

**VA FILEMAN**

**SQL INTERFACE (SQLI)**

**VENDOR GUIDE**

**(DRAFT)**

Patch DI\*21.0\*38

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Department of Veterans Affairs

VistA Health Systems Design & Development (HSD&D)

Infrastructure & Security Services (ISS)

## Revision History

**Documentation Revisions**

The following table displays the revision history for this document. Revisions to the documentation are based on patches and new versions released to the field.

|  |  |  |  |
| --- | --- | --- | --- |
| **Date** | **Revision** | **Description** | **Author** |
| 01/18/98 | 1.0 | Initial SQL Interface (SQLI), Patch DI\*21.0\*38 software documentation creation. | REDACTED |
| 05/11/98 | 1.1 | Added explanation of P\_START\_AT and P\_END\_IF for index tables.Changed documentation of pointer domains from Numeric to Integer.Corrected table to note that all Computed fields except Numeric are projected as CHARACTER data type. | REDACTED |
| 01/19/05 | 2.0 | Reformatted document to follow current ISS standards. No other major content changes made.Reviewed document and edited for the "Data Scrubbing" and the "PDF 508 Compliance" projects.**Data Scrubbing—**Changed all patient/user TEST data to conform to HSD&D standards and conventions as indicated below:* The first three digits (prefix) of any Social Security Numbers (SSN) start with "000" or "666."
* Patient or user names are formatted as follows: KMPDPATIENT,[N] or KMPDUSER,[N] respectively, where the N is a number written out and incremented with each new entry (e.g., KMPDPATIENT, ONE, KMPDPATIENT, TWO, etc.).
* Other personal demographic-related data (e.g., addresses, phones, IP addresses, etc.) were also changed to be generic.

**PDF 508 Compliance—**The final PDF document was recreated and now supports the minimum requirements to be 508 compliant (i.e., accessibility tags, language selection, alternate text for all images/icons, fully functional Web links, successfully passed Adobe Acrobat Quick Check). | REDACTED |

Table i: Documentation revision history

**Patch Revisions**

For a complete list of patches related to this software, please refer to the Patch Module on FORUM.

Contents

[Revision History iii](#_Toc94346498)

[Figures and Tables ix](#_Toc94346499)

[Orientation xiii](#_Toc94346500)

[1. Introduction 1-1](#_Toc94346501)

[What is VA FileMan? 1-1](#_Toc94346502)

[What is SQLI? 1-1](#_Toc94346503)

[What is the Purpose of this Manual? 1-1](#_Toc94346504)

[2. Building an SQLI Mapper 2-1](#_Toc94346505)

[Information Provided by SQLI 2-2](#_Toc94346506)

[Organization of SQLI Information 2-2](#_Toc94346507)

[SQLI Entity-Relationship Diagram 2-3](#_Toc94346508)

[Guidelines for SQLI Mappers 2-4](#_Toc94346509)

[VA Programming Standards and Conventions 2-4](#_Toc94346510)

[Populating the SQLI\_KEY\_WORD File 2-4](#_Toc94346511)

[Data Dictionary Synchronization 2-4](#_Toc94346512)

[Kernel Compatibility 2-5](#_Toc94346513)

[3. Parsing the SQLI Projection 3-1](#_Toc94346514)

[About the Examples in this Chapter 3-1](#_Toc94346515)

[Using the {B}, {E}, {I}, {K}, and {V} Placeholders 3-1](#_Toc94346516)

[Field Value Placeholders: {I}, {B} and {E} 3-2](#_Toc94346517)

[Key Placeholders: {K1}, {K2}, etc. 3-2](#_Toc94346518)

[Return Value Placeholder: {V} 3-2](#_Toc94346519)

[Example File 3-3](#_Toc94346520)

[Starting Point: SQLI\_SCHEMA File 3-3](#_Toc94346521)

[Find the Projected Table for a File 3-4](#_Toc94346522)

[Processing Tables 3-4](#_Toc94346523)

[About Table Elements 3-5](#_Toc94346524)

[Processing Columns 3-6](#_Toc94346525)

[Find a Table Element's Column Entry 3-6](#_Toc94346526)

[IEN Columns 3-7](#_Toc94346527)

[Find the Primary Key for a Given Table 3-7](#_Toc94346528)

[Primary Key for a Projected Subfile 3-8](#_Toc94346529)

[$ORDERING to Loop Through a File's Data Entries 3-9](#_Toc94346530)

[Assembling Record Locations 3-10](#_Toc94346531)

[Retrieving Column Values 3-11](#_Toc94346532)

[Column Value Conversions 3-12](#_Toc94346533)

[Domain Conversions (Base to Internal) 3-12](#_Toc94346534)

[Output Format Conversions (Base to External) 3-12](#_Toc94346535)

[Foreign Keys 3-13](#_Toc94346536)

[4. VA FileMan and SQL 4-1](#_Toc94346537)

[VA FileMan, SQL, and the Relational Model 4-1](#_Toc94346538)

[VA FileMan File Definition Structures 4-1](#_Toc94346539)

[VA FileMan Field Types 4-2](#_Toc94346540)

[VA FileMan Subfiles (Multiples) 4-2](#_Toc94346541)

[Mapping VA FileMan Fields to SQL Data Types 4-3](#_Toc94346542)

[IEN Columns 4-3](#_Toc94346543)

[Computed Fields 4-3](#_Toc94346544)

[Date Fields 4-3](#_Toc94346545)

[Free Text, Numeric, and MUMPS Fields 4-3](#_Toc94346546)

[Pointer Fields 4-3](#_Toc94346547)

[Set of Codes Fields 4-4](#_Toc94346548)

[Variable Pointer Fields 4-4](#_Toc94346549)

[Word-processing Fields 4-6](#_Toc94346550)

[VA FileMan Indexes 4-6](#_Toc94346551)

[5. File References 5-8](#_Toc94346552)

[SQLI\_SCHEMA File 5-10](#_Toc94346553)

[SQLI\_KEY\_WORD File 5-11](#_Toc94346554)

[SQLI\_DATA\_TYPE File 5-12](#_Toc94346555)

[SQLI\_DOMAIN File 5-13](#_Toc94346556)

[SQLI\_KEY\_FORMAT File 5-15](#_Toc94346557)

[SQLI\_OUTPUT\_FORMAT File 5-17](#_Toc94346558)

[SQLI\_TABLE File 5-19](#_Toc94346559)

[SQLI\_TABLE\_ELEMENT File 5-20](#_Toc94346560)

[SQLI\_COLUMN File 5-22](#_Toc94346561)

[SQLI\_PRIMARY\_KEY File 5-25](#_Toc94346562)

[SQLI\_FOREIGN\_KEY File 5-27](#_Toc94346563)

[SQLI\_FOREIGN\_KEY File 5-27](#_Toc94346564)

[SQLI\_ERROR\_TEXT File 5-28](#_Toc94346565)

[SQLI\_ERROR\_LOG File 5-29](#_Toc94346566)

[6. Application Program Interfaces (APIs)—Supported References 6-1](#_Toc94346567)

[7. Other Issues 7-1](#_Toc94346568)

[Domain Cardinality 7-1](#_Toc94346569)

[SQLI and Schemas 7-1](#_Toc94346570)

[SQL Identifier Naming Algorithms 7-1](#_Toc94346571)

[Which Objects Are Processed Through Naming Algorithms? 7-2](#_Toc94346572)

[VA Business Rules and Insert/Update/Delete Operations 7-2](#_Toc94346573)

[SQLI Implementation Notes 7-2](#_Toc94346574)

[Glossary Glossary-1](#_Toc94346575)

[Appendix A—Quick Reference Card A-1](#_Toc94346576)

[Index Index-1](#_Toc94346577)

## Figures and Tables

[Table i: Documentation revision history iv](#_Toc94346428)

[Table ii: Documentation symbol descriptions xiii](#_Toc94346429)

[Table iii: A FileMan and SQL terminology equivalents xiv](#_Toc94346430)

[Figure 2‑1: SQLI mapper utility diagram 2-1](#_Toc94346431)

[Figure 2‑2: SQLI entity-relationship diagram 2-3](#_Toc94346432)

[Table 3‑1: Placeholder symbols and usage 3-1](#_Toc94346433)

[Figure 3‑1: Key Placeholders: {K1}, {K2}, etc. 3-2](#_Toc94346434)

[Figure 3‑2: Return Value Placeholder: {V} 3-2](#_Toc94346435)

[Figure 3‑3: Sample condensed VA FileMan data dictionary (DD) listing of the DA RETURN CODES file 3-3](#_Toc94346436)

[Figure 3‑4: Sample global map VA FileMan data dictionary (DD) listing of the DA RETURN CODES file 3-3](#_Toc94346437)

[Figure 3‑5: Sample code to determine the corresponding SQLI\_TABLE file for a particular VA FileMan file 3-4](#_Toc94346438)

[Figure 3‑6: Sample DA RETURN CODES file entry in the SQLI\_TABLE file (#1.5215) 3-4](#_Toc94346439)

[Figure 3‑7: Sample code finding the table elements for a given table 3-4](#_Toc94346440)

[Figure 3‑8: Sample showing how many and what types of table elements exist for a given table 3-5](#_Toc94346441)

[Figure 3‑9: Sample column-type table element entries for the DA\_RETURN\_CODES table 3-6](#_Toc94346442)

[Figure 3‑10: Sample code to find corresponding columns by using table elements 3-6](#_Toc94346443)

[Figure 3‑11: Sample entry in the SQLI\_COLUMN file 3-7](#_Toc94346444)

[Figure 3‑12: Sample code searching for a primary key (type of "P") for a given table 3-7](#_Toc94346445)

[Figure 3‑13: Sample code to obtain the primary key for the DA\_RETURN\_CODES table 3-7](#_Toc94346446)

[Figure 3‑14: Sample showing the number of parts of a primary key for the DA RETURN CODES file 3-8](#_Toc94346447)

[Figure 3‑15: Sample of a single-part key 3-8](#_Toc94346448)

[Figure 3‑16: Sample code for obtaining the primary key for the SQLI\_TABLE\_ELEMENT file 3-8](#_Toc94346449)

[Figure 3‑17: Sample entries in the SQLI\_PRIMARY\_KEY file (1 of 2) 3-9](#_Toc94346450)

[Figure 3‑18: Sample entries in the SQLI\_PRIMARY\_KEY file (2 of 2) 3-9](#_Toc94346451)

[Figure 3‑19: Sample code for a simple loop of entries in a subfile for the primary key 3-10](#_Toc94346452)

[Figure 3‑20: Sample full global reference location of a record with placeholders for each IEN 3-10](#_Toc94346453)

[Figure 3‑21: Sample routine that loops through each column in a table's primary key to assemble the global reference for file entries for that table 3-10](#_Toc94346454)

[Table 3‑2: Standard situations where SQLI provides foreign keys 3-13](#_Toc94346455)

[Figure 3‑22: Sample code finding all foreign keys for a given table 3-13](#_Toc94346456)

[Table 4‑1: Terminology between VA FileMan, SQL, and the Relational Model 4-1](#_Toc94346457)

[Table 4‑2: VA FileMan DD elements and their locations 4-1](#_Toc94346458)

[Table 4‑3: VA FileMan field types 4-2](#_Toc94346459)

[Figure 4‑1: VistA Pointer field types 4-4](#_Toc94346460)

[Figure 4‑2: VistA Set of Code field types 4-4](#_Toc94346461)

[Table 4‑4: SQLI translation from VA FileMan field types to SQL columns 4-6](#_Toc94346462)

[Figure 4‑3: Sample naming convention of tables derived from cross-reference 4-6](#_Toc94346463)

[Figure 4‑4: Table projected for "B" index of the PATIENT file (#2) 4-7](#_Toc94346464)

[Figure 4‑5: Table elements projected for PATIENT\_XB\_NAME 4-7](#_Toc94346465)

[Figure 4‑6: Columns projected for PATIENT\_XB\_NAME 4-7](#_Toc94346466)

[Figure 4‑7: Primary key projected for PATIENT\_XB\_NAME 4-8](#_Toc94346467)

[Figure 4‑8: Partial index listing 4-8](#_Toc94346468)

[Figure 5‑1: SQLI\_SCHEMA file—Index 5-10](#_Toc94346469)

[Table 5‑1: SQLI\_SCHEMA file—Fields 5-10](#_Toc94346470)

[Figure 5‑2: SQLI\_KEY\_WORD file—Index 5-11](#_Toc94346471)

[Table 5‑2: SQLI\_KEY\_WORD file—Field 5-11](#_Toc94346472)

[Figure 5‑3: SQLI\_DATA\_TYPE file—Indexes 5-12](#_Toc94346473)

[Table 5‑3: SQLI\_DATA\_TYPE file—Fields 5-12](#_Toc94346474)

[Figure 5‑4: SQLI\_DOMAIN file—Indexes 5-13](#_Toc94346475)

[Table 5‑4: SQLI\_DOMAIN file—Fields 5-14](#_Toc94346476)

[Figure 5‑5: SQLI\_KEY\_FORMAT file—Indexes 5-15](#_Toc94346477)

[Table 5‑5: SQLI\_KEY\_FORMAT file—Fields 5-15](#_Toc94346478)

[Figure 5‑6: SQLI\_OUTPUT\_FORMAT file—Index 5-17](#_Toc94346479)

[Table 5‑6: SQLI\_OUTPUT\_FORMAT file—Fields 5-17](#_Toc94346480)

[Figure 5‑7: SQLI\_TABLE file—Indexes 5-19](#_Toc94346481)

[Table 5‑7: SQLI\_TABLE file—Fields 5-19](#_Toc94346482)

[Figure 5‑8: SQLI\_TABLE\_ELEMENT file—Indexes 5-20](#_Toc94346483)

[Table 5‑8: SQLI\_TABLE\_ELEMENT file—Fields 5-20](#_Toc94346484)

[Figure 5‑9: DDL command to define a table 5-20](#_Toc94346485)

[Figure 5‑10: SQLI\_COLUMN file—Indexes 5-22](#_Toc94346486)

[Table 5‑9: SQLI\_COLUMN file—Fields 5-24](#_Toc94346487)

[Figure 5‑11: SQLI\_PRIMARY\_KEY file—Indexes 5-25](#_Toc94346488)

[Table 5‑10: SQLI\_PRIMARY\_KEY file—Fields 5-26](#_Toc94346489)

[Figure 5‑12: SQLI\_FOREIGN\_KEY file—Index 5-27](#_Toc94346490)

[Table 5‑11: SQLI\_FOREIGN\_KEY file—Fields 5-27](#_Toc94346491)

[Figure 5‑13: SQLI\_ERROR\_TEXT file—Index 5-28](#_Toc94346492)

[Table 5‑12: SQLI\_ERROR\_TEXT file—Field 5-28](#_Toc94346493)

[Figure 5‑14: SQLI\_ERROR\_LOG file—Indexes 5-29](#_Toc94346494)

[Table 5‑13: SQLI\_ERROR\_LOG file—Fields 5-29](#_Toc94346495)

[Table 6‑1: SQLI APIs 6-1](#_Toc94346496)

[Table A-1: SQLI Quick Reference Card 6](#_Toc94346497)

## Orientation

**How to Use this Manual**

The purpose of this manual is to provide information about the SQL Interface (SQLI) software (i.e., VA FileMan Patch DI\*21.0\*38).

This manual provides guidance about how VA FileMan files and fields may be projected through SQL and ODBC. It does *not* attempt to explain relational database concepts, SQL queries, or how to access ODBC data sources. For this information, you should consult the documentation provided with the relational database products you are using. You may want to purchase training in these areas as well.

Throughout this manual, advice and instructions are offered regarding the use of the SQL Interface (SQLI) software and the functionality it provides for Veterans Health Information Systems and Technology Architecture (VistA) software products.

This manual uses several methods to highlight different aspects of the material:

* Various symbols are used throughout the documentation to alert the reader to special information. The following table gives a description of each of these symbols:

|  |  |
| --- | --- |
| **Symbol** | **Description** |
| Note | Used to inform the reader of general information including references to additional reading material. |
|  | Used to caution the reader to take special notice of critical information. |

Table ii: Documentation symbol descriptions

* Descriptive text is presented in a proportional font (as represented by this font).
* Conventions for displaying TEST data in this document are as follows:
	+ The first three digits (prefix) of any Social Security Numbers (SSN) will be in the "000" or "666."
	+ Patient and user names will be formatted as follows: [Application Name]PATIENT,[N] and [Application Name]USER,[N] respectively, where "Application Name" is defined in the Approved Application Abbreviations document and "N" represents the first name as a number spelled out and incremented with each new entry. For example, in Kernel (KRN) test patient and user names would be documented as follows: KRNPATIENT,ONE; KRNPATIENT,TWO; KRNPATIENT,THREE; etc.
* HL7 messages, "snapshots" of computer online displays (i.e., roll-and-scroll screen captures/dialogues) and computer source code, if any, are shown in a *non*-proportional font and enclosed within a box.
* User's responses to online prompts will be boldface type. The following example is a screen capture of computer dialogue, and indicates that the user should enter two question marks:

Select Primary Menu option: **??**

* The "**<Enter>**" found within these snapshots indicate that the user should press the Enter key on their keyboard. Other special keys are represented within **< >** angle brackets. For example, pressing the PF1 key can be represented as pressing **<PF1>**.
* Author's comments, if any, are displayed in italics or as "callout" boxes.

|  |  |
| --- | --- |
| Note | Callout boxes refer to labels or descriptions usually enclosed within a box, which point to specific areas of a displayed image. |

* All uppercase is reserved for the representation of M code, variable names, or the formal name of options, field and file names, and security keys (e.g., the XUPROGMODE key).

**VA FileMan and SQL Terminology**

The following table lists the equivalent terminology between VA FileMan and SQL:

| **VA FileMan** | **SQL** |
| --- | --- |
| n/a | Schema |
| File or Multiple | Table |
| Field | Column |
| Field Type | Domain |
| Record | Row |

Table iii: A FileMan and SQL terminology equivalents

**How to Obtain Technical Information Online**

Exported file, routine, and global documentation can be generated through the use of Kernel, MailMan, and VA FileMan utilities.

|  |  |
| --- | --- |
| Note | Methods of obtaining specific technical information online will be indicated where applicable under the appropriate topic. |

**Help at Prompts**

VistA software provides online help and commonly used system default prompts. Users are encouraged to enter question marks at any response prompt. At the end of the help display, you are immediately returned to the point from which you started. This is an easy way to learn about any aspect of VistA software.

To retrieve online documentation in the form of Help in any VistA character-based product:

* Enter a single question mark ("**?**") at a field/prompt to obtain a brief description. If a field is a pointer, entering one question mark ("**?**") displays the HELP PROMPT field contents and a list of choices, if the list is short. If the list is long, the user will be asked if the entire list should be displayed. A **YES** response will invoke the display. The display can be given a starting point by prefacing the starting point with an up-arrow ("**^**") as a response. For example, **^M** would start an alphabetic listing at the letter M instead of the letter A while **^127** would start any listing at the 127th entry.
* Enter two question marks ("**??**") at a field/prompt for a more detailed description. Also, if a field is a pointer, entering two question marks displays the HELP PROMPT field contents and the list of choices.
* Enter three question marks ("**???**") at a field/prompt to invoke any additional Help text stored in Help Frames.

**Obtaining Data Dictionary Listings**

Technical information about files and the fields in files is stored in data dictionaries. You can use the List File Attributes option on the Data Dictionary Utilities submenu in VA FileMan to print formatted data dictionaries.

|  |  |
| --- | --- |
| Note | For details about obtaining data dictionaries and about the formats available, please refer to the "List File Attributes" chapter in the "File Management" section of the *VA FileMan Advanced User Manual*. |

**Assumptions About the Reader**

This manual is written with the assumption that the reader is familiar with the following:

1. VistA computing environment (e.g., Kernel Installation and Distribution System [KIDS])
2. VA FileMan data structures and terminology
3. Microsoft Windows
4. M programming language
5. Relational Database Concepts
6. SQL Queries
7. How to access ODBC Data Sources

It provides an overall explanation of configuring and using the SQL Interface (SQLI) software contained in VA FileMan Patch DI\*21.0\*38. However, no attempt is made to explain how the overall VistA programming system is integrated and maintained. Such methods and procedures are documented elsewhere. We suggest you look at the various VA home pages on the World Wide Web (WWW) for a general orientation to VistA. For example, go to the Veterans Health Administration (VHA) Office of Information (OI) Health Systems Design & Development (HSD&D) Home Page at the following Web address:

<http://vista.med.va.gov/>

**Reference Materials**

Readers who wish to learn more about the SQL Interface (SQLI) software should consult the following:

1. *VA FileMan SQLI Site Manual*
2. *VA FileMan SQLI Vendor Manual* (this manual; targeted for M-to-SQL vendors)
3. SQLI Home Page (for more information on SQLI) at the following temporary Web address:

<http://vista.med.va.gov/sqli/index.asp>

This site contains additional information and documentation.

VistA documentation is made available online in Microsoft Word format and in Adobe Acrobat Portable Document Format (PDF). The PDF documents *must* be read using the Adobe Acrobat Reader (i.e., ACROREAD.EXE), which is freely distributed by Adobe Systems Incorporated at the following Web address:

<http://www.adobe.com/>

|  |  |
| --- | --- |
| Note | For more information on the use of the Adobe Acrobat Reader, please refer to the *Adobe Acrobat Quick Guide* at the following Web address:<http://vista.med.va.gov/iss/acrobat/index.asp> |

VistA documentation can be downloaded from the Health Systems Design and Development (HSD&D) VistA Documentation Library (VDL) Web site:

<http://www.va.gov/vdl/>

VistA documentation and software can also be downloaded from the Enterprise VistA Support (EVS) anonymous directories:

* Albany OIFO REDACTED
* Hines OIFO REDACTED
* Salt Lake City OIFO REDACTED
* Preferred Method REDACTED

This method transmits the files from the first available FTP server.

|  |  |
| --- | --- |
|  | DISCLAIMER: The appearance of external hyperlink references in this manual does *not* constitute endorsement by the Department of Veterans Affairs (VA) of this Web site or the information, products, or services contained therein. The VA does *not* exercise any editorial control over the information you may find at these locations. Such links are provided and are consistent with the stated purpose of this VA Intranet Service. |

# Introduction

### What is VA FileMan?

VA FileMan is a database management system (DBMS) which is used at DVA medical facilities. It is implemented in the M programming language.

With the release of VA FileMan Version 21 in December of 1994, VA FileMan introduced a silent Database Server (DBS) programming API, which set the stage for extending database access to non-host users on local and wide area networks. SQLI, for example, makes extensive use of VA FileMan's DBS API.

### What is SQLI?

VA FileMan's SQLI (SQL Interface) product projects a relational view of VA FileMan data dictionaries for use by M-to-SQL vendors. This provides a supported mechanism for M-to-SQL vendors to access VA FileMan's internal data dictionaries. M-to-SQL vendors can use SQLI to map their SQL data dictionaries directly to VA FileMan data. By doing this they view and access VA FileMan data as native SQL tables.

### What is the Purpose of this Manual?

This manual is designed to help you, the M-to-SQL vendor, create and maintain an SQLI mapper utility. An SQLI mapper utility reads the projection of VA FileMan's data dictionaries provided by SQLI. It maps your M-to-SQL product's data dictionaries based on SQLI's projection so that your M-to-SQL product can directly access VA FileMan data as relational tables.

This manual may also be useful if you are providing technical support for an SQLI system; it can help provide an understanding of how SQLI works.

# Building an SQLI Mapper

To map your M-to-SQL product's data dictionaries to directly access VA FileMan data, based on the information projected by SQLI, you will need to create an SQLI mapper utility. This SQLI mapper utility should read the published information on each VA FileMan file from the SQLI's projection. It should use this information to generate DDL commands (or use some similar method) that map your SQL data dictionaries directly to VA FileMan data.

****

Figure 2‑1: SQLI mapper utility diagram

### Information Provided by SQLI

SQLI's projection of VA FileMan data dictionaries provides:

1. A complete projection of VA FileMan files and fields as relational tables.
2. Pre-defined SQL-compatible names for tables, columns, and keys.
3. Global locations to retrieve data elements directly.
4. Code to retrieve data elements through API calls.
5. Code to convert retrieved data elements from internal FileMan format to base and external column formats.
6. A standard set of strategies for VA FileMan field types whose projection in relational terms is non-trivial (pointer fields, variable pointer fields, word-processing fields, and subfiles).

This information is published in a way that is tailored to use by an M-to-SQL vendor. It relieves you from having to access VA FileMan's internal data dictionary structures to determine certain parameters that are not explicit in VA FileMan. Also, using SQLI should insulate your code from proposed changes in the VA FileMan data dictionary.

### Organization of SQLI Information

SQLI is implemented as a set of VA FileMan files within a single M global, with no multiples or word-processing fields.

The organization of the files mirrors SQL2 standard Data Definition Language (DDL) syntax. Every data structure in the main SQLI files reflects some portion of the DDL commands needed to create SQL data dictionaries for VA FileMan data (essentially, the CREATE TABLE command).

Additional syntax has been added to support the definition of M global structures, virtual columns, key and output formats and other objects outside the scope of the SQL standard.

### SQLI Entity-Relationship Diagram

This diagram organizes the file entities in their importance to the operation of the SQLI package. It shows conceptual relationships between the files, but not a comprehensive view of the physical pointer relationships between files.

****

Figure 2‑2: SQLI entity-relationship diagram

### Guidelines for SQLI Mappers

#### VA Programming Standards and Conventions

Be aware that your code will be running in VA production accounts along with VA code. Adherence to the VA Programming SAC (Standards and Conventions) is highly recommended. This includes guidelines about the setting and killing of variables, the ways that devices are used, and not interfering with the error trapping provided by VA's Kernel package.

Obtaining a formal namespace from the VA's DBA (Database Administrator) is also advised.

#### Populating the SQLI\_KEY\_WORD File

The SQLI\_KEY\_WORD file (#1.52101) stores any words that SQLI should not use for SQL entity names. At any given site, it may not be populated with any keywords at all. So you (the M-to-SQL vendor) should use SQLI's KW^DMSQD entry point to populate this SQLI\_KEY\_WORD file (#1.52101):

1. Any keywords specific to your (vendor) M-to-SQL product.
2. The standard set of reserved keywords for SQL as defined by the ANSI standard for SQL.
3. The keywords for ODBC as defined by Microsoft.

Also, in your instructions to sites using your SQLI mapper, make sure that adding your keywords to the SQLI\_KEY\_WORD file (#1.52101) is done *prior* to the site generating their first SQLI projection.

#### Data Dictionary Synchronization

To aid sites with data dictionary synchronization, your SQLI mapper utility should provide entry points for the following functions:

1. Remapping your SQL data dictionary for *all* tables projected by SQLI.
2. Remapping your SQL data dictionary for *one* table projected by SQLI.

#### Kernel Compatibility

Besides conforming to the VA Programming SAC, be aware that sites will probably want to run your utilities as background tasks using TaskMan, a module of VA's Kernel package. Sites are likely to want to create a single "task" that calls your keyword utility, runs the VA SQLI projection, and then runs your SQLI mapper.

To be compatible with running as a background task in TaskMan, your keyword utility and SQLI mapper should:

1. Not issue any READs or in any way make either entry point interactive. This allows the entry point to run in the background. If you need to ask questions, separate that section of code from the actual SQLI mapper code.
2. Not issue USE commands. The "current device" is already opened and available when an entry point is run as a task in the Kernel environment. If you need to use USE commands (e.g., to write to a host file), make sure you store the value of the current device so you can return to it.
3. For output, issue WRITE commands. Do *not* use escape sequences, however; any output should be able to print on a simple line printer.

|  |  |
| --- | --- |
| Note | For more information on background tasks in the Kernel environment, please refer to the "TaskMan" section of the *Kernel Systems Manual*. |

# Parsing the SQLI Projection

This chapter gives examples of how to traverse SQLI's indexes and retrieve the information needed to map your SQL data dictionaries.

Retrieving the information stored in the SQLI files involves traversing their indexes and retrieving the field values stored in their indexes and in the entries themselves.

|  |  |
| --- | --- |
| Note | Full descriptions of the SQLI file and index structures are contained in the "File References" chapter in this manual. You may also want to refer to Appendix A—Quick Reference Card in this manual. |

The global location of each SQLI file and its associated fields and indexes are stable, supported references. You can reference these locations directly.

### About the Examples in this Chapter

The specific approaches provided in this chapter are suggestions only, and do not cover all of the ways you can retrieve information from SQLI.

### Using the {B}, {E}, {I}, {K}, and {V} Placeholders

SQLI provides M executable code and expressions in certain fields. This M code provided by SQLI can use the following placeholder symbols:

| **Symbol** | **Usage** |
| --- | --- |
| **{B}** | Base value of a column—used for computation |
| **{E}** | External value of a column—used for display |
| **{I}** | Internal value of a VA FileMan field—used for storage |
| **{K[1..n]}** | Key value—**{K}** is the current key, **{K1}** is the first key, etc. |
| **{V[1..n]}** | Value—used for function arguments and output value |

Table 3‑1: Placeholder symbols and usage

#### Field Value Placeholders: {I}, {B} and {E}

* The {I} placeholder is used to represent Internal values, that is, the VA FileMan internal value of a field.
* The {B} placeholder is used to represent Base values, that is, the base value of a column.
* The {E} placeholders is used to represent External values, that is, the externally formatted view of the field that a user should see.

#### Key Placeholders: {K1}, {K2}, etc.

These placeholders represent portions of the primary key for a table column, numbered corresponding to the P\_SEQUENCE values of a primary key. They are used primarily in the C\_FM\_EXEC field of the SQLI\_COLUMN file (#1.5217). Substitute the appropriate primary key values to assemble a global reference to retrieve a particular column value. For example:

^DMSQ("C",672,3) = S {V}=$$GET^DMSQU(9.4901,"{K3},{K2},{K1},",.03)

Figure 3‑1: Key Placeholders: {K1}, {K2}, etc.

In this case, {K3} represents the value of the part of the primary key whose P\_SEQUENCE is 3; {K2} represents the part of the primary key whose P\_SEQUENCE is 2; and {K1} represents the part of the primary key whose P\_SEQUENCE is 1. This call retrieves the value of a column from its corresponding VA FileMan field.

#### Return Value Placeholder: {V}

This placeholder is used to denote where to place a variable that should receive a return value. One example of where the {V} "value" placeholder is used is in the SQLI\_COLUMN file (#1.5217), in M code provided by the C\_FM\_EXEC field. For example:

^DMSQ("C",485,3) = S {V}=$$GET^DMSQU(1.1,"{K1},",.04)

Figure 3‑2: Return Value Placeholder: {V}

In this case, substitute the variable name you want the output of the $$GET function returned in, for the {V} placeholder, before executing the M code.

### Example File

Throughout this chapter, a simple VA FileMan file, DA RETURN CODES file, is projected by SQLI. Here is a condensed VA FileMan data dictionary listing of this file:

CONDENSED DATA DICTIONARY---DA RETURN CODES FILE (#3.22)

UCI: VAH,FLD VERSION: 8.0

STORED IN: ^%ZIS(3.22,

--------- -----------------------------------------------------------

FIELD FIELD

NUMBER NAME

.01 DA Return String (RF), [0;1]

2 Terminal Type String (RFX), [0;2]

3 DESCRIPTION (Multiple-3.223), [1;0]

 .01 DESCRIPTION (WL), [0;1]

Figure 3‑3: Sample condensed VA FileMan data dictionary (DD) listing of the DA RETURN CODES file

The following is a global map VA FileMan data dictionary (DD) listing of this file:

GLOBAL MAP DATA DICTIONARY #3.22 -- DA RETURN CODES FILE

STORED IN ^%ZIS(3.22, (15 ENTRIES) SITE: KERNEL UCI: KRN,KDE

---------------------------------------------------------------------------

This file holds the translation between the ANSI DA return code and the name in the terminal type file that should be used.

CROSS REFERENCED BY: DA Return String(B), DA Return String(B1)

^%ZIS(3.22,D0,0)= (#.01) DA Return String [1F] ^ (#2) Terminal Type String

 ==>[2F] ^

^%ZIS(3.22,D0,1,0)=^3.223^^ (#3) DESCRIPTION

^%ZIS(3.22,D0,1,D1,0)= (#.01) DESCRIPTION [1W] ^

Figure 3‑4: Sample global map VA FileMan data dictionary (DD) listing of the DA RETURN CODES file

### Starting Point: SQLI\_SCHEMA File

This version of SQLI maps all VA FileMan files to a single schema, SQLI. So for the time being, you can assume that all tables are projected within the same schema (SQLI). Therefore, your starting point when processing the information in SQLI should be the SQLI\_TABLE file (#1.5215; *not* the SQLI\_SCHEMA file [#1.521]).

In the future, however, SQLI may project tables in more than one schema. At that point in time, an index may be added on the T\_SCHEMA field of the SQLI\_TABLE file (#1.5215), such that you can loop through schemas, and within schemas process tables.

### Find the Projected Table for a File

Within a given schema, you CAN loop through each table and process the information for that table.

To find the SQLI\_TABLE file (#1.5215) entry for a particular VA FileMan file, you can look up the file's number in the "C" cross-reference of the SQLI\_TABLE file (#1.5215). For example, to determine the corresponding SQLI\_TABLE file (#1.5215) entry for the DA RETURN CODES file (#3.22), do the following:

> **W $O(^DMSQ("T","C",3.22,""))**

97

Figure 3‑5: Sample code to determine the corresponding SQLI\_TABLE file for a particular VA FileMan file

Therefore the internal entry number (IEN) of the SQLI\_TABLE file (#1.5215) entry for DA RETURN CODES is 97. That entry in the SQLI\_TABLE file (#1.5215) looks like the following:

NUMBER: 97 T\_NAME: DA\_RETURN\_CODES

 T\_SCHEMA: SQLI

 T\_COMMENT: This file holds the translation between the ANSI DA return c

 T\_VERSION\_FM: 1 T\_FILE: DA\_RETURN\_CODES

 T\_UPDATE: JUL 31, 1997 T\_GLOBAL: ^%ZIS(3.22,{K})

Figure 3‑6: Sample DA RETURN CODES file entry in the SQLI\_TABLE file (#1.5215)

### Processing Tables

When processing a table, once you have the table's IEN in the SQLI\_TABLE file (#1.5215), the next thing to do is loop through the set of table elements for that table.

One way to find the table elements for a given SQLI\_TABLE file (#1.5215) entry is to look up that entry's IEN in the "D" index of the SQLI\_TABLE\_ELEMENT file (#1.5216), and find each matching table element:

**S EL="" F S EL=$O(^DMSQ("E","D",tableien,EL)) Q:EL']""**

Figure 3‑7: Sample code finding the table elements for a given table

However, using the "F" index of the SQLI\_TABLE\_ELEMENT file (#1.5216), you can see both how many and also what type of table elements were projected for a table.

For example, in the case of the DA\_RETURN\_CODES table (IEN #97):

Global ^DMSQ("E","F",97

 DMSQ("E","F",97

^DMSQ("E","F",97,"C",256) =

^DMSQ("E","F",97,"C",2273) =

^DMSQ("E","F",97,"C",2274) =

^DMSQ("E","F",97,"C",2275) =

^DMSQ("E","F",97,"P",255) =

Global ^

Figure 3‑8: Sample showing how many and what types of table elements exist for a given table

This shows that five table elements (four columns and one primary key) are projected for the DA\_RETURN\_CODES table.

### About Table Elements

Every entry in the SQLI\_TABLE\_ELEMENT file (#1.5216) is associated with at least one entry in the SQLI\_COLUMN (#1.5217), SQLI\_PRIMARY\_KEY (#1.5218), or SQLI\_FOREIGN\_KEY file (#1.5219). The associated entries contain the details of each table element, and associate themselves with table elements by pointing to the SQLI\_TABLE\_ELEMENT file (#1.5216).

For columns, only a single column in the SQLI\_COLUMN file (#1.5217) will point to any given column-type table element.

For primary keys however, one or more entries in the SQLI\_PRIMARY\_KEY file (#1.5218) will point to the single primary key table element for any given table. This is because some primary keys have many parts. Pointing to a single primary key table element is how these many parts in the SQLI\_PRIMARY\_KEY file (#1.5218) are organized into a single comprehensive primary key.

Likewise for foreign keys, one or more entries in the SQLI\_FOREIGN\_KEY file (#1.5219) will point to the single foreign key table element for any given foreign key.

### Processing Columns

The following example (Figure 3‑9) looks at the column-type table element entries for the DA\_RETURN\_CODES table. These provide the relational specifications for each table element:

NUMBER: 256 E\_NAME: DA\_RETURN\_CODES\_ID

 E\_DOMAIN: INTEGER E\_TABLE: DA\_RETURN\_CODES

 E\_TYPE: Column

 E\_COMMENT: Primary key #1 of table DA\_RETURN\_CODES

NUMBER: 2273 E\_NAME: DA\_RETURN\_STRING

 E\_DOMAIN: CHARACTER E\_TABLE: DA\_RETURN\_CODES

 E\_TYPE: Column

 E\_COMMENT: This field holds the string returned from sending a ANSI DA to

NUMBER: 2274 E\_NAME: TERMINAL\_TYPE\_STRING

 E\_DOMAIN: CHARACTER E\_TABLE: DA\_RETURN\_CODES

 E\_TYPE: Column

 E\_COMMENT: This is the string that should be used in a lookup to the terminal type

NUMBER: 2275 E\_NAME: DESCRIPTION

 E\_DOMAIN: WORD\_PROCESSING E\_TABLE: DA\_RETURN\_CODES

 E\_TYPE: Column

 E\_COMMENT: The description of the description field is that of holding the description

Figure 3‑9: Sample column-type table element entries for the DA\_RETURN\_CODES table

### Find a Table Element's Column Entry

For table elements that correspond to columns, use the "B" index of the SQLI\_COLUMN file (#1.5217) to find the corresponding column entry in SQLI.

For example, for the column-type table element entry #2273, the corresponding column is as follows:

> **W $O(^DMSQ("C","B",2273,""))**

1734

Figure 3‑10: Sample code to find corresponding columns by using table elements

This entry, in the SQLI\_COLUMN file (#1.5217), looks like the following:

NUMBER: 1734 C\_TABLE\_ELEMENT: DA\_RETURN\_STRING

 C\_WIDTH: 70 C\_FILE: 3.22

 C\_FIELD: .01 C\_NOT\_NULL: Required

 C\_SECURE: Not secure C\_VIRTUAL: Base column

 C\_PARENT: DA\_RETURN\_CODES\_ID C\_PIECE: 1

 C\_GLOBAL: ,0)

Figure 3‑11: Sample entry in the SQLI\_COLUMN file

### IEN Columns

SQLI projects one internal entry number (IEN) column for every top-level VA FileMan table. This column is intended to be used by you to store the IEN of each record. This IEN is important for a number reasons, one of which is that SQLI projects the primary key of each table based on the IEN column. So you need provide IEN columns for each table. In the case of the DA\_RETURN\_CODