESTAMP and DATE arguments, all units can be used. (Prior to Firebird 2.5, units smaller than DAY were disallowed for DATES.)
- With TIME arguments, only HOUR, MINUTE, SECOND and MILLISECOND can be used.

*Examples:*

```
dateadd (28 day to current_date)
dateadd (-6 hour to current_time)
dateadd (month, 9, DateOfConception)
dateadd (-38 week to DateOfBirth)
dateadd (minute, 90, time 'now')
dateadd (? year to date '11-Sep-1973')
```

## DATEDIFF()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Changed in:* 2.5

*Description:* Returns the number of years, months, weeks, days, hours, minutes, seconds or milliseconds elapsed between two date/time values. (The WEEK unit is new in 2.5.)

*Result type:* BIGINT

*Syntax:*

```
DATEDIFF (<args>)

<args>      ::= <unit> FROM <moment1> TO <moment2>
```

```

| <unit>, <moment1>, <moment2>

<unit>      ::= YEAR | MONTH | WEEK | DAY
              | HOUR | MINUTE | SECOND | MILLISECOND
<momentN>  ::= a DATE, TIME or TIMESTAMP expression

```

- DATE and TIMESTAMP arguments can be combined. No other mixes are allowed.
- With TIMESTAMP and DATE arguments, all units can be used. (Prior to Firebird 2.5, units smaller than DAY were disallowed for DATES.)
- With TIME arguments, only HOUR, MINUTE, SECOND and MILLISECOND can be used.

#### Computation:

- DATEDIFF doesn't look at any smaller units than the one specified in the first argument. As a result,
  - “datediff (year, date '1-Jan-2009', date '31-Dec-2009’)” returns 0, but
  - “datediff (year, date '31-Dec-2009', date '1-Jan-2010’)” returns 1
- It does, however, look at all the *bigger* units. So:
  - “datediff (day, date '26-Jun-1908', date '11-Sep-1973’)” returns 23818
- A negative result value indicates that *moment2* lies before *moment1*.

#### Examples:

```

datediff (hour from current_timestamp to timestamp '12-Jun-2059 06:00')
datediff (minute from time '0:00' to current_time)
datediff (month, current_date, date '1-1-1900')
datediff (day from current_date to cast(? as date))

```

## DECODE()

Available in: DSQL, PSQL

Added in: 2.1

*Description:* DECODE is a shortcut for the so-called “[simple CASE](#)” construct, in which a given expression is compared to a number of other expressions until a match is found. The result is determined by the value listed after the matching expression. If no match is found, the default result is returned, if present. Otherwise, NULL is returned.

*Result type:* Varies

*Syntax:*

```

DECODE ( <test-expr>,
        <expr>, result
        [, <expr>, result ...]
        [, defaultresult] )

```

The equivalent CASE construct:

```

CASE <test-expr>
  WHEN <expr> THEN result
  [WHEN <expr> THEN result ...]
  [ELSE defaultresult]
END

```

**Caution**

Matching is done with the “=” operator, so if <test-expr> is NULL, it won't match any of the <expr>s, not even those that are NULL.

*Example:*

```

select name,
       age,
       decode( upper(sex),
              'M', 'Male',
              'F', 'Female',
              'Unknown' ),
       religion
from people

```

*See also:* [CASE](#), [Simple CASE](#)

**EXP()**

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the natural exponential,  $e^{\text{number}}$

*Result type:* DOUBLE PRECISION

*Syntax:*

```
EXP (number)
```

*See also:* [LN\(\)](#)

**EXTRACT()**

*Available in:* DSQL, ESQL, PSQL

*Added in:* IB 6

*Changed in:* 2.1

*Description:* Extracts and returns an element from a DATE, TIME or TIMESTAMP expression. This function was already added in InterBase 6, but not documented in the *Language Reference* at the time.

*Result type:* SMALLINT or NUMERIC

*Syntax:*

```
EXTRACT (<part> FROM <datetime>)

<part>      ::=  YEAR | MONTH | WEEK
              | DAY | WEEKDAY | YEARDAY
              | HOUR | MINUTE | SECOND | MILLISECOND
<datetime> ::=  a DATE, TIME or TIMESTAMP expression
```

The returned data types and possible ranges are shown in the table below. If you try to extract a part that isn't present in the date/time argument (e.g. SECOND from a DATE or YEAR from a TIME), an error occurs.

**Table 14.2. Types and ranges of EXTRACT results**

Part	Type	Range	Comment
YEAR	SMALLINT	1–9999	
MONTH	SMALLINT	1–12	
WEEK	SMALLINT	1–53	
DAY	SMALLINT	1–31	
WEEKDAY	SMALLINT	0–6	0 = Sunday
YEARDAY	SMALLINT	0–365	0 = January 1
HOUR	SMALLINT	0–23	
MINUTE	SMALLINT	0–59	
SECOND	NUMERIC(9,4)	0.0000–59.9999	includes millisecond as fraction
MILLISECOND	NUMERIC(9,1)	0.0–999.9	broken in 2.1, 2.1.1

## MILLISECOND

*Added in:* 2.1 (with bug)

*Fixed in:* 2.1.2

*Description:* Firebird 2.1 and up support extraction of the millisecond from a TIME or TIMESTAMP. The datatype returned is NUMERIC(9,1).

### Note

If you extract the millisecond from [CURRENT\\_TIME](#), be aware that this variable defaults to seconds precision, so the result will always be 0. Extract from [CURRENT\\_TIME\(3\)](#) or [CURRENT\\_TIMESTAMP](#) to get milliseconds precision.

## WEEK

Added in: 2.1

*Description:* Firebird 2.1 and up support extraction of the ISO-8601 week number from a DATE or TIMESTAMP. ISO-8601 weeks start on a Monday and always have the full seven days. Week 1 is the first week that has a majority (at least 4) of its days in the new year. The first 1–3 days of the year may belong to the last week (52 or 53) of the previous year. Likewise, a year's final 1–3 days may belong to week 1 of the following year.

### Caution

Be careful when combining WEEK and YEAR results. For instance, 30 December 2008 lies in week 1 of 2009, so “extract (week from date '30 Dec 2008')” returns 1. However, extracting YEAR always gives the calendar year, which is 2008. In this case, WEEK and YEAR are at odds with each other. The same happens when the first days of January belong to the last week of the previous year.

Please also notice that WEEKDAY is *not* ISO-8601 compliant: it returns 0 for Sunday, whereas ISO-8601 specifies 7.

## FLOOR()

Available in: DSQL, PSQL

Added in: 2.1

*Description:* Returns the largest whole number smaller than or equal to the argument.

*Result type:* BIGINT or DOUBLE PRECISION

*Syntax:*

```
FLOOR ( number )
```

### Important

If the external function FLOOR is declared in your database, it will override the internal function. To make the internal function available, DROP or ALTER the external function (UDF).

See also: [CEIL\(\) / CEILING\(\)](#)

## GEN\_ID()

Available in: DSQL, ESQL, PSQL

Added in: IB

*Description:* Increments a generator or sequence and returns its new value. From Firebird 2.0 onward, the SQL-compliant NEXT VALUE FOR syntax is preferred, except when an increment other than 1 is needed.

*Result type:* BIGINT

*Syntax:*

```
GEN_ID (generator-name, <step>)  
<step> ::= An integer expression.
```

*Example:*

```
new.rec_id = gen_id(gen_recnum, 1);
```

**Warning**

Unless you know very well what you are doing, using GEN\_ID() with step values lower than 1 may compromise your data's integrity.

*See also:* [NEXT VALUE FOR](#), [CREATE GENERATOR](#)

## GEN\_UUID()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns a universally unique ID as a 16-byte character string.

*Result type:* CHAR(16) CHARACTER SET OCTETS

*Syntax:*

```
GEN_UUID ()
```

*Example:*

```
select gen_uuid() from rdb$database  
-- returns e.g. 017347BFE212B2479C00FA4323B36320 (16-byte string)
```

*See also:* [UUID\\_TO\\_CHAR\(\)](#), [CHAR\\_TO\\_UUID\(\)](#)

## HASH()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns a hash value for the input string. This function fully supports text BLOBs of any length and character set.

*Result type:* BIGINT

*Syntax:*

```
HASH (string)
```

## IIF()

*Available in:* DSQL, PSQL

*Added in:* 2.0

*Description:* IIF takes three arguments. If the first evaluates to `true`, the second argument is returned; otherwise the third is returned.

*Result type:* Depends on input.

*Syntax:*

```
IIF (<condition>, ResultT, ResultF)  
  
<condition> ::= A boolean expression.
```

*Example:*

```
select iif( sex = 'M', 'Sir', 'Madam' ) from Customers
```

IIF(*Cond*, *Result1*, *Result2*) is a shortcut for “CASE WHEN *Cond* THEN *Result1* ELSE *Result2* END”. You can also compare IIF to the ternary “? :” operator in C-like languages.

## LEFT()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the leftmost part of the argument string. The number of characters is given in the second argument.

*Result type:* VARCHAR or BLOB

*Syntax:*

```
LEFT (string, length)
```

- This function fully supports text BLOBs of any length, including those with a multi-byte character set.
- If *string* is a BLOB, the result is a BLOB. Otherwise, the result is a VARCHAR(*n*) with *n* the length of the input string.
- If the *length* argument exceeds the string length, the input string is returned unchanged.

- If the *length* argument is not a whole number, bankers' rounding (round-to-even) is applied, i.e. 0.5 becomes 0, 1.5 becomes 2, 2.5 becomes 2, 3.5 becomes 4, etc.

See also: [RIGHT\(\)](#)

## LN()

Available in: DSQL, PSQL

Added in: 2.1

Description: Returns the natural logarithm of the argument.

Result type: DOUBLE PRECISION

Syntax:

```
LN (number)
```

- An error is raised if the argument is negative or 0.

### Important

If the [external function LN](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

See also: [EXP\(\)](#)

## LOG()

Available in: DSQL, PSQL

Added in: 2.1

Changed in: 2.5

Description: Returns the *x*-based logarithm of *y*.

Result type: DOUBLE PRECISION

Syntax:

```
LOG (x, y)
```

- If either argument is 0 or below, an error is raised. (Before 2.5, this would result in NaN, ±INF or 0, depending on the exact values of the arguments.)
- If both arguments are 1, NaN is returned.
- If  $x = 1$  and  $y < 1$ , -INF is returned.



- If  $x = 1$  and  $y > 1$ , INF is returned.

**Important**

If the [external function LOG](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## LOG10()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Changed in:* 2.5

*Description:* Returns the 10-based logarithm of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
LOG10 (number)
```

- An error is raised if the argument is negative or 0. (In versions prior to 2.5, such values would result in NaN and -INF, respectively.)

**Important**

If the [external function LOG10](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## LOWER()

*Available in:* DSQL, ESQL, PSQL

*Added in:* 2.0

*Changed in:* 2.1

*Description:* Returns the lower-case equivalent of the input string. The exact result depends on the character set. With ASCII or NONE for instance, only ASCII characters are lowercased; with OCTETS, the entire string is returned unchanged. Since Firebird 2.1 this function also fully supports text BLOBs of any length and character set.

*Result type:* (VAR)CHAR or BLOB

*Syntax:*

```
LOWER (str)
```

**Note**

Because LOWER is a reserved word, the internal function will take precedence even if the [external function by that name](#) has also been declared. To call the (inferior!) external function, use double-quotes and the exact capitalisation, as in "LOWER"(str).

*Example:*

```
select Sheriff from Towns
where lower(Name) = 'cooper''s valley'
```

*See also:* [UPPER](#)

## LPAD()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Changed in:* 2.5 (backported to 2.1.4)

*Description:* Left-pads a string with spaces or with a user-supplied string until a given length is reached.

*Result type:* VARCHAR or BLOB

*Syntax:*

```
LPAD (str, endlen [, padstr])
```

- This function fully supports text BLOBs of any length and character set.
- If *str* is a BLOB, the result is a BLOB. Otherwise, the result is a VARCHAR(*endlen*).
- If *padstr* is given and equals ' ' (empty string), no padding takes place.
- If *endlen* is less than the current string length, the string is truncated to *endlen*, even if *padstr* is the empty string.

**Important**

If the [external function LPAD](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

**Note**

In Firebird 2.1–2.1.3, all non-BLOB results were of type VARCHAR(32765), which made it advisable to cast them to a more modest size. This is no longer the case.

*Examples:*

```
lpad ('Hello', 12)           -- returns '      Hello'
lpad ('Hello', 12, '-')     -- returns '-----Hello'
```

```

lpad ('Hello', 12, '')           -- returns 'Hello'
lpad ('Hello', 12, 'abc')       -- returns 'abcabcaHello'
lpad ('Hello', 12, 'abcdefghij') -- returns 'abcdefghHello'
lpad ('Hello', 2)               -- returns 'He'
lpad ('Hello', 2, '-')          -- returns 'He'
lpad ('Hello', 2, '')           -- returns 'He'

```

**Warning**

When used on a BLOB, this function may need to load the entire object into memory. Although it does try to limit memory consumption, this may affect performance if huge BLOBs are involved.

See also: [RPAD\(\)](#)

## MAXVALUE()

Available in: DSQL, PSQL

Added in: 2.1

*Description:* Returns the maximum value from a list of numerical, string, or date/time expressions. This function fully supports text BLOBs of any length and character set.

*Result type:* Varies

*Syntax:*

```
MAXVALUE (expr [, expr ...])
```

- If one or more expressions resolve to NULL, MAXVALUE returns NULL. This behaviour differs from the aggregate function MAX.

See also: [MINVALUE\(\)](#)

## MINVALUE()

Available in: DSQL, PSQL

Added in: 2.1

*Description:* Returns the minimum value from a list of numerical, string, or date/time expressions. This function fully supports text BLOBs of any length and character set.

*Result type:* Varies

*Syntax:*

```
MINVALUE (expr [, expr ...])
```

- If one or more expressions resolve to NULL, MINVALUE returns NULL. This behaviour differs from the aggregate function MIN.

See also: [MAXVALUE\(\)](#)

## MOD()

Available in: DSQL, PSQL

Added in: 2.1

Description: Returns the remainder of an integer division.

Result type: INTEGER or BIGINT

Syntax:

```
MOD ( a , b )
```

- Non-integer arguments are rounded before the division takes place. So, “7.5 mod 2.5” gives 2 (8 mod 3), not 0.

### Important

If the [external function MOD](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## NULLIF()

Available in: DSQL, PSQL

Added in: 1.5

Description: NULLIF returns the value of the first argument, unless it is equal to the second. In that case, NULL is returned.

Result type: Depends on input.

Syntax:

```
NULLIF (<exp1>, <exp2>)
```

Example:

```
select avg( nullif(Weight, -1) ) from FatPeople
```

This will return the average weight of the persons listed in FatPeople, excluding those having a weight of -1, since AVG skips NULL data. Presumably, -1 indicates “weight unknown” in this table. A plain AVG(Weight) would include the -1 weights, thus skewing the result.

### Note

In Firebird 1.0.x, where NULLIF is not available, you can accomplish the same with the [\\*nullif](#) external functions.

## OCTET\_LENGTH()

Available in: DSQL, PSQL

Added in: 2.0

Changed in: 2.1

*Description:* Gives the length in bytes (octets) of the input string. For multi-byte character sets, this may be less than the number of characters times the “formal” number of bytes per character as found in RDB \$CHARACTER\_SETS.

### Note

With arguments of type CHAR, this function takes the entire formal string length (e.g. the declared length of a field or variable) into account. If you want to obtain the “logical” byte length, not counting the trailing spaces, right-**TRIM** the argument before passing it to OCTET\_LENGTH.

*Result type:* INTEGER

*Syntax:*

```
OCTET_LENGTH (str)
```

*BLOB support:* Since Firebird 2.1, this function fully supports text BLOBs of any length and character set.

*Examples:*

```
select octet_length('Hello!') from rdb$database
-- returns 6
```

```
select octet_length(_iso8859_1 'Grüß di!') from rdb$database
-- returns 8: ü and ß take up one byte each in ISO8859_1
```

```
select octet_length
  (cast (_iso8859_1 'Grüß di!' as varchar(24) character set utf8))
from rdb$database
-- returns 10: ü and ß take up two bytes each in UTF8
```

```
select octet_length
  (cast (_iso8859_1 'Grüß di!' as char(24) character set utf8))
from rdb$database
-- returns 26: all 24 CHAR positions count, and two of them are 2-byte
```

See also: [BIT\\_LENGTH\(\)](#), [CHARACTER\\_LENGTH\(\)](#)

## OVERLAY()

Available in: DSQL, PSQL

Added in: 2.1

*Description:* Overwrites part of a string with another string. By default, the number of characters removed from the host string equals the length of the replacement string. With the optional fourth argument, the user can specify a different number of characters to be removed.

*Result type:* VARCHAR or BLOB

*Syntax:*

```
OVERLAY (string PLACING replacement FROM pos [FOR length])
```

- This function supports BLOBs of any length.
- If *string* or *replacement* is a BLOB, the result is a BLOB. Otherwise, the result is a VARCHAR(*n*) with *n* the sum of the lengths of *string* and *replacement*.
- As usual in SQL string functions, *pos* is 1-based.
- If *pos* is beyond the end of *string*, *replacement* is placed directly after *string*.
- If the number of characters from *pos* to the end of *string* is smaller than the length of *replacement* (or than the *length* argument, if present), *string* is truncated at *pos* and *replacement* placed after it.
- The effect of a “FOR 0” clause is that *replacement* is simply inserted into *string*.
- If any argument is NULL, the result is NULL.
- If *pos* or *length* is not a whole number, bankers' rounding (round-to-even) is applied, i.e. 0.5 becomes 0, 1.5 becomes 2, 2.5 becomes 2, 3.5 becomes 4, etc.

*Examples:*

```
overlay ('Goodbye' placing 'Hello' from 2)      -- returns 'GHelloe'
overlay ('Goodbye' placing 'Hello' from 5)      -- returns 'GoodHello'
overlay ('Goodbye' placing 'Hello' from 8)      -- returns 'GoodbyeHello'
overlay ('Goodbye' placing 'Hello' from 20)     -- returns 'GoodbyeHello'

overlay ('Goodbye' placing 'Hello' from 2 for 0) -- r. 'GHelloodbye'
overlay ('Goodbye' placing 'Hello' from 2 for 3) -- r. 'GHellobye'
overlay ('Goodbye' placing 'Hello' from 2 for 6) -- r. 'GHello'
overlay ('Goodbye' placing 'Hello' from 2 for 9) -- r. 'GHello'

overlay ('Goodbye' placing '' from 4)           -- returns 'Goodbye'
overlay ('Goodbye' placing '' from 4 for 3)     -- returns 'Gooe'
overlay ('Goodbye' placing '' from 4 for 20)    -- returns 'Goo'

overlay ('' placing 'Hello' from 4)             -- returns 'Hello'
overlay ('' placing 'Hello' from 4 for 0)       -- returns 'Hello'
overlay ('' placing 'Hello' from 4 for 20)      -- returns 'Hello'
```

### Warning

When used on a BLOB, this function may need to load the entire object into memory. This may affect performance if huge BLOBs are involved.

See also: [REPLACE\(\)](#)

## PI()

Available in: DSQL, PSQL

Added in: 2.1

Description: Returns an approximation of the value of #.

Result type: DOUBLE PRECISION

Syntax:

```
PI ( )
```

### Important

If the [external function](#) `PI` is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## POSITION()

Available in: DSQL, PSQL

Added in: 2.1

Description: Returns the (1-based) position of the first occurrence of a substring in a host string. With the optional third argument, the search starts at a given offset, disregarding any matches that may occur earlier in the string. If no match is found, the result is 0.

Result type: INTEGER

Syntax:

```
POSITION (<args>)
<args> ::= substr IN string
         | substr, string [, startpos]
```

- The optional third argument is only supported in the second syntax (comma syntax).
- The empty string is considered a substring of every string. Therefore, if *substr* is "" (empty string) and *string* is not NULL, the result is:
  - 1 if *startpos* is not given;
  - *startpos* if *startpos* lies within *string*;
  - 0 if *startpos* lies beyond the end of *string*.

**Notice:** A bug in Firebird 2.1–2.1.3 and 2.5 causes `POSITION` to *always* return 1 if *substr* is the empty string. This is fixed in 2.1.4 and 2.5.1.

- This function fully supports text BLOBs of any size and character set.

*Examples:*

```
position ('be' in 'To be or not to be')      -- returns 4
position ('be', 'To be or not to be')      -- returns 4
position ('be', 'To be or not to be', 4)   -- returns 4
position ('be', 'To be or not to be', 8)   -- returns 17
position ('be', 'To be or not to be', 18)  -- returns 0
position ('be' in 'Alas, poor Yorick!')    -- returns 0
```

### Warning

When used on a BLOB, this function may need to load the entire object into memory. This may affect performance if huge BLOBs are involved.

## POWER()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns  $x$  to the  $y$ 'th power.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
POWER ( $x$ ,  $y$ )
```

- If  $x$  negative, an error is raised.

### Important

If the [external function POWER](#) is declared in your database as `power` instead of the default `dPower`, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## RAND()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns a random number between 0 and 1.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
RAND ( )
```



**Important**

If the [external function](#) `RAND` is declared in your database, it will override the internal function. To make the internal function available, `DROP` or `ALTER` the external function (UDF).

## RDB\$GET\_CONTEXT()

**Note**

`RDB$GET_CONTEXT` and its counterpart `RDB$SET_CONTEXT` are actually predeclared UDFs. They are listed here as internal functions because they are always present – the user doesn't have to do anything to make them available.

*Available in:* DSQL, ESQL, PSQL

*Added in:* 2.0

*Changed in:* 2.1

*Description:* Retrieves the value of a context variable from one of the namespaces `SYSTEM`, `USER_SESSION` and `USER_TRANSACTION`.

*Result type:* `VARCHAR(255)`

*Syntax:*

```
RDB$GET_CONTEXT ( '<namespace>', '<varname>' )

<namespace> ::= SYSTEM | USER_SESSION | USER_TRANSACTION
<varname>   ::= A case-sensitive string of max. 80 characters
```

*The namespaces:* The `USER_SESSION` and `USER_TRANSACTION` namespaces are initially empty. The user can create and set variables in them with `RDB$SET_CONTEXT()` and retrieve them with `RDB$GET_CONTEXT()`. The `SYSTEM` namespace is read-only. It contains a number of predefined variables, shown in the table below.

**Table 14.3. Context variables in the `SYSTEM` namespace**

<code>DB_NAME</code>	Either the full path to the database or – if connecting via the path is disallowed – its alias.
<code>NETWORK_PROTOCOL</code>	The protocol used for the connection: <code>'TCPv4'</code> , <code>'WNET'</code> , <code>'XNET'</code> or <code>NULL</code> .
<code>CLIENT_ADDRESS</code>	For <code>TCPv4</code> , this is the IP address. For <code>XNET</code> , the local process ID. For all other protocols this variable is <code>NULL</code> .
<code>CURRENT_USER</code>	Same as global <code>CURRENT_USER</code> variable.
<code>CURRENT_ROLE</code>	Same as global <code>CURRENT_ROLE</code> variable.
<code>SESSION_ID</code>	Same as global <code>CURRENT_CONNECTION</code> variable.
<code>TRANSACTION_ID</code>	Same as global <code>CURRENT_TRANSACTION</code> variable.

ISOLATION_LEVEL	The isolation level of the current transaction: 'READ COMMITTED', 'SNAPSHOT' or 'CONSISTENCY'.
ENGINE_VERSION	The Firebird engine (server) version. Added in 2.1.

*Return values and error behaviour:* If the polled variable exists in the given namespace, its value will be returned as a string of max. 255 characters. If the namespace doesn't exist or if you try to access a non-existing variable in the SYSTEM namespace, an error is raised. If you poll a non-existing variable in one of the other namespaces, NULL is returned. Both namespace and variable names must be given as single-quoted, case-sensitive, non-NULL strings.

*Examples:*

```
select rdb$get_context('SYSTEM', 'DB_NAME') from rdb$database
```

```
New.UserAddr = rdb$get_context('SYSTEM', 'CLIENT_ADDRESS');
```

```
insert into MyTable (TestField)
values (rdb$get_context('USER_SESSION', 'MyVar'))
```

See also: [RDB\\$SET\\_CONTEXT\(\)](#)

## RDB\$SET\_CONTEXT()

### Note

RDB\$SET\_CONTEXT and its counterpart RDB\$GET\_CONTEXT are actually predeclared UDFs. They are listed here as internal functions because they are always present – the user doesn't have to do anything to make them available.

*Available in:* DSQL, ESQL, PSQL

*Added in:* 2.0

*Description:* Creates, sets or unsets a variable in one of the user-writable namespaces USER\_SESSION and USER\_TRANSACTION.

*Result type:* INTEGER

*Syntax:*

```
RDB$SET_CONTEXT ('<namespace>', '<varname>', <value> | NULL)

<namespace> ::= USER_SESSION | USER_TRANSACTION
<varname>   ::= A case-sensitive string of max. 80 characters
<value>     ::= A value of any type, as long as it's castable
               to a VARCHAR(255)
```

*The namespaces:* The USER\_SESSION and USER\_TRANSACTION namespaces are initially empty. The user can create and set variables in them with RDB\$SET\_CONTEXT() and retrieve them with RDB\$GET\_CONTEXT(). The USER\_SESSION context is bound to the current connection. Variables in USER\_TRANSACTION only exist in the transaction in which they have been set. When the transaction ends, the context and all the variables defined in it are destroyed.

*Return values and error behaviour:* The function returns 1 if the variable already existed before the call and 0 if it didn't. To remove a variable from a context, set it to NULL. If the given namespace doesn't exist, an error is raised. Both namespace and variable names must be entered as single-quoted, case-sensitive, non-NULL strings.

*Examples:*

```
select rdb$set_context('USER_SESSION', 'MyVar', 493) from rdb$database
rdb$set_context('USER_SESSION', 'RecordsFound', RecCounter);
select rdb$set_context('USER_TRANSACTION', 'Savepoints', 'Yes')
from rdb$database
```

*Notes:*

- The maximum number of variables in any single context is 1000.
- All USER\_TRANSACTION variables will survive a [ROLLBACK RETAIN](#) or [ROLLBACK TO SAVEPOINT](#) unaltered, no matter at which point during the transaction they were set.
- Due to its UDF-like nature, RDB\$SET\_CONTEXT can – in PSQL only – be called like a void function, without assigning the result, as in the second example above. Regular internal functions don't allow this type of use.

*See also:* [RDB\\$GET\\_CONTEXT\(\)](#)

## REPLACE()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Replaces all occurrences of a substring in a string.

*Result type:* VARCHAR or BLOB

*Syntax:*

```
REPLACE (str, find, repl)
```

- This function fully supports text BLOBs of any length and character set.
- If any argument is a BLOB, the result is a BLOB. Otherwise, the result is a VARCHAR(*n*) with *n* calculated from the lengths of *str*, *find* and *repl* in such a way that even the maximum possible number of replacements won't overflow the field.
- If *find* is the empty string, *str* is returned unchanged.
- If *repl* is the empty string, all occurrences of *find* are deleted from *str*.
- If any argument is NULL, the result is always NULL, even if nothing would have been replaced.

*Examples:*

```
replace ('Billy Wilder', 'il', 'oog') -- returns 'Boogly Woogder'
replace ('Billy Wilder', 'il', '') -- returns 'Bly Wder'
```

```

replace ('Billy Wilder', null, 'oog')      -- returns NULL
replace ('Billy Wilder', 'il', null)      -- returns NULL
replace ('Billy Wilder', 'xyz', null)     -- returns NULL (!)
replace ('Billy Wilder', 'xyz', 'abc')    -- returns 'Billy Wilder'
replace ('Billy Wilder', ' ', 'abc')      -- returns 'Billy Wilder'

```

**Warning**

When used on a BLOB, this function may need to load the entire object into memory. This may affect performance if huge BLOBs are involved.

See also: [OVERLAY\(\)](#)

## REVERSE()

Available in: DSQL, PSQL

Added in: 2.1

Description: Returns a string backwards.

Result type: VARCHAR

Syntax:

```
REVERSE (str)
```

Examples:

```

reverse ('spoonful')          -- returns 'lufnoops'
reverse ('Was it a cat I saw?') -- returns '?was I tac a ti saW'

```

**Tip**

This function comes in very handy if you want to group, search or order on string endings, e.g. when dealing with domain names or email addresses:

```

create index ix_people_email on people
  computed by (reverse(email));

select * from people
  where reverse(email) starting with reverse('.br');

```

## RIGHT()

Available in: DSQL, PSQL

Added in: 2.1

*Description:* Returns the rightmost part of the argument string. The number of characters is given in the second argument.

*Result type:* VARCHAR or BLOB

*Syntax:*

```
RIGHT (string, length)
```

- This function supports text BLOBs of any length, but has a bug in versions 2.1–2.1.3 and 2.5 that makes it fail with text BLOBs larger than 1024 bytes that have a multi-byte character set. This has been fixed in versions 2.1.4 and 2.5.1.
- If *string* is a BLOB, the result is a BLOB. Otherwise, the result is a VARCHAR(*n*) with *n* the length of the input string.
- If the *length* argument exceeds the string length, the input string is returned unchanged.
- If the *length* argument is not a whole number, bankers' rounding (round-to-even) is applied, i.e. 0.5 becomes 0, 1.5 becomes 2, 2.5 becomes 2, 3.5 becomes 4, etc.

#### Warning

When used on a BLOB, this function may need to load the entire object into memory. This may affect performance if huge BLOBs are involved.

#### Important

If the [external function RIGHT](#) is declared in your database as `right` instead of the default `sright`, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

*See also:* [LEFT\(\)](#)

## ROUND()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Rounds a number to the nearest integer. If the fractional part is exactly 0.5, rounding is upward for positive numbers and downward for negative numbers. With the optional *scale* argument, the number can be rounded to powers-of-ten multiples (tens, hundreds, tenths, hundredths, etc.) instead of just integers.

*Result type:* INTEGER, (scaled) BIGINT or DOUBLE

*Syntax:*

```
ROUND (<number> [, <scale>])
```

<number> ::= a numerical expression

<scale> ::= an integer specifying the number of decimal places toward which should be rounded, e.g.:

```
2 for rounding to the nearest multiple of 0.01
1 for rounding to the nearest multiple of 0.1
0 for rounding to the nearest whole number
-1 for rounding to the nearest multiple of 10
-2 for rounding to the nearest multiple of 100
```

Notes:

- If the *scale* argument is present, the result usually has the same scale as the first argument, e.g.
  - ROUND(123.654, 1) returns 123.700 (not 123.7)
  - ROUND(8341.7, -3) returns 8000.0 (not 8000)
  - ROUND(45.1212, 0) returns 45.0000 (not 45)

Otherwise, the result scale is 0:

- ROUND(45.1212) returns 45

### Important

- If the [external function ROUND](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).
- If you are used to the behaviour of the external function ROUND, please notice that the *internal* function always rounds halves away from zero, i.e. downward for negative numbers.

## RPAD()

Available in: DSQL, PSQL

Added in: 2.1

Changed in: 2.5 (backported to 2.1.4)

Description: Right-pads a string with spaces or with a user-supplied string until a given length is reached.

Result type: VARCHAR or BLOB

Syntax:

```
RPAD (str, endlen [, padstr])
```

- This function fully supports text BLOBs of any length and character set.
- If *str* is a BLOB, the result is a BLOB. Otherwise, the result is a VARCHAR(*endlen*).
- If *padstr* is given and equals ' ' (empty string), no padding takes place.
- If *endlen* is less than the current string length, the string is truncated to *endlen*, even if *padstr* is the empty string.

### Important

If the [external function RPAD](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

**Note**

In Firebird 2.1–2.1.3, all non-BLOB results were of type VARCHAR(32765), which made it advisable to cast them to a more modest size. This is no longer the case.

*Examples:*

```

rpad ('Hello', 12)           -- returns 'Hello      '
rpad ('Hello', 12, '-')     -- returns 'Hello-----'
rpad ('Hello', 12, '')      -- returns 'Hello'
rpad ('Hello', 12, 'abc')   -- returns 'Helloabcabca'
rpad ('Hello', 12, 'abcdefghij') -- returns 'Helloabcdefghg'
rpad ('Hello', 2)           -- returns 'He'
rpad ('Hello', 2, '-')     -- returns 'He'
rpad ('Hello', 2, '')      -- returns 'He'

```

**Warning**

When used on a BLOB, this function may need to load the entire object into memory. Although it does try to limit memory consumption, this may affect performance if huge BLOBs are involved.

*See also:* LPAD()

## SIGN()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the sign of the argument: -1, 0 or 1.

*Result type:* SMALLINT

*Syntax:*

```
SIGN (number)
```

**Important**

If the [external function SIGN](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## SIN()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns an angle's sine. The argument must be given in radians.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
SIN (angle)
```

- Any non-NULL result is – obviously – in the range [-1, 1].

**Important**

If the [external function SIN](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## SINH()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the hyperbolic sine of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
SINH (number)
```

**Important**

If the [external function SINH](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## SQRT()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the square root of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
SQRT (number)
```

**Important**

If the [external function SQRT](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).



## SUBSTRING()

Available in: DSQL, PSQL

Added in: 1.0

Changed in: 2.0, 2.1, 2.1.5, 2.5.1

**Description:** Returns a string's substring starting at the given position, either to the end of the string or with a given length.

**Result type:** VARCHAR(*n*) or BLOB

**Syntax:**

```
SUBSTRING (str FROM startpos [FOR length])
```

This function returns the substring starting at character position *startpos* (the first position being 1). Without the FOR argument, it returns all the remaining characters in the string. With FOR, it returns *length* characters or the remainder of the string, whichever is shorter.

In Firebird 1.x, *startpos* and *length* must be integer literals. In 2.0 and above they can be any valid integer expression.

Starting with Firebird 2.1, this function fully supports binary and text BLOBs of any length and character set. If *str* is a BLOB, the result is also a BLOB. For any other argument type, the result is a VARCHAR(*n*). Previously, the result type used to be CHAR(*n*) if the argument was a CHAR(*n*) or a string literal.

For non-BLOB arguments, the width of the result field is always equal to the length of *str*, regardless of *startpos* and *length*. So, `substring('pinhead' from 4 for 2)` will return a VARCHAR(7) containing the string 'he'.

If any argument is NULL, the result is NULL.

### Bugs

- If *str* is a BLOB and the *length* argument is not present, the output is limited to 32767 characters. Workaround: with long BLOBs, always specify `char_length(str)` – or a sufficiently high integer – as the third argument, unless you are sure that the requested substring fits within 32767 characters.

This bug has been fixed in version 2.5.1; the fix was also backported to 2.1.5.

- A bug in Firebird 2.0 which caused the function to return “false emptystrings” if *startpos* or *length* was NULL, has been fixed.

**Example:**

```
insert into AbbrNames(AbbrName)
select substring(LongName from 1 for 3) from LongNames
```

### Warning

When used on a BLOB, this function may need to load the entire object into memory. Although it does try to limit memory consumption, this may affect performance if huge BLOBs are involved.

## TAN()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns an angle's tangent. The argument must be given in radians.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
TAN (angle)
```

### Important

If the [external function TAN](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## TANH()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the hyperbolic tangent of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
TANH (number)
```

- Due to rounding, any non-NULL result is in the range [-1, 1] (mathematically, it's <-1, 1>).

### Important

If the [external function TANH](#) is declared in your database, it will override the internal function. To make the internal function available, [DROP](#) or [ALTER](#) the external function (UDF).

## TRIM()

*Available in:* DSQL, PSQL

*Added in:* 2.0

*Changed in:* 2.1

*Description:* Removes leading and/or trailing spaces (or optionally other strings) from the input string. Since Firebird 2.1 this function fully supports text BLOBs of any length and character set.

*Result type:* VARCHAR(*n*) or BLOB

*Syntax:*

```
TRIM ([<adjust>] str)

<adjust> ::= { [where] [what] } FROM

where    ::= BOTH | LEADING | TRAILING      /* default is BOTH */

what     ::= The substring to be removed (repeatedly if necessary)
           from str's head and/or tail. Default is ' ' (space).
```

*Examples:*

```
select trim (' Waste no space ') from rdb$database
-- returns 'Waste no space'
```

```
select trim (leading from ' Waste no space ') from rdb$database
-- returns 'Waste no space '
```

```
select trim (leading '.' from ' Waste no space ') from rdb$database
-- returns ' Waste no space '
```

```
select trim (trailing '!' from 'Help!!!!') from rdb$database
-- returns 'Help'
```

```
select trim ('la' from 'lalala I love you Ella') from rdb$database
-- returns ' I love you El'
```

```
select trim ('la' from 'Lalala I love you Ella') from rdb$database
-- returns 'Lalala I love you El'
```

*Notes:*

- If *str* is a BLOB, the result is a BLOB. Otherwise, it is a VARCHAR(*n*) with *n* the formal length of *str*.
- The substring to be removed, if specified, may not be bigger than 32767 bytes. However, if this substring is *repeated* at *str*'s head or tail, the total number of bytes removed may be far greater. (The restriction on the size of the substring will be lifted in Firebird 3.)

#### Warning

When used on a BLOB, this function may need to load the entire object into memory. This may affect performance if huge BLOBs are involved.

## TRUNC()

*Available in:* DSQL, PSQL

*Added in:* 2.1

*Description:* Returns the integer part of a number. With the optional *scale* argument, the number can be truncated to powers-of-ten multiples (tens, hundreds, tenths, hundredths, etc.) instead of just integers.

*Result type:* INTEGER, (scaled) BIGINT or DOUBLE

*Syntax:*

```
TRUNC (<number> [, <scale>])

<number> ::= a numerical expression
<scale>   ::= an integer specifying the number of decimal places
              toward which should be truncated, e.g.:
                2 for truncating to a multiple of 0.01
                1 for truncating to a multiple of 0.1
                0 for truncating to a whole number
               -1 for truncating to a multiple of 10
               -2 for truncating to a multiple of 100
```

*Notes:*

- If the *scale* argument is present, the result usually has the same scale as the first argument, e.g.
  - TRUNC(789.2225, 2) returns 789.2200 (not 789.22)
  - TRUNC(345.4, -2) returns 300.0 (not 300)
  - TRUNC(-163.41, 0) returns -163.00 (not -163)

Otherwise, the result scale is 0:

- TRUNC(-163.41) returns -163

### Important

If you are used to the behaviour of the [external function TRUNCATE](#), please notice that the *internal* function TRUNC always truncates toward zero, i.e. upward for negative numbers.

## UPPER()

*Available in:* DSQL, ESQL, PSQL

*Added in:* IB

*Changed in:* 2.0, 2.1

*Description:* Returns the upper-case equivalent of the input string. The exact result depends on the character set. With ASCII or NONE for instance, only ASCII characters are uppercased; with OCTETS, the entire string is returned unchanged. Since Firebird 2.1 this function also fully supports text BLOBs of any length and character set.

*Result type:* (VAR)CHAR or BLOB

*Syntax:*

```
UPPER (str)
```

*Examples:*

```
select upper(_iso8859_1 'Débâcle')
from rdb$database
-- returns 'DÉBÂCLE' (before Firebird 2.0: 'DÉBÂCLE')
```

```
select upper(_iso8859_1 'Débâcle' collate fr_fr)
from rdb$database
-- returns 'DEBACLE', following French uppercasing rules
```

*See also:* [LOWER](#)

## UUID\_TO\_CHAR()

*Available in:* DSQL, PSQL

*Added in:* 2.5

*Description:* Converts a 16-byte UUID to its 36-character, human-readable ASCII representation.

*Result type:* CHAR(36)

*Syntax:*

```
UUID_TO_CHAR (uuid)

uuid ::= a string consisting of 16 single-byte characters
```

*Examples:*

```
select uuid_to_char(x'876C45F4569B320DBC4735AC3509E5F') from rdb$database
-- returns '876C45F4-569B-320D-BCB4-735AC3509E5F'
```

```
select uuid_to_char(gen_uuid()) from rdb$database
-- returns e.g. '680D946B-45FF-DB4E-B103-BB5711529B86'
```

```
select uuid_to_char('Firebird swings!') from rdb$database
-- returns '46697265-6269-7264-2073-77696E677321'
```

*See also:* [CHAR\\_TO\\_UUID\(\)](#), [GEN\\_UUID\(\)](#)

# External functions (UDFs)

External functions must be “declared” (made known) to the database before they can be used. Firebird ships with two external function libraries:

- `ib_udf` – inherited from InterBase;
- `fbudf` – a new library using [descriptors](#), present as from Firebird 1.0 (Windows) and 1.5 (Linux).

Users can also create their own UDF libraries or acquire them from third parties.

## abs

*Library:* `ib_udf`

*Added in:* IB

*Better alternative:* Internal function [ABS\(\)](#)

*Description:* Returns the absolute value of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
abs (number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION abs
DOUBLE PRECISION
RETURNS DOUBLE PRECISION BY VALUE
ENTRY_POINT 'IB_UDF_abs' MODULE_NAME 'ib_udf'
```

## acos

*Library:* `ib_udf`

*Added in:* IB

*Better alternative:* Internal function [ACOS\(\)](#)

*Description:* Returns the arc cosine of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
acos (number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION acos
DOUBLE PRECISION
RETURNS DOUBLE PRECISION BY VALUE
ENTRY_POINT 'IB_UDF_acos' MODULE_NAME 'ib_udf'
```

## addDay

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* Internal function [DATEADD](#)

*Description:* Returns the first argument with *number* days added. Use negative numbers to subtract.

*Result type:* TIMESTAMP

*Syntax:*

```
addday (atimestamp, number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION addDay
TIMESTAMP, INT
RETURNS TIMESTAMP
ENTRY_POINT 'addDay' MODULE_NAME 'fbudf'
```

## addHour

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* Internal function [DATEADD](#)

*Description:* Returns the first argument with *number* hours added. Use negative numbers to subtract.

*Result type:* TIMESTAMP

*Syntax:*

```
addhour (atimestamp, number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION addHour
  TIMESTAMP, INT
  RETURNS TIMESTAMP
  ENTRY_POINT 'addHour' MODULE_NAME 'fbudf'
```

## addMillisecond

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* Internal function [DATEADD](#)

*Description:* Returns the first argument with *number* milliseconds added. Use negative numbers to subtract.

*Result type:* TIMESTAMP

*Syntax:*

```
addmillisecond (timestamp, number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION addMillisecond
  TIMESTAMP, INT
  RETURNS TIMESTAMP
  ENTRY_POINT 'addMillisecond' MODULE_NAME 'fbudf'
```

## addMinute

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* Internal function [DATEADD](#)

*Description:* Returns the first argument with *number* minutes added. Use negative numbers to subtract.

*Result type:* TIMESTAMP

*Syntax:*

```
addminute (timestamp, number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION addMinute
  TIMESTAMP, INT
  RETURNS TIMESTAMP
  ENTRY_POINT 'addMinute' MODULE_NAME 'fbudf'
```



## addMonth

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* Internal function [DATEADD](#)

*Description:* Returns the first argument with *number* months added. Use negative numbers to subtract.

*Result type:* TIMESTAMP

*Syntax:*

```
addmonth (atimestamp, number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION addMonth
    TIMESTAMP, INT
    RETURNS TIMESTAMP
    ENTRY_POINT 'addMonth' MODULE_NAME 'fbudf'
```

## addSecond

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* Internal function [DATEADD](#)

*Description:* Returns the first argument with *number* seconds added. Use negative numbers to subtract.

*Result type:* TIMESTAMP

*Syntax:*

```
addsecond (atimestamp, number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION addSecond
    TIMESTAMP, INT
    RETURNS TIMESTAMP
    ENTRY_POINT 'addSecond' MODULE_NAME 'fbudf'
```

## addWeek

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* Internal function [DATEADD](#)

*Description:* Returns the first argument with *number* weeks added. Use negative numbers to subtract.

*Result type:* `TIMESTAMP`

*Syntax:*

```
addweek (atimestamp, number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION addWeek
    TIMESTAMP, INT
    RETURNS TIMESTAMP
    ENTRY_POINT 'addWeek' MODULE_NAME 'fbudf'
```

## addYear

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* Internal function [DATEADD](#)

*Description:* Returns the first argument with *number* years added. Use negative numbers to subtract.

*Result type:* `TIMESTAMP`

*Syntax:*

```
addyear (atimestamp, number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION addYear
    TIMESTAMP, INT
    RETURNS TIMESTAMP
    ENTRY_POINT 'addYear' MODULE_NAME 'fbudf'
```

## ascii\_char

*Library:* ib\_udf

*Changed in:* 1.0, 2.0

*Better alternative:* Internal function [ASCII\\_CHAR\(\)](#)

*Description:* Returns the ASCII character corresponding to the integer value passed in.

*Result type:* VARCHAR(1)

*Syntax (unchanged):*

```
ascii_char (intval)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION ascii_char
  INTEGER NULL
  RETURNS CSTRING(1) FREE_IT
  ENTRY_POINT 'IB_UDF_ascii_char' MODULE_NAME 'ib_udf'
```

The declaration reflects the fact that the UDF as such returns a 1-character C string, not an SQL CHAR(1) as stated in the InterBase declaration. The engine will pass the result to the caller as a VARCHAR(1) though.

The **NULL** after INTEGER is an optional addition that became available in Firebird 2. When declared with the NULL keyword, the engine will pass a NULL argument unchanged to the function. This causes a NULL result, which is correct. Without the NULL keyword (your only option in pre-2.0 versions), NULL is passed to the function as 0 and the result is an empty string.

For more information about passing NULLs to UDFs, see the [note](#) at the end of this book.

*Notes:*

- `ascii_char(0)` returns an empty string in all versions, not a character with ASCII value 0.
- Before Firebird 2.0, the result type was CHAR(1).

## ascii\_val

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [ASCII\\_VAL\(\)](#)

*Description:* Returns the ASCII code of the character passed in.

*Result type:* INTEGER

*Syntax:*

```
ascii_val (ch)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION ascii_val
  CHAR(1)
  RETURNS INTEGER BY VALUE
```

```
ENTRY_POINT 'IB_UDF_ascii_val' MODULE_NAME 'ib_udf'
```

### Caution

Because CHAR fields are padded with spaces, an empty string argument will be seen as a space, and yield a result of 32. The internal function `ASCII_VAL` returns 0 in this case.

## asin

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function `ASIN()`

*Description:* Returns the arc sine of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
asin (number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION asin
  DOUBLE PRECISION
  RETURNS DOUBLE PRECISION BY VALUE
  ENTRY_POINT 'IB_UDF_asin' MODULE_NAME 'ib_udf'
```

## atan

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function `ATAN()`

*Description:* Returns the arc tangent of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
atan (number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION atan
  DOUBLE PRECISION
```

```
RETURNS DOUBLE PRECISION BY VALUE  
ENTRY_POINT 'IB_UDF_atan' MODULE_NAME 'ib_udf'
```

## atan2

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [ATAN2\(\)](#)

*Description:* Returns the angle whose sine-to-cosine *ratio* is given by the two arguments, and whose sine and cosine *signs* correspond to the signs of the arguments. This allows results across the entire circle, including the angles  $-\pi/2$  and  $\pi/2$ .

*Result type:* DOUBLE PRECISION

*Syntax:*

```
atan2 (num1, num2)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION atan2  
DOUBLE PRECISION, DOUBLE PRECISION  
RETURNS DOUBLE PRECISION BY VALUE  
ENTRY_POINT 'IB_UDF_atan2' MODULE_NAME 'ib_udf'
```

## bin\_and

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [BIN\\_AND\(\)](#)

*Description:* Returns the bitwise AND result of the arguments.

*Result type:* INTEGER

*Syntax:*

```
bin_and (num1, num2)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION bin_and  
INTEGER, INTEGER  
RETURNS INTEGER BY VALUE  
ENTRY_POINT 'IB_UDF_bin_and' MODULE_NAME 'ib_udf'
```

## bin\_or

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [BIN\\_OR\(\)](#)

*Description:* Returns the bitwise OR result of the arguments.

*Result type:* INTEGER

*Syntax:*

```
bin_or (num1, num2)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION bin_or
  INTEGER, INTEGER
  RETURNS INTEGER BY VALUE
  ENTRY_POINT 'IB_UDF_bin_or' MODULE_NAME 'ib_udf'
```

## bin\_xor

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [BIN\\_XOR\(\)](#)

*Description:* Returns the bitwise XOR result of the arguments.

*Result type:* INTEGER

*Syntax:*

```
bin_xor (num1, num2)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION bin_xor
  INTEGER, INTEGER
  RETURNS INTEGER BY VALUE
  ENTRY_POINT 'IB_UDF_bin_xor' MODULE_NAME 'ib_udf'
```

## ceiling

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [CEIL\(\)](#) / [CEILING\(\)](#)

*Description:* Returns the smallest whole number that is greater than or equal to the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
ceiling (number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION ceiling
DOUBLE PRECISION
RETURNS DOUBLE PRECISION BY VALUE
ENTRY_POINT 'IB_UDF_ceiling' MODULE_NAME 'ib_udf'
```

## COS

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [COS\(\)](#)

*Description:* Returns an angle's cosine. The argument must be given in radians.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
cos (angle)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION cos
DOUBLE PRECISION
RETURNS DOUBLE PRECISION BY VALUE
ENTRY_POINT 'IB_UDF_cos' MODULE_NAME 'ib_udf'
```

## cosh

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [COSH\(\)](#)

*Description:* Returns the hyperbolic cosine of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
cosh (number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION cosh
DOUBLE PRECISION
RETURNS DOUBLE PRECISION BY VALUE
ENTRY_POINT 'IB_UDF_cosh' MODULE_NAME 'ib_udf'
```

## cot

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [COT\(\)](#)

*Description:* Returns an angle's cotangent. The argument must be given in radians.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
cot (angle)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION cot
DOUBLE PRECISION
RETURNS DOUBLE PRECISION BY VALUE
ENTRY_POINT 'IB_UDF_cot' MODULE_NAME 'ib_udf'
```

## dow

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Description:* Returns the day of the week from a timestamp argument. The returned name may be localized.

*Result type:* VARCHAR(15)

*Syntax:*

```
dow (timestamp)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION dow
```



```
TIMESTAMP,  
VARCHAR(15) RETURNS PARAMETER 2  
ENTRY_POINT 'DOW' MODULE_NAME 'fbudf'
```

See also: [sdow](#)

## dpower

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* Internal function [POWER\(\)](#)

*Description:* Returns  $x$  to the  $y$ 'th power.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
dpower ( $x$ ,  $y$ )
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION dPower  
DOUBLE PRECISION BY DESCRIPTOR, DOUBLE PRECISION BY DESCRIPTOR,  
DOUBLE PRECISION BY DESCRIPTOR  
RETURNS PARAMETER 3  
ENTRY_POINT 'power' MODULE_NAME 'fbudf'
```

## floor

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [FLOOR\(\)](#)

*Description:* Returns the largest whole number that is smaller than or equal to the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
floor ( $number$ )
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION floor  
DOUBLE PRECISION
```

```
RETURNS DOUBLE PRECISION BY VALUE  
ENTRY_POINT 'IB_UDF_floor' MODULE_NAME 'ib_udf'
```

## getExactTimestamp

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* [CURRENT\\_TIMESTAMP](#) or 'NOW'

*Description:* Returns the system time with milliseconds precision. This function was added because in pre-2.0 versions, [CURRENT\\_TIMESTAMP](#) always had .0000 in the fractional part of the second. In Firebird 2.0 and up it is better to use [CURRENT\\_TIMESTAMP](#), which now also defaults to milliseconds precision. To measure time intervals in PSQL modules, use 'NOW'.

*Result type:* TIMESTAMP

*Syntax:*

```
getexacttimestamp()
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION getExactTimestamp  
TIMESTAMP RETURNS PARAMETER 1  
ENTRY_POINT 'getExactTimestamp' MODULE_NAME 'fbudf'
```

## i64round

See [round](#).

## i64truncate

See [truncate](#).

## ln

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [LN\(\)](#)

*Description:* Returns the natural logarithm of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
ln (number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION ln
  DOUBLE PRECISION
  RETURNS DOUBLE PRECISION BY VALUE
  ENTRY_POINT 'IB_UDF_ln' MODULE_NAME 'ib_udf'
```

## log

*Library:* ib\_udf

*Added in:* IB

*Changed in:* 1.5

*Better alternative:* Internal function [LOG\(\)](#)

*Description:* In Firebird 1.5 and up,  $\log(x, y)$  returns the base- $x$  logarithm of  $y$ . In Firebird 1.0.x and InterBase, it erroneously returns the base- $y$  logarithm of  $x$ .

*Result type:* DOUBLE PRECISION

*Syntax (unchanged):*

```
log (x, y)
```

*Declaration (unchanged):*

```
DECLARE EXTERNAL FUNCTION log
  DOUBLE PRECISION, DOUBLE PRECISION
  RETURNS DOUBLE PRECISION BY VALUE
  ENTRY_POINT 'IB_UDF_log' MODULE_NAME 'ib_udf'
```

### Warning

If any of your pre-1.5 databases use `log`, check your PSQL and application code. It may contain workarounds to return the right results. Under Firebird 1.5 and up, any such workarounds should be removed or you'll get wrong results.

## log10

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [LOG10\(\)](#)

*Description:* Returns the 10-based logarithm of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
log10 (number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION log10
DOUBLE PRECISION
RETURNS DOUBLE PRECISION BY VALUE
ENTRY_POINT 'IB_UDF_log10' MODULE_NAME 'ib_udf'
```

## lower

*Library:* ib\_udf

*Added in:* IB

*Changed in:* 2.0

*Better alternative:* Internal function [LOWER\(\)](#)

*Description:* Returns the lower-case version of the input string. Please notice that only ASCII characters are handled correctly. If possible, use the superior internal function [LOWER](#) instead.

*Result type:* VARCHAR(*n*)

*Syntax:*

```
"LOWER" (str)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION "LOWER"
CSTRING(255) NULL
RETURNS CSTRING(255) FREE_IT
ENTRY_POINT 'IB_UDF_lower' MODULE_NAME 'ib_udf'
```

The above declaration is from the file `ib_udf2.sql`. "LOWER" has been surrounded by double-quotes because LOWER, being a reserved word, cannot be used as an identifier except when quoted. When you call the function, you also have to add the quotes and use the exact capitalization, otherwise the internal function will take precedence. (Most other internal function names are not reserved words; in those cases, the external function prevails if it is declared.)

The **NULL** after CSTRING(255) is an optional addition that became available in Firebird 2. When declared with the NULL keyword, the engine will pass a NULL argument unchanged to the function. This leads to a NULL result, which is correct. Without the NULL keyword (your only option in pre-2.0 versions), NULL is passed to the function as an empty string and the result is an empty string as well.

For more information about passing NULLs to UDFs, see the [note](#) at the end of this book.

*Notes:*

- Depending on how you declare it (see [CSTRING note](#)), this function can accept and return strings of up to 32767 characters.
- Before Firebird 2.0, the result type was CHAR(*n*).
- In Firebird 1.5.1 and below, the default declaration used CSTRING(80) instead of CSTRING(255).

## lpad

*Library:* ib\_udf

*Added in:* 1.5

*Changed in:* 1.5.2, 2.0

*Better alternative:* Internal function [LPAD\(\)](#)

*Description:* Returns the input string left-padded with *padchars* until *endlength* is reached.

*Result type:* VARCHAR(*n*)

*Syntax:*

```
lpad (str, endlength, padchar)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION lpad
  CSTRING(255) NULL, INTEGER, CSTRING(1) NULL
  RETURNS CSTRING(255) FREE_IT
  ENTRY_POINT 'IB_UDF_lpad' MODULE_NAME 'ib_udf'
```

The above declaration is from the file `ib_udf2.sql`. The **NULL**s after the CSTRING arguments are an optional addition that became available in Firebird 2. If an argument is declared with the NULL keyword, the engine will pass a NULL argument value unchanged to the function. This leads to a NULL result, which is correct. Without the NULL keyword (your only option in pre-2.0 versions), NULLs are passed to the function as empty strings and the result is a string with *endlength* padchars (if *str* is NULL) or a copy of *str* itself (if *padchar* is NULL).

For more information about passing NULLs to UDFs, see the [note](#) at the end of this book.

*Notes:*

- Depending on how you declare it (see [CSTRING note](#)), this function can accept and return strings of up to 32767 characters.
- When calling this function, make sure *endlength* does not exceed the declared result length.
- If *endlength* is less than *str*'s length, *str* is truncated to *endlength*. If *endlength* is negative, the result is NULL.

- A `NULL` *endlength* is treated as if it were 0.
- If *padchar* is empty, or if *padchar* is `NULL` and the function has been declared without the `NULL` keyword after the last argument, *str* is returned unchanged (or truncated to *endlength*).
- Before Firebird 2.0, the result type was `CHAR(n)`.
- A bug that caused an endless loop if *padchar* was empty or `NULL` has been fixed in 2.0.
- In Firebird 1.5.1 and below, the default declaration used `CSTRING(80)` instead of `CSTRING(255)`.

## ltrim

*Library:* `ib_udf`

*Changed in:* 1.5, 1.5.2, 2.0

*Better alternative:* Internal function [TRIM\(\)](#)

*Description:* Returns the input string with any leading space characters removed. In new code, you are advised to use the internal function [TRIM](#) instead, as it is both more powerful and more versatile.

*Result type:* `VARCHAR(n)`

*Syntax (unchanged):*

```
ltrim (str)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION ltrim
  CSTRING(255) NULL
  RETURNS CSTRING(255) FREE_IT
  ENTRY_POINT 'IB_UDF_ltrim' MODULE_NAME 'ib_udf'
```

The above declaration is from the file `ib_udf2.sql`. The `NULL` after the argument is an optional addition that became available in Firebird 2. If the argument is declared with the `NULL` keyword, the engine will pass a `NULL` argument value unchanged to the function. This leads to a `NULL` result, which is correct. Without the `NULL` keyword (your only option in pre-2.0 versions), `NULL` is passed to the function as an empty string and the result is an empty string as well.

For more information about passing `NULL`s to UDFs, see the [note](#) at the end of this book.

*Notes:*

- Depending on how you declare it (see [CSTRING note](#)), this function can accept and return strings of up to 32767 characters.
- Before Firebird 2.0, the result type was `CHAR(n)`.
- In Firebird 1.5.1 and below, the default declaration used `CSTRING(80)` instead of `CSTRING(255)`.
- In Firebird 1.0.x, this function returned `NULL` if the input string was either empty or `NULL`.

## mod

*Library:* `ib_udf`

*Added in:* IB

*Better alternative:* Internal function `MOD()`

*Description:* Returns the remainder of an integer division.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
mod (a, b)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION mod
  INTEGER, INTEGER
RETURNS DOUBLE PRECISION BY VALUE
ENTRY_POINT 'IB_UDF_mod' MODULE_NAME 'ib_udf'
```

## \*nullif

*Library:* `fbudf`

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* Internal function `NULLIF()`

*Description:* The four `*nullif` functions – for integers, bigints, doubles and strings, respectively – each return the first argument if it is not equal to the second. If the arguments are equal, the functions return NULL.

*Result type:* Varies, see declarations.

*Syntax:*

```
inullif (int1, int2)
i64nullif (bigint1, bigint2)
dnullif (double1, double2)
snullif (string1, string2)
```

As from Firebird 1.5, use of the internal function `NULLIF` is preferred.

### Warnings

- These functions return NULL when the second argument is NULL, even if the first argument is a proper value. This is a wrong result. The NULLIF internal function doesn't have this bug.
- `i64nullif` and `dnullif` will return wrong and/or bizarre results if it is not 100% clear to the engine that each argument is of the intended type (NUMERIC(18,0) or DOUBLE PRECISION). If in doubt, cast them both explicitly to the declared type (see declarations below).

*Declarations:*

```
DECLARE EXTERNAL FUNCTION inullif
  INT BY DESCRIPTOR, INT BY DESCRIPTOR
  RETURNS INT BY DESCRIPTOR
  ENTRY_POINT 'iNullif' MODULE_NAME 'fbudf'
```

```
DECLARE EXTERNAL FUNCTION i64nullif
  NUMERIC(18,4) BY DESCRIPTOR, NUMERIC(18,4) BY DESCRIPTOR
  RETURNS NUMERIC(18,4) BY DESCRIPTOR
  ENTRY_POINT 'iNullif' MODULE_NAME 'fbudf'
```

```
DECLARE EXTERNAL FUNCTION dnullif
  DOUBLE PRECISION BY DESCRIPTOR, DOUBLE PRECISION BY DESCRIPTOR
  RETURNS DOUBLE PRECISION BY DESCRIPTOR
  ENTRY_POINT 'dNullif' MODULE_NAME 'fbudf'
```

```
DECLARE EXTERNAL FUNCTION snullif
  VARCHAR(100) BY DESCRIPTOR, VARCHAR(100) BY DESCRIPTOR,
  VARCHAR(100) BY DESCRIPTOR RETURNS PARAMETER 3
  ENTRY_POINT 'sNullif' MODULE_NAME 'fbudf'
```

**\*nvl**

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* Internal function [COALESCE\(\)](#)

*Description:* The four nvl functions – for integers, bigints, doubles and strings, respectively – are NULL replacers. They each return the first argument's value if it is not NULL. If the first argument is NULL, the value of the second argument is returned.

*Result type:* Varies, see declarations.

*Syntax:*

```
invl    (int1, int2)
i64nvl  (bigint1, bigint2)
dnvl    (double1, double2)
snvl    (string1, string2)
```

As from Firebird 1.5, use of the internal function [COALESCE](#) is preferred.

**Warning**

i64nvl and dnvl will return wrong and/or bizarre results if it is not absolutely clear to the engine that each argument is of the intended type (NUMERIC(18,0) or DOUBLE PRECISION). If in doubt, cast both arguments explicitly to the declared type (see declarations below).

*Declarations:*

```
DECLARE EXTERNAL FUNCTION invl
```



```
INT BY DESCRIPTOR, INT BY DESCRIPTOR
RETURNS INT BY DESCRIPTOR
ENTRY_POINT 'idNv1' MODULE_NAME 'fbudf'
```

```
DECLARE EXTERNAL FUNCTION i64nv1
  NUMERIC(18,0) BY DESCRIPTOR, NUMERIC(18,0) BY DESCRIPTOR
RETURNS NUMERIC(18,0) BY DESCRIPTOR
ENTRY_POINT 'idNv1' MODULE_NAME 'fbudf'
```

```
DECLARE EXTERNAL FUNCTION dnv1
  DOUBLE PRECISION BY DESCRIPTOR, DOUBLE PRECISION BY DESCRIPTOR
RETURNS DOUBLE PRECISION BY DESCRIPTOR
ENTRY_POINT 'idNv1' MODULE_NAME 'fbudf'
```

```
DECLARE EXTERNAL FUNCTION snv1
  VARCHAR(100) BY DESCRIPTOR, VARCHAR(100) BY DESCRIPTOR,
  VARCHAR(100) BY DESCRIPTOR RETURNS PARAMETER 3
ENTRY_POINT 'sNv1' MODULE_NAME 'fbudf'
```

## pi

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [PI\(\)](#)

*Description:* Returns an approximation of the value of #.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
pi ( )
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION pi
  RETURNS DOUBLE PRECISION BY VALUE
  ENTRY_POINT 'IB_UDF_pi' MODULE_NAME 'ib_udf'
```

## rand

*Library:* ib\_udf

*Changed in:* 2.0

*Better alternative:* Internal function [RAND\(\)](#)

*Description:* Returns a pseudo-random number. Before Firebird 2.0, this function would first seed the random number generator with the current time in seconds. Multiple `rand()` calls within the same second would therefore return the same value. If you want that old behaviour in Firebird 2 and up, use [srand\(\)](#).

*Result type:* DOUBLE PRECISION

*Syntax:*

```
rand ( )
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION rand
  RETURNS DOUBLE PRECISION BY VALUE
  ENTRY_POINT 'IB_UDF_rand' MODULE_NAME 'ib_udf'
```

## right

See [sright](#).

## round, i64round

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Changed in:* 1.5, 2.1.3

*Better alternative:* Internal function [ROUND\(\)](#)

*Description:* These functions return the whole number that is nearest to their (scaled numeric/decimal) argument. They do not work with floats or doubles.

*Result type:* INTEGER / NUMERIC(18,4)

*Syntax:*

```
round    (number)
i64round (bignumber)
```

### Caution

Halves are always rounded upward, i.e. away from zero for positive numbers and toward zero for negative numbers. For instance, 3.5 is rounded to 4, but -3.5 is rounded to -3. The internal function [ROUND](#), available since Firebird 2.1, rounds all halves away from zero.

*Declarations:*

In Firebird 1.0.x, the entry point for both functions is round:

```
DECLARE EXTERNAL FUNCTION Round
  INT BY DESCRIPTOR, INT BY DESCRIPTOR
  RETURNS PARAMETER 2
```

```
ENTRY_POINT 'round' MODULE_NAME 'fbudf'
```

```
DECLARE EXTERNAL FUNCTION i64Round
  NUMERIC(18,4) BY DESCRIPTOR, NUMERIC(18,4) BY DESCRIPTOR
  RETURNS PARAMETER 2
  ENTRY_POINT 'round' MODULE_NAME 'fbudf'
```

In Firebird 1.5, the entry point has been renamed to `fbround`:

```
DECLARE EXTERNAL FUNCTION Round
  INT BY DESCRIPTOR, INT BY DESCRIPTOR
  RETURNS PARAMETER 2
  ENTRY_POINT 'fbround' MODULE_NAME 'fbudf'
```

```
DECLARE EXTERNAL FUNCTION i64Round
  NUMERIC(18,4) BY DESCRIPTOR, NUMERIC(18,4) BY DESCRIPTOR
  RETURNS PARAMETER 2
  ENTRY_POINT 'fbround' MODULE_NAME 'fbudf'
```

If you move an existing database from Firebird 1.0.x to 1.5 or higher, drop any existing `*round` and `*truncate` declarations and declare them anew, using the updated entry point names. From Firebird 2.0 onward you can also perform this update with [ALTER EXTERNAL FUNCTION](#).

## rpad

*Library:* `ib_udf`

*Added in:* 1.5

*Changed in:* 1.5.2, 2.0

*Better alternative:* Internal function [RPAD\(\)](#)

*Description:* Returns the input string right-padded with `padchars` until `endlength` is reached.

*Result type:* `VARCHAR(n)`

*Syntax:*

```
rpad (str, endlength, padchar)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION rpad
  CSTRING(255) NULL, INTEGER, CSTRING(1) NULL
  RETURNS CSTRING(255) FREE_IT
  ENTRY_POINT 'IB_UDF_rpad' MODULE_NAME 'ib_udf'
```

The above declaration is from the file `ib_udf2.sql`. The **NULL**s after the `CSTRING` arguments are an optional addition that became available in Firebird 2. If an argument is declared with the `NULL` keyword, the engine will pass a `NULL` argument value unchanged to the function. This leads to a `NULL` result, which is correct. Without the `NULL` keyword (your only option in pre-2.0 versions), `NULL`s are passed to the function as empty strings and the result is a string with `endlength` `padchars` (if `str` is `NULL`) or a copy of `str` itself (if `padchar` is `NULL`).

For more information about passing NULLs to UDFs, see the [note](#) at the end of this book.

*Notes:*

- Depending on how you declare it (see [CSTRING note](#)), this function can accept and return strings of up to 32767 characters.
- When calling this function, make sure *endlength* does not exceed the declared result length.
- If *endlength* is less than *str*'s length, *str* is truncated to *endlength*. If *endlength* is negative, the result is NULL.
- A NULL *endlength* is treated as if it were 0.
- If *padchar* is empty, or if *padchar* is NULL and the function has been declared without the NULL keyword after the last argument, *str* is returned unchanged (or truncated to *endlength*).
- Before Firebird 2.0, the result type was CHAR(*n*).
- A bug that caused an endless loop if *padchar* was empty or NULL has been fixed in 2.0.
- In Firebird 1.5.1 and below, the default declaration used CSTRING(80) instead of CSTRING(255).

## rtrim

*Library:* ib\_udf

*Changed in:* 1.5, 1.5.2, 2.0

*Better alternative:* Internal function [TRIM\(\)](#)

*Description:* Returns the input string with any trailing space characters removed. In new code, you are advised to use the internal function [TRIM](#) instead, as it is both more powerful and more versatile.

*Result type:* VARCHAR(*n*)

*Syntax (unchanged):*

```
rtrim (str)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION rtrim
  CSTRING(255) NULL
  RETURNS CSTRING(255) FREE_IT
  ENTRY_POINT 'IB_UDF_rtrim' MODULE_NAME 'ib_udf'
```

The above declaration is from the file `ib_udf2.sql`. The **NULL** after the argument is an optional addition that became available in Firebird 2. If the argument is declared with the NULL keyword, the engine will pass a NULL argument value unchanged to the function. This leads to a NULL result, which is correct. Without the NULL keyword (your only option in pre-2.0 versions), NULL is passed to the function as an empty string and the result is an empty string as well.

For more information about passing NULLs to UDFs, see the [note](#) at the end of this book.

*Notes:*

- Depending on how you declare it (see [CSTRING note](#)), this function can accept and return strings of up to 32767 characters.
- Before Firebird 2.0, the result type was CHAR(*n*).
- In Firebird 1.5.1 and below, the default declaration used CSTRING(80) instead of CSTRING(255).
- In Firebird 1.0.x, this function returned NULL if the input string was either empty or NULL.

## sdow

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Description:* Returns the abbreviated day of the week from a timestamp argument. The returned abbreviation may be localized.

*Result type:* VARCHAR(5)

*Syntax:*

```
sdow (atimestamp)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION sdow
    TIMESTAMP,
    VARCHAR(5) RETURNS PARAMETER 2
    ENTRY_POINT 'SDOW' MODULE_NAME 'fbudf'
```

*See also:* [dow](#)

## sign

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [SIGN\(\)](#)

*Description:* Returns the sign of the argument: -1, 0 or 1.

*Result type:* INTEGER

*Syntax:*

```
sign (number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION sign
  DOUBLE PRECISION
  RETURNS INTEGER BY VALUE
  ENTRY_POINT 'IB_UDF_sign' MODULE_NAME 'ib_udf'
```

## sin

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [SIN\(\)](#)

*Description:* Returns an angle's sine. The argument must be given in radians.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
sin (angle)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION sin
  DOUBLE PRECISION
  RETURNS DOUBLE PRECISION BY VALUE
  ENTRY_POINT 'IB_UDF_sin' MODULE_NAME 'ib_udf'
```

## sinh

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [SINH\(\)](#)

*Description:* Returns the hyperbolic sine of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
sinh (number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION sinh
  DOUBLE PRECISION
  RETURNS DOUBLE PRECISION BY VALUE
  ENTRY_POINT 'IB_UDF_sinh' MODULE_NAME 'ib_udf'
```

## sqrt

*Library:* ib\_udf

*Added in:* IB

*Better alternative:* Internal function [SQRT\(\)](#)

*Description:* Returns the square root of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
sqrt (number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION sqrt
  DOUBLE PRECISION
  RETURNS DOUBLE PRECISION BY VALUE
  ENTRY_POINT 'IB_UDF_sqrt' MODULE_NAME 'ib_udf'
```

## srand

*Library:* ib\_udf

*Added in:* 2.0

*Description:* Seeds the random number generator with the current time in seconds and then returns the first number. Multiple `srand()` calls within the same second will return the same value. This is exactly how `rand()` behaved before Firebird 2.0.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
srand ()
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION srand
  RETURNS DOUBLE PRECISION BY VALUE
  ENTRY_POINT 'IB_UDF_srand' MODULE_NAME 'ib_udf'
```

## sright

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* Internal function [RIGHT\(\)](#)

*Description:* Returns the rightmost *numchars* characters of the input string. Only works with 1-byte character sets.

*Result type:* VARCHAR(100)

*Syntax:*

```
sright (str, numchars)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION sright  
  VARCHAR(100) BY DESCRIPTOR, SMALLINT,  
  VARCHAR(100) BY DESCRIPTOR RETURNS PARAMETER 3  
  ENTRY_POINT 'right' MODULE_NAME 'fbudf'
```

## string2blob

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Better alternative:* Internal function [CAST\(\)](#)

*Description:* Returns the input string as a BLOB.

*Result type:* BLOB

*Syntax:*

```
string2blob (str)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION string2blob  
  VARCHAR(300) BY DESCRIPTOR,  
  BLOB RETURNS PARAMETER 2  
  ENTRY_POINT 'string2blob' MODULE_NAME 'fbudf'
```

## strlen

*Library:* ib\_udf

*Added in:* IB

*Better alternatives:* Internal functions [BIT\\_LENGTH\(\)](#), [CHAR\[ACTER\]\\_LENGTH](#) and [OCTET\\_LENGTH\(\)](#)



*Description:* Returns the length of the argument string.

*Result type:* INTEGER

*Syntax:*

```
strlen (str)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION strlen
  CSTRING(32767)
  RETURNS INTEGER BY VALUE
  ENTRY_POINT 'IB_UDF_strlen' MODULE_NAME 'ib_udf'
```

## substr

*Library:* ib\_udf

*Changed in:* 1.0, 1.5.2, 2.0

*Description:* Returns a string's substring from *startpos* to *endpos*, inclusively. Positions are 1-based. If *endpos* is past the end of the string, *substr* returns all the characters from *startpos* to the end of the string. This function only works correctly with single-byte characters.

*Result type:* VARCHAR(*n*)

*Syntax (unchanged):*

```
substr (str, startpos, endpos)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION substr
  CSTRING(255) NULL, SMALLINT, SMALLINT
  RETURNS CSTRING(255) FREE_IT
  ENTRY_POINT 'IB_UDF_substr' MODULE_NAME 'ib_udf'
```

The above declaration is from the file `ib_udf2.sql`. The **NULL** after the argument is an optional addition that became available in Firebird 2. If the argument is declared with the **NULL** keyword, the engine will pass a **NULL** argument value unchanged to the function. This leads to a **NULL** result, which is correct. Without the **NULL** keyword (your only option in pre-2.0 versions), **NULL** is passed to the function as an empty string and the result is an empty string as well.

For more information about passing **NULL**s to UDFs, see the [note](#) at the end of this book.

*Notes:*

- Depending on how you declare it (see [CSTRING note](#)), this function can accept and return strings of up to 32767 characters.
- Before Firebird 2.0, the result type was CHAR(*n*).

- In Firebird 1.5.1 and below, the default declaration used CSTRING(80) instead of CSTRING(255).
- In InterBase, `substr` returned NULL if `endpos` lay past the end of the string.

**Tip**

Although the function arguments are slightly different, consider using the internal SQL function `SUBSTRING` instead, for better compatibility and multi-byte character set support.

## substrlen

*Library:* `ib_udf`

*Added in:* 1.0

*Changed in:* 1.5.2, 2.0

*Better alternative:* Internal function `SUBSTRING()`

*Description:* Returns the substring starting at `startpos` and having `length` characters (or less, if the end of the string is reached first). Positions are 1-based. If either `startpos` or `length` is smaller than 1, an empty string is returned. This function only works correctly with single-byte characters.

*Result type:* `VARCHAR(n)`

*Syntax:*

```
substrlen (str, startpos, length)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION substrlen
  CSTRING(255) NULL, SMALLINT, SMALLINT
  RETURNS CSTRING(255) FREE_IT
  ENTRY_POINT 'IB_UDF_substrlen' MODULE_NAME 'ib_udf'
```

The above declaration is from the file `ib_udf2.sql`. The **NULL** after the argument is an optional addition that became available in Firebird 2. If the argument is declared with the **NULL** keyword, the engine will pass a **NULL** argument value unchanged to the function. This leads to a **NULL** result, which is correct. Without the **NULL** keyword (your only option in pre-2.0 versions), **NULL** is passed to the function as an empty string and the result is an empty string as well.

For more information about passing **NULL**s to UDFs, see the [note](#) at the end of this book.

*Notes:*

- Depending on how you declare it (see [CSTRING note](#)), this function can accept and return strings of up to 32767 characters.
- Before Firebird 2.0, the result type was `CHAR(n)`.
- In Firebird 1.5.1 and below, the default declaration used CSTRING(80) instead of CSTRING(255).

**Tip**

Firebird 1.0 has also implemented the internal SQL function `SUBSTRING`, effectively rendering `substrlen` obsolete in the same version in which it was introduced. `SUBSTRING` also supports multi-byte character sets. In new code, use `SUBSTRING`.

## tan

*Library:* `ib_udf`

*Added in:* IB

*Better alternative:* Internal function `TAN()`

*Description:* Returns an angle's tangent. The argument must be given in radians.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
tan (angle)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION tan
DOUBLE PRECISION
RETURNS DOUBLE PRECISION BY VALUE
ENTRY_POINT 'IB_UDF_tan' MODULE_NAME 'ib_udf'
```

## tanh

*Library:* `ib_udf`

*Added in:* IB

*Better alternative:* Internal function `TANH()`

*Description:* Returns the hyperbolic tangent of the argument.

*Result type:* DOUBLE PRECISION

*Syntax:*

```
tanh (number)
```

*Declaration:*

```
DECLARE EXTERNAL FUNCTION tanh
DOUBLE PRECISION
RETURNS DOUBLE PRECISION BY VALUE
```

```
ENTRY_POINT 'IB_UDF_tanh' MODULE_NAME 'ib_udf'
```

## truncate, i64truncate

*Library:* fbudf

*Added in:* 1.0 (Win), 1.5 (Linux)

*Changed in:* 1.5, 2.1.3

*Better alternative:* Internal function [TRUNC\(\)](#)

*Description:* These functions return the whole-number portion of their (scaled numeric/decimal) argument. They do not work with floats or doubles.

*Result type:* INTEGER / NUMERIC(18)

*Syntax:*

```
truncate    (number)
i64truncate (bignumber)
```

### Caution

Both functions round to the nearest whole number that is lower than or equal to the argument. This means that negative numbers are also “truncated” downward. For instance, `truncate(-2.37)` returns `-3`. The internal function [TRUNC](#), available since Firebird 2.1, always truncates toward zero.

*Declarations:*

In Firebird 1.0.x, the entry point for both functions is `truncate`:

```
DECLARE EXTERNAL FUNCTION Truncate
  INT BY DESCRIPTOR, INT BY DESCRIPTOR
  RETURNS PARAMETER 2
  ENTRY_POINT 'truncate' MODULE_NAME 'fbudf'
```

```
DECLARE EXTERNAL FUNCTION i64Truncate
  NUMERIC(18) BY DESCRIPTOR, NUMERIC(18) BY DESCRIPTOR
  RETURNS PARAMETER 2
  ENTRY_POINT 'truncate' MODULE_NAME 'fbudf'
```

In Firebird 1.5, the entry point has been renamed to `fbtruncate`:

```
DECLARE EXTERNAL FUNCTION Truncate
  INT BY DESCRIPTOR, INT BY DESCRIPTOR
  RETURNS PARAMETER 2
  ENTRY_POINT 'fbtruncate' MODULE_NAME 'fbudf'
```

```
DECLARE EXTERNAL FUNCTION i64Truncate
  NUMERIC(18) BY DESCRIPTOR, NUMERIC(18) BY DESCRIPTOR
  RETURNS PARAMETER 2
  ENTRY_POINT 'fbtruncate' MODULE_NAME 'fbudf'
```

If you move an existing database from Firebird 1.0.x to 1.5 or higher, drop any existing `*round` and `*truncate` declarations and declare them anew, using the updated entry point names. From Firebird 2.0 onward you can also perform this update with [ALTER EXTERNAL FUNCTION](#).

---

# Appendix A: Notes

## Character set NONE data accepted “as is”

In Firebird 1.5.1 and up

Firebird 1.5.1 has improved the way character set NONE data are moved to and from fields or variables with another character set, resulting in fewer transliteration errors.

In Firebird 1.5.0, from a client connected with character set NONE, you could read data in two incompatible character sets – such as SJIS (Japanese) and WIN1251 (Russian) – even though you could not read one of those character sets while connected from a client with the other character set. Data would be received “as is” and be stored without raising an exception.

However, from this character set NONE client connection, an attempt to update any Russian or Japanese data columns using either parameterized queries or literal strings without introducer syntax would fail with transliteration errors; and subsequent queries on the stored “NONE” data would similarly fail.

In Firebird 1.5.1, both problems have been circumvented. Data received from the client in character set NONE are still stored “as is” but what is stored is an exact, binary copy of the received string. In the reverse case, when stored data are read into this client from columns with specific character sets, there will be no transliteration error. When the connection character set is NONE, no attempt is made in either case to resolve the string to well-formed characters, so neither the write nor the read will throw a transliteration error.

This opens the possibility for working with data from multiple character sets in a single database, as long as the connection character set is NONE. The client has full responsibility for submitting strings in the appropriate character set and converting strings returned by the engine, as needed.

Abstraction layers that have to manage this can read the low byte of the *sqlsubtype* field in the XSQLVAR structure, which contains the character set identifier.

While character set NONE literals are accepted and implicitly stored in the character set of their context, the use of introducer syntax to coerce the character sets of literals is highly recommended when the application is handling literals in a mixture of character sets. This should avoid the string's being misinterpreted when the application shifts the context for literal usage to a different character set.

### Note

Coercion of the character set, using the introducer syntax or casting, is still required when handling heterogeneous character sets from a client context that is anything other than NONE. Both methods are shown below, using character set ISO8859\_1 as an example target. Notice the “\_” prefix in the introducer syntax.

*Introducer syntax:*

```
_ISO8859_1 mystring
```

*Casting:*

```
CAST (mystring AS VARCHAR(n) CHARACTER SET ISO8859_1)
```

## Understanding the WITH LOCK clause

This note looks a little deeper into explicit locking and its ramifications. The WITH LOCK feature, added in Firebird 1.5, provides a limited explicit pessimistic locking capability for cautious use in conditions where the affected row set is:

- a. extremely small (ideally, a singleton), *and*
- b. precisely controlled by the application code.

Pessimistic locks are rarely needed in Firebird. This is an expert feature, intended for use by those who thoroughly understand its consequences. Knowledge of the various levels of transaction isolation is essential. WITH LOCK is available in DSQL and PSQL, and only for top-level, single-table SELECTs. As stated in the reference part of this guide, WITH LOCK is *not* available:

- in a subquery specification;
- for joined sets;
- with the DISTINCT operator, a GROUP BY clause or any other aggregating operation;
- with a view;
- with the output of a selectable stored procedure;
- with an external table.

### Syntax and behaviour

```
SELECT ... FROM single_table
  [WHERE ...]
  [FOR UPDATE [OF ...]]
  [WITH LOCK]
```

If the WITH LOCK clause succeeds, it will secure a lock on the selected rows and prevent any other transaction from obtaining write access to any of those rows, or their dependants, until your transaction ends.

If the FOR UPDATE clause is included, the lock will be applied to each row, one by one, as it is fetched into the server-side row cache. It becomes possible, then, that a lock which appeared to succeed when requested will nevertheless *fail subsequently*, when an attempt is made to fetch a row which becomes locked by another transaction.

As the engine considers, in turn, each record falling under an explicit lock statement, it returns either the record version that is the most currently committed, regardless of database state when the statement was submitted, or an exception.

Wait behaviour and conflict reporting depend on the transaction parameters specified in the TPB block:

**Table A.1. How TPB settings affect explicit locking**

TPB mode	Behaviour
isc_tpb_consistency	Explicit locks are overridden by implicit or explicit table-level locks and are ignored.
isc_tpb_concurrency	If a record is modified by any transaction that was committed since the transaction attempting to get explicit lock started, or an active transaction has

TPB mode	Behaviour
+ isc_tpb_nowait	performed a modification of this record, an update conflict exception is raised immediately.
isc_tpb_concurrency + isc_tpb_wait	<p>If the record is modified by any transaction that has committed since the transaction attempting to get explicit lock started, an update conflict exception is raised immediately.</p> <p>If an active transaction is holding ownership on this record (via explicit locking or by a normal optimistic write-lock) the transaction attempting the explicit lock waits for the outcome of the blocking transaction and, when it finishes, attempts to get the lock on the record again. This means that, if the blocking transaction committed a modified version of this record, an update conflict exception will be raised.</p>
isc_tpb_read_committed + isc_tpb_nowait	If there is an active transaction holding ownership on this record (via explicit locking or normal update), an update conflict exception is raised immediately.
isc_tpb_read_committed + isc_tpb_wait	<p>If there is an active transaction holding ownership on this record (via explicit locking or by a normal optimistic write-lock), the transaction attempting the explicit lock waits for the outcome of blocking transaction and when it finishes, attempts to get the lock on the record again.</p> <p>Update conflict exceptions can never be raised by an explicit lock statement in this TPB mode.</p>

## How the engine deals with WITH LOCK

When an UPDATE statement tries to access a record that is locked by another transaction, it either raises an update conflict exception or waits for the locking transaction to finish, depending on TPB mode. Engine behaviour here is the same as if this record had already been modified by the locking transaction.

No special gds codes are returned from conflicts involving pessimistic locks.

The engine guarantees that all records returned by an explicit lock statement are actually locked and *do* meet the search conditions specified in WHERE clause, as long as the search conditions do not depend on any other tables, via joins, subqueries, etc. It also guarantees that rows not meeting the search conditions will not be locked by the statement. It can *not* guarantee that there are no rows which, though meeting the search conditions, are not locked.

### Note

This situation can arise if other, parallel transactions commit their changes during the course of the locking statement's execution.

The engine locks rows at fetch time. This has important consequences if you lock several rows at once. Many access methods for Firebird databases default to fetching output in packets of a few hundred rows (“buffered fetches”). Most data access components cannot bring you the rows contained in the last-fetched packet, where an error occurred.



## The optional “OF <column-names>” sub-clause

The FOR UPDATE clause provides a technique to prevent usage of buffered fetches, optionally with the “OF <column-names>” subclause to enable positioned updates.

### Tip

Alternatively, it may be possible in your access components to set the size of the fetch buffer to 1. This would enable you to process the currently-locked row before the next is fetched and locked, or to handle errors without rolling back your transaction.

## Caveats using WITH LOCK

- Rolling back of an implicit or explicit savepoint releases record locks that were taken under that savepoint, but it doesn't notify waiting transactions. Applications should not depend on this behaviour as it may get changed in the future.
- While explicit locks can be used to prevent and/or handle unusual update conflict errors, the volume of deadlock errors will grow unless you design your locking strategy carefully and control it rigorously.
- Most applications do not need explicit locks at all. The main purposes of explicit locks are (1) to prevent expensive handling of update conflict errors in heavily loaded applications and (2) to maintain integrity of objects mapped to a relational database in a clustered environment. If your use of explicit locking doesn't fall in one of these two categories, then it's the wrong way to do the task in Firebird.
- Explicit locking is an advanced feature; do not misuse it! While solutions for these kinds of problems may be very important for web sites handling thousands of concurrent writers, or for ERP/CRM systems operating in large corporations, most application programs do not need to work in such conditions.

## Examples using explicit locking

i. Simple:

```
SELECT * FROM DOCUMENT WHERE ID=? WITH LOCK
```

ii. Multiple rows, one-by-one processing with DSQL cursor:

```
SELECT * FROM DOCUMENT WHERE PARENT_ID=?  
FOR UPDATE WITH LOCK
```

## A note on CSTRING parameters

External functions involving strings often use the type CSTRING(*n*) in their declarations. This type represents a zero-terminated string of maximum length *n*. Most of the functions handling CSTRINGs are programmed in such a way that they can accept and return zero-terminated strings of any length. So why the *n*? Because the Firebird engine has to set up space to process the input and output parameters, and convert them to and from SQL data types. Most strings used in databases are only dozens to hundreds of bytes long; it would be a waste

to reserve 32 KB of memory each time such a string is processed. Therefore, the *standard* declarations of most CSTRING functions – as found in the file `ib_udf.sql` – specify a length of 255 bytes. (In Firebird 1.5.1 and below, this default length is 80 bytes.) As an example, here's the SQL declaration of `lpad`:

```
DECLARE EXTERNAL FUNCTION lpad
  CSTRING(255), INTEGER, CSTRING(1)
  RETURNS CSTRING(255) FREE_IT
  ENTRY_POINT 'IB_UDF_lpad' MODULE_NAME 'ib_udf'
```

Once you've declared a CSTRING parameter with a certain length, you cannot call the function with a longer input string, or cause it to return a string longer than the declared output length. But the standard declarations are just reasonable defaults; they're not cast in concrete, and you can change them if you want to. If you have to left-pad strings of up to 500 bytes long, then it's perfectly OK to change both 255's in the declaration to 500 or more.

A special case is when you usually operate on short strings (say less than 100 bytes) but occasionally have to call the function with a huge (VAR)CHAR argument. Declaring CSTRING(32000) makes sure that all the calls will be successful, but it will also cause 32000 bytes per parameter to be reserved, even in that majority of cases where the strings are under 100 bytes. In that situation you may consider declaring the function twice, with different names and different string lengths:

```
DECLARE EXTERNAL FUNCTION lpad
  CSTRING(100), INTEGER, CSTRING(1)
  RETURNS CSTRING(100) FREE_IT
  ENTRY_POINT 'IB_UDF_lpad' MODULE_NAME 'ib_udf';

DECLARE EXTERNAL FUNCTION lpadbig
  CSTRING(32000), INTEGER, CSTRING(1)
  RETURNS CSTRING(32000) FREE_IT
  ENTRY_POINT 'IB_UDF_lpad' MODULE_NAME 'ib_udf';
```

Now you can call `lpad()` for all the small strings and `lpadbig()` for the occasional monster. Notice how the declared names in the first line differ (they determine how you call the functions from within your SQL), but the entry point (the function name in the library) is the same in both cases.

## Passing NULL to UDFs in Firebird 2

If a pre-2.0 Firebird engine must pass an SQL NULL argument to a user-defined function, it always converts it to a zero-equivalent, e.g. a numerical 0 or an empty string. The only exception to this rule are UDFs that make use of the “BY DESCRIPTOR” mechanism introduced in Firebird 1. The `fbudf` library uses descriptors, but the vast majority of UDFs, including those in Firebird's standard `ib_udf` library, still use the old style of parameter passing, inherited from InterBase.

As a consequence, most UDFs can't tell the difference between NULL and zero input.

Firebird 2 comes with a somewhat improved calling mechanism for these old-style UDFs. The engine will now pass NULL input as a null pointer to the function, **if** the function has been declared to the database with a NULL keyword after the argument(s) in question, e.g. like this:

```
declare external function ltrim
  cstring(255) null
  returns cstring(255) free_it
  entry_point 'IB_UDF_ltrim' module_name 'ib_udf';
```

This requirement ensures that existing databases and their applications can continue to function like before. Leave out the NULL keyword and the function will behave like it did under Firebird 1.5 and earlier.

Please note that you can't just add NULL keywords to your declarations and then expect every function to handle NULL input correctly. Each function has to be (re)written in such a way that NULLs are dealt with correctly. Always look at the declarations provided by the function implementor. For the functions in the `ib_udf` library, consult `ib_udf2.sql` in the Firebird UDF directory. Notice the 2 in the file name; the old-style declarations are in `ib_udf.sql`.

These are the `ib_udf` functions that have been updated to recognise NULL input and handle it properly:

- `ascii_char`
- `lower`
- `lpad` and `rpadd`
- `ltrim` and `rtrim`
- `substr` and `substrlen`

Most `ib_udf` functions remain as they were; in any case, passing NULL to an old-style UDF is never possible if the argument isn't of a referenced type.

On a side note: don't use `lower`, `.trim` and `substr*` in new code; use the internal functions `LOWER`, `TRIM` and `SUBSTRING` instead.

## “Upgrading” `ib_udf` functions in an existing database

If you are using an existing database with one or more of the functions listed above under Firebird 2, and you want to benefit from the improved NULL handling, run the script `ib_udf_upgrade.sql` against your database. It is located in the Firebird `misc\upgrade\ib_udf` directory.

## Maximum number of indices in different Firebird versions

Between Firebird 1.0 and 2.0 there have been quite a few changes to the maximum number of indices per database table. The table below sums them all up.

**Table A.2. Max. indices per table in Firebird 1.0 – 2.0**

Page size	Firebird version(s)											
	1.0, 1.0.2			1.0.3			1.5.x			2.0.x		
	1 col	2 cols	3 cols	1 col	2 cols	3 cols	1 col	2 cols	3 cols	1 col	2 cols	3 cols
1024	62	50	41	62	50	41	62	50	41	50	35	27
2048	65	65	65	126	101	84	126	101	84	101	72	56
4096	65	65	65	254	203	169	254	203	169	203	145	113
8192	65	65	65	510	408	340	257	257	257	408	291	227
16384	65	65	65	1022	818	681	257	257	257	818	584	454

## The RDB\$VALID\_BLR field

The field RDB\$VALID\_BLR was added to the system tables RDB\$PROCEDURES and RDB\$TRIGGERS in Firebird 2.1. Its purpose is to signal possible invalidation of a PSQL module when a domain or a table column upon which the module depends is altered. If such invalidations occur, RDB\$VALID\_BLR is set to 0 for any procedure or trigger whose code is no longer valid.

The following query will find the modules that depend on a specific *domain* and report the state of their RDB\$VALID\_BLR fields:

```
select * from (
  select 'Procedure', rdb$procedure_name, rdb$valid_blr from rdb$procedures
  union
  select 'Trigger', rdb$trigger_name, rdb$valid_blr from rdb$triggers
) (type, name, valid)
where exists
  (select * from rdb$dependencies
   where rdb$dependent_name = name and rdb$depended_on_name = 'MYDOMAIN')

/* Replace MYDOMAIN with the actual domain name. Use all-caps if the domain
   was created case-insensitively. Otherwise, use the exact capitalisation. */
```

The following query will find the modules that depend on a specific *table column* and report the state of their RDB\$VALID\_BLR fields:

```
select * from (
  select 'Procedure', rdb$procedure_name, rdb$valid_blr from rdb$procedures
  union
  select 'Trigger', rdb$trigger_name, rdb$valid_blr from rdb$triggers
) (type, name, valid)
where exists
  (select * from rdb$dependencies
   where rdb$dependent_name = name
   and rdb$depended_on_name = 'MYTABLE' and rdb$field_name = 'MYCOLUMN')

/* Replace MYTABLE and MYCOLUMN with the actual table and column names.
   Use all-caps if the table/column was created case-insensitively.
   Otherwise, use the exact capitalisation. */
```

Unfortunately, not all PSQL invalidations will be reflected in the RDB\$VALID\_BLR field. After changing a domain or table column, it is therefore advisable to have a good look at all the procedures and triggers reported by the above queries, even those having a 1 in the “VALID” column.

Please notice that for PSQL modules inherited from earlier Firebird versions (including a number of system triggers, even if the database was created under Firebird 2.1 or higher), RDB\$VALID\_BLR is NULL. This does *not* imply that their BLR is invalid.

The isql commands SHOW PROCEDURES and SHOW TRIGGERS flag modules whose RDB\$VALID\_BLR field is zero with an asterisk. SHOW PROCEDURE *PROCNAME* and SHOW TRIGGER *TRIGNAME*, which display individual PSQL modules, do not signal invalid BLR.

---

# Appendix B: Reserved words and keywords – full lists

## Reserved words

Full list of reserved words in Firebird 2.5:

ADD  
ADMIN  
ALL  
ALTER  
AND  
ANY  
AS  
AT  
AVG  
BEGIN  
BETWEEN  
BIGINT  
BIT\_LENGTH  
BLOB  
BOTH  
BY  
CASE  
CAST  
CHAR  
CHAR\_LENGTH  
CHARACTER  
CHARACTER\_LENGTH  
CHECK  
CLOSE  
COLLATE  
COLUMN  
COMMIT  
CONNECT  
CONSTRAINT  
COUNT  
CREATE  
CROSS  
CURRENT  
CURRENT\_CONNECTION  
CURRENT\_DATE  
CURRENT\_ROLE

CURRENT\_TIME  
CURRENT\_TIMESTAMP  
CURRENT\_TRANSACTION  
CURRENT\_USER  
CURSOR  
DATE  
DAY  
DEC  
DECIMAL  
DECLARE  
DEFAULT  
DELETE  
DISCONNECT  
DISTINCT  
DOUBLE  
DROP  
ELSE  
END  
ESCAPE  
EXECUTE  
EXISTS  
EXTERNAL  
EXTRACT  
FETCH  
FILTER  
FLOAT  
FOR  
FOREIGN  
FROM  
FULL  
FUNCTION  
GDSCODE  
GLOBAL  
GRANT  
GROUP  
HAVING  
HOUR  
IN  
INDEX  
INNER  
INSENSITIVE  
INSERT  
INT  
INTEGER  
INTO  
IS  
JOIN  
LEADING  
LEFT  
LIKE  
LONG  
LOWER

MAX  
MAXIMUM\_SEGMENT  
MERGE  
MIN  
MINUTE  
MONTH  
NATIONAL  
NATURAL  
NCHAR  
NO  
NOT  
NULL  
NUMERIC  
OCTET\_LENGTH  
OF  
ON  
ONLY  
OPEN  
OR  
ORDER  
OUTER  
PARAMETER  
PLAN  
POSITION  
POST\_EVENT  
PRECISION  
PRIMARY  
PROCEDURE  
RDB\$DB\_KEY  
REAL  
RECORD\_VERSION  
RECREATE  
RECURSIVE  
REFERENCES  
RELEASE  
RETURNING\_VALUES  
RETURNS  
REVOKE  
RIGHT  
ROLLBACK  
ROW\_COUNT  
ROWS  
SAVEPOINT  
SECOND  
SELECT  
SENSITIVE  
SET  
SIMILAR  
SMALLINT  
SOME  
SQLCODE  
SQLSTATE (2.5.1)

START  
SUM  
TABLE  
THEN  
TIME  
TIMESTAMP  
TO  
TRAILING  
TRIGGER  
TRIM  
UNION  
UNIQUE  
UPDATE  
UPPER  
USER  
USING  
VALUE  
VALUES  
VARCHAR  
VARIABLE  
VARYING  
VIEW  
WHEN  
WHERE  
WHILE  
WITH  
YEAR

## Keywords

The following terms have a special meaning in Firebird 2.5 DSQL. Some of them are also reserved words, others aren't.

!<  
^<  
^=  
^>  
,  
:=  
!=  
!>  
(  
)  
<  
<=  
<>  
=  
>  
>=  
||  
~<



~=

~>

ABS

ACCENT

ACOS

ACTION

ACTIVE

ADD

ADMIN

AFTER

ALL

ALTER

ALWAYS

AND

ANY

AS

ASC

ASCENDING

ASCII\_CHAR

ASCII\_VAL

ASIN

AT

ATAN

ATAN2

AUTO

AUTONOMOUS

AVG

BACKUP

BEFORE

BEGIN

BETWEEN

BIGINT

BIN\_AND

BIN\_NOT

BIN\_OR

BIN\_SHL

BIN\_SHR

BIN\_XOR

BIT\_LENGTH

BLOB

BLOCK

BOTH

BREAK

BY

CALLER

CASCADE

CASE

CAST

CEIL

CEILING

CHAR

CHAR\_LENGTH

CHAR\_TO\_UUID  
CHARACTER  
CHARACTER\_LENGTH  
CHECK  
CLOSE  
COALESCE  
COLLATE  
COLLATION  
COLUMN  
COMMENT  
COMMIT  
COMMITTED  
COMMON  
COMPUTED  
CONDITIONAL  
CONNECT  
CONSTRAINT  
CONTAINING  
COS  
COSH  
COT  
COUNT  
CREATE  
CROSS  
CSTRING  
CURRENT  
CURRENT\_CONNECTION  
CURRENT\_DATE  
CURRENT\_ROLE  
CURRENT\_TIME  
CURRENT\_TIMESTAMP  
CURRENT\_TRANSACTION  
CURRENT\_USER  
CURSOR  
DATA  
DATABASE  
DATE  
DATEADD  
DATEDIFF  
DAY  
DEC  
DECIMAL  
DECLARE  
DECODE  
DEFAULT  
DELETE  
DELETING  
DESC  
DESCENDING  
DESCRIPTOR  
DIFFERENCE  
DISCONNECT

DISTINCT  
DO  
DOMAIN  
DOUBLE  
DROP  
ELSE  
END  
ENTRY\_POINT  
ESCAPE  
EXCEPTION  
EXECUTE  
EXISTS  
EXIT  
EXP  
EXTERNAL  
EXTRACT  
FETCH  
FILE  
FILTER  
FIRST  
FIRSTNAME  
FLOAT  
FLOOR  
FOR  
FOREIGN  
FREE\_IT  
FROM  
FULL  
FUNCTION  
GDSCODE  
GEN\_ID  
GEN\_UUID  
GENERATED  
GENERATOR  
GLOBAL  
GRANT  
GRANTED  
GROUP  
HASH  
HAVING  
HOUR  
IF  
IGNORE  
IIF  
IN  
INACTIVE  
INDEX  
INNER  
INPUT\_TYPE  
INSENSITIVE  
INSERT  
INSERTING

INT  
INTEGER  
INTO  
IS  
ISOLATION  
JOIN  
KEY  
LAST  
LASTNAME  
LEADING  
LEAVE  
LEFT  
LENGTH  
LEVEL  
LIKE  
LIMBO  
LIST  
LN  
LOCK  
LOG  
LOG10  
LONG  
LOWER  
LPAD  
MANUAL  
MAPPING  
MATCHED  
MATCHING  
MAX  
MAXIMUM\_SEGMENT  
MAXVALUE  
MERGE  
MIDDLENAME  
MILLISECOND  
MIN  
MINUTE  
MINVALUE  
MOD  
MODULE\_NAME  
MONTH  
NAMES  
NATIONAL  
NATURAL  
NCHAR  
NEXT  
NO  
NOT  
NULL  
NULLIF  
NULLS  
NUMERIC  
OCTET\_LENGTH

OF  
ON  
ONLY  
OPEN  
OPTION  
OR  
ORDER  
OS\_NAME  
OUTER  
OUTPUT\_TYPE  
OVERFLOW  
OVERLAY  
PAD  
PAGE  
PAGE\_SIZE  
PAGES  
PARAMETER  
PASSWORD  
PI  
PLACING  
PLAN  
POSITION  
POST\_EVENT  
POWER  
PRECISION  
PRESERVE  
PRIMARY  
PRIVILEGES  
PROCEDURE  
PROTECTED  
RAND  
RDB\$DB\_KEY  
READ  
REAL  
RECORD\_VERSION  
RECREATE  
RECURSIVE  
REFERENCES  
RELEASE  
REPLACE  
REQUESTS  
RESERV  
RESERVING  
RESTART  
RESTRICT  
RETAIN  
RETURNING  
RETURNING\_VALUES  
RETURNS  
REVERSE  
REVOKE  
RIGHT

ROLE  
ROLLBACK  
ROUND  
ROW\_COUNT  
ROWS  
RPAD  
SAVEPOINT  
SCALAR\_ARRAY  
SCHEMA  
SECOND  
SEGMENT  
SELECT  
SENSITIVE  
SEQUENCE  
SET  
SHADOW  
SHARED  
SIGN  
SIMILAR  
SIN  
SINGULAR  
SINH  
SIZE  
SKIP  
SMALLINT  
SNAPSHOT  
SOME  
SORT  
SOURCE  
SPACE  
SQLCODE  
SQLSTATE (2.5.1)  
SQRT  
STABILITY  
START  
STARTING  
STARTS  
STATEMENT  
STATISTICS  
SUB\_TYPE  
SUBSTRING  
SUM  
SUSPEND  
TABLE  
TAN  
TANH  
TEMPORARY  
THEN  
TIME  
TIMEOUT  
TIMESTAMP  
TO

TRAILING  
TRANSACTION  
TRIGGER  
TRIM  
TRUNC  
TWO\_PHASE  
TYPE  
UNCOMMITTED  
UNDO  
UNION  
UNIQUE  
UPDATE  
UPDATING  
UPPER  
USER  
USING  
UUID\_TO\_CHAR  
VALUE  
VALUES  
VARCHAR  
VARIABLE  
VARYING  
VIEW  
WAIT  
WEEK  
WEEKDAY  
WHEN  
WHERE  
WHILE  
WITH  
WORK  
WRITE  
YEAR  
YEARDAY

---

# Appendix C: Document History

The exact file history is recorded in the `manual` module in our CVS tree; see <http://firebird.cvs.sourceforge.net/viewvc/firebird/manual/>

## Revision History

0.0	—	PV	Creation of the document as a copy of the <i>Firebird 2.1 Language Reference Update</i> with IDs, titles, version numbers etc. updated to 2.5.
1.0	12 Jun 2011	PV	<p><i>Introduction :: Subject matter:</i> Added “Security and access control statements” to first list. Changed ulink to Firebird Documentation Index (both text and url).</p> <p><i>Introduction :: Authorship:</i> Changed percentage of included material to 2–3%.</p> <p><i>Introduction:</i> New section <i>Acknowledgments</i>. New chapter: <i>New in Firebird 2.5</i>.</p> <p><i>Reserved words and keywords:</i> Updated/corrected all the lists in all the subsections (except <i>Possibly reserved in future versions</i>). Also changed/added much of the text above and below the lists.</p> <p><i>Reserved words and keywords :: Dropped since InterBase 6:</i> Changed subsection titles to <i>No longer reserved, still keywords</i> and <i>No longer reserved, not keywords</i>, for better clarity.</p> <p><i>Miscellaneous language elements:</i> New section <i>Hexadecimal notation for numerals</i>.</p> <p><i>Miscellaneous language elements:</i> New section <i>Hexadecimal notation for “binary” strings</i>.</p> <p><i>Data types and subtypes :: BIGINT data type:</i> Added information on hex notation; added second example.</p> <p><i>Data types and subtypes :: BLOB data type :: Text BLOB support in functions and operators:</i> Altered “Changed in”; edited 2nd listitem under “Level of support” (CORE-3233 fixed).</p> <p><i>Data types and subtypes :: New character sets:</i> Added 2.5 to “Changed in”; added new charset GB18030 and new alias WIN_1258.</p> <p><i>Data types and subtypes :: New collations:</i> Added 2.5 to “Changed in”; added new collations GB18030_UNICODE (for GB18030) and UNICODE_CI_AI (for UTF8). Added line on UNICODE_CI_AI to Note.</p> <p><i>Data types and subtypes:</i> New section <i>SQL_NULL data type</i>.</p> <p><i>DDL statements:</i> Removed last line from introductory text.</p> <p><i>DDL statements:</i> New section <i>CHARACTER SET</i>, with subsection <i>ALTER CHARACTER SET</i>.</p> <p><i>DDL statements :: COLLATION :: CREATE COLLATION:</i> Added “Changed in”; altered explanation of “UNI” in specific attributes table; gave table body <code>valign=top</code>; added NUMERIC-SORT to specific attributes table and added note beneath table.</p> <p><i>DDL statements :: DATABASE :: CREATE DATABASE:</i> New subsection <i>Default collation for the database</i>.</p>



*DDL statements :: DATABASE :: ALTER DATABASE :: END BACKUP:* Updated URL of Firebird Documentation Index in Tip.

*DDL statements :: DOMAIN :: ALTER DOMAIN:* Replaced contents of Warning with reference to RDB\$VALID\_BLR note.

*DDL statements :: Privileges: GRANT and REVOKE:* Moved to chapter *Security and access control*.

*DDL statements :: PROCEDURE:* Changed introductory text (mentioned executable blocks).

*DDL statements :: PROCEDURE :: CREATE PROCEDURE:* Altered Syntax (added TYPE OF COLUMN).

*DDL statements :: PROCEDURE :: CREATE PROCEDURE:* New subsection *TYPE OF COLUMN in parameter and variable declarations*.

*DDL statements :: PROCEDURE :: CREATE PROCEDURE :: Domains supported in parameter and variable declarations:* Edited and extended Description. Replaced contents of Warning with reference to RDB\$VALID\_BLR note.

*DDL statements :: PROCEDURE :: CREATE PROCEDURE :: NOT NULL in variable and parameter declarations:* Changed layout of Example (first line too long for PDF).

*DDL statements :: PROCEDURE :: ALTER PROCEDURE:* New subsection *Classic Server: Altered procedure immediately visible to other clients*.

*DDL statements :: PROCEDURE :: ALTER PROCEDURE:* New subsection *TYPE OF COLUMN in parameter and variable declarations*.

*DDL statements :: TABLE :: ALTER TABLE:* New subsection *ALTER COLUMN also for generated (computed) columns*.

*DDL statements :: TABLE :: ALTER TABLE:* New subsection *ALTER COLUMN ... TYPE no longer fails if column is used in trigger or SP*.

*DDL statements :: TRIGGER :: CREATE TRIGGER:* New subsection *TYPE OF COLUMN in variable declarations*.

*DDL statements :: TRIGGER :: ALTER TRIGGER:* New subsection *TYPE OF COLUMN in variable declarations*.

*DDL statements :: VIEW :: CREATE VIEW:* Added Syntax.

*DDL statements :: VIEW :: CREATE VIEW:* New subsection *Views can select from stored procedures*.

*DDL statements :: VIEW :: CREATE VIEW:* New subsection *Views can infer column names from derived tables or GROUP BY*.

*DDL statements :: VIEW :: CREATE VIEW :: Per-column aliases supported in view definition:* Shortened partial Syntax.

*DDL statements :: VIEW :: CREATE VIEW :: Full SELECT syntax supported:* Altered “Changed in”. Altered Note on union views.

*DDL statements :: VIEW:* New sections *ALTER VIEW* and *CREATE OR ALTER VIEW*.

*DML statements :: DELETE:* Improved formal syntax (*values -> <values>* and added specification of latter).

*DML statements :: EXECUTE BLOCK:* Added 2.5 to “Changed in”. Altered Syntax (added TYPE OF COLUMN).

*DML statements :: EXECUTE BLOCK :: Domains instead of data types:* Extended Description. Added Warning about collations.

*DML statements :: EXECUTE BLOCK:* New subsection *TYPE OF COLUMN in parameter and variable declarations*.

*DML statements :: INSERT*: Improved formal syntax (*value* -> *value\_expression*) and removed erroneous space.

*DML statements :: UPDATE*: Improved formal syntax (*values* -> *<values>*) and added specification of latter).

*DML statements :: UPDATE*: New section *Changed SET semantics*.

*PSQL statements*: Changed introductory paragraph to mention executable blocks.

*PSQL statements :: DECLARE*: Altered Syntax (added TYPE OF COLUMN). Made itemizedlist after Syntax compact.

*PSQL statements :: DECLARE :: DECLARE with DOMAIN instead of datatype*: Extended Description. Replaced contents of Warning with reference to RDB\$VALID\_BLR note.

*PSQL statements :: DECLARE*: New subsection *TYPE OF COLUMN in variable declaration*.

*PSQL statements :: EXECUTE STATEMENT*: Added “Changed in”. Altered Description. Added Syntax. Added para introducing following subsections.

*PSQL statements :: EXECUTE STATEMENT :: Any number of data rows returned*: Improved Syntax block. Removed spaces inside parentheses in Example.

*PSQL statements :: EXECUTE STATEMENT*: New section *Improved performance*.

*PSQL statements :: EXECUTE STATEMENT*: New section *WITH {AUTONOMOUS|COMMON} TRANSACTION*.

*PSQL statements :: EXECUTE STATEMENT*: New section *WITH CALLER PRIVILEGES*.

*PSQL statements :: EXECUTE STATEMENT*: New section *ON EXTERNAL [DATA SOURCE]*.

*PSQL statements :: EXECUTE STATEMENT*: New section *AS USER, PASSWORD and ROLE*.

*PSQL statements :: EXECUTE STATEMENT*: New section *Parameterized statements*.

*PSQL statements :: EXECUTE STATEMENT :: Caveats with EXECUTE STATEMENT*: Edited item 3 (performance). Removed items 4 and 6. Edited final paragraph (less negative).

*PSQL statements*: New section *IN AUTONOMOUS TRANSACTION*.

*PSQL statements*: New section *Subqueries as PSQL expressions*.

New chapter: *Security and access control*.

*Security and access control*: New section *ALTER ROLE*.

*Security and access control :: GRANT and REVOKE*: Moved here from DDL chapter. Changed id.

*Security and access control :: GRANT and REVOKE*: New section *GRANTED BY*.

*Security and access control :: GRANT and REVOKE*: New section *REVOKE ALL ON ALL*.

*Security and access control :: GRANT and REVOKE :: REVOKE ADMIN OPTION*: Changed id.

*Security and access control*: New section *The RDB\$ADMIN role*.

*Security and access control*: New section *AUTO ADMIN MAPPING*.

*Security and access control*: New section *SQL user management commands*.

*Operators and predicates*: New section *SIMILAR TO*.

*Aggregate functions* :: *LIST()*: Added “Changed in” formalpara. Edited second Syntax note (about separator). Removed Warning about truncation bug in 2.1–2.1.3.

*Internal functions* :: *ASCII\_VAL()*: Edited listitem about bug (mentioned 2.5.x versions).

*Internal functions* :: *ATAN2()*: Edited 3rd Syntax note (mentioned error raised in Fb 3).

*Internal functions* :: *CAST()*: Added 2.5 to “Changed in”. Altered Syntax (added TYPE OF COLUMN). Added formalpara *Casting to a column's type*.

*Internal functions*: New section *CHAR\_TO\_UUID()*.

*Internal functions* :: *DATEADD()*: WEEK unit added and sub-DAY units allowed with DATES: Added “Changed in”. Edited Description, Syntax, 2nd listitem after Syntax, and added additional example.

*Internal functions* :: *DATEDIFF()*: WEEK unit added and sub-DAY units allowed with DATES: Added “Changed in”. Edited Description, Syntax, and 2nd listitem after Syntax.

*Internal functions* :: *EXTRACT()*: Corrected millisecond range in table (0.0000 -> 0.0).

*Internal functions* :: *EXTRACT()* :: *MILLISECOND*: Removed Bug alert for 2.1–2.1.1.

*Internal functions* :: *GEN\_UUID()*: Added Example. Added links to new UUID functions.

*Internal functions* :: *LOG()*: Added “Changed in”. Edited all the listitems under Syntax.

*Internal functions* :: *LOG10()*: Added “Changed in”. Edited listitem under Syntax.

*Internal functions* :: *LOWER()*: Replaced Important after Syntax with Note, with different text.

*Internal functions* :: *LPAD()*: Added “Changed in”. Altered result type. Altered 2nd listitem after Syntax. Changed Tip to Note and edited text.

*Internal functions* :: *OVERLAY()*: Changed 1st word of Description (“Replaces” -> “Overwrites”). Shortened 1st listitem after Syntax: removed description of 2.1-specific bug.

*Internal functions* :: *RDB\$GET\_CONTEXT()*: Added *ENGINE\_VERSION* context var (added in 2.1).

*Internal functions* :: *RIGHT()*: Edited 1st listitem after Syntax, about CORE-3228.

*Internal functions* :: *RPAD()*: Added “Changed in”. Altered result type. Altered 2nd listitem after Syntax. Changed Tip to Note and edited text.

*Internal functions* :: *SUBSTRING()*: Added 2.1.5 and 2.5.1 to “Changed in”. Noted fixing of first bug in 2.1.5 and 2.5.1.

*Internal functions*: New section *UUID\_TO\_CHAR()*.

*External functions* :: *addWeek*: Added “Better alternative”. Removed “The DATEADD alternative” formalpara.

*External functions* :: *lower*: Dropped last sentence from Description. Altered first paragraph after Declaration block and removed comment.

*External functions* :: *round*, *i64round*: Removed bug alert (fixed before 2.5).

*External functions* :: *truncate*, *i64truncate*: Removed bug alert (fixed before 2.5).

*Notes:* New section *The RDB\$VALID\_BLR field*. This note contains the (heavily edited and extended!) text previously contained in the Warnings in *ALTER DOMAIN, CREATE PROCEDURE :: Domains supported in parameter and variable declarations* and *DECLARE :: DECLARE with DOMAIN instead of datatype*.

New appendix: *Reserved words and keywords – full lists*.

*Document history:* Link to CVS changed, points directly to manual module now.

*License Notice:* Copyright end year 2011.

First publication, based on the *Firebird 2.1 Language Reference Update* with the above changes for 2.5 added (adding 25–30% to the size).

1.1      8 Oct 2011      PV      *articleinfo* and *Introduction :: Versions covered:* Added 2.5.1 to covered versions.  
*New in Firebird 2.5:* Edited first para (mentioned 2.5.1).  
*New in Firebird 2.5:* Started all 10 subsections with “Changed since Firebird 2.1”, for clarity.  
*New in Firebird 2.5 :: Reserved words and keywords:* Added SQLSTATE to “Newly reserved words”. Changed “New keywords” to “New non-reserved keywords”.  
*New in Firebird 2.5 :: Context variables:* New subsection.  
*Reserved words and keywords :: Added since InterBase 6 :: Newly reserved words:* Added SQLSTATE.  
*Reserved words and keywords :: Added since InterBase 6 :: New keywords:* Renamed this section to *New non-reserved keywords*.  
*Miscellaneous language elements :: Shorthand casts:* Renamed *Shorthand datetime casts*.  
*Miscellaneous language elements :: Shorthand datetime casts:* Added Note warning that value stays the same as long as the statement remains prepared.  
*DDL statements :: PROCEDURE :: CREATE PROCEDURE:* Shortened *relname.colname* to *rel.col* in Syntax, to keep line length within bounds for PDF.  
*DDL statements :: PROCEDURE :: CREATE PROCEDURE :: TYPE OF COLUMN in parameter and variable declarations:* Moved title “Warnings” from itemizedlist to parent warning, where it belongs.  
*DML statements :: SELECT :: ORDER BY :: Order by column alias:* Corrected section title: *Order by column alias*.  
*PSQL statements :: EXECUTE STATEMENT :: ON EXTERNAL [DATA SOURCE] :: Exception handling:* *isc\_eds\_connection, isc\_eds\_statement -> eds\_connection, eds\_statement*.  
*Context variables :: CURRENT\_TIME:* Edited second Note to warn against shorthand syntax.  
*Context variables :: CURRENT\_TIMESTAMP:* Edited second Note to warn against shorthand syntax.  
*Context variables :: GDSCODE:* Rewrote Description in light of new, so far undocumented behaviour since Firebird 2.0 (!). Corrected Example: after WHEN GDSCODE a symbolic name must follow, not a number. Added notice after Example to explain same.  
*Context variables :: 'NOW':* Edited the two existing Notes and inserted one about the freeze effect of the shorthand syntax. In the last

Note, removed the link elements from around `CURRENT_TIME` and `CURRENT_TIMESTAMP`.

*Context variables :: SQLCODE*: Added “Changed in” and “Deprecated in” formalparas. Rewrote Description in light of new, so far undocumented behaviour since Firebird 2.0 (!). Added Notice at the end (also about the deprecation).

*Context variables :: SQLSTATE*: New section (variable implemented in 2.5.1).

*Internal functions :: CAST()*: Added notice that when using the shorthand syntax, the value stays the same as long as the statement remains prepared.

*Reserved words and keywords – full lists*: Added `SQLSTATE` to both Reserved words and Keywords.

1.2      18 Oct 2011    PV

*DML statements :: SELECT*: New subsection *[AS] before relation alias*.

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# Appendix D: License notice

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The Original Documentation is titled *Firebird 2.5 Language Reference Update*.

The Initial Writers of the Original Documentation are: Paul Vinkenoog et al.

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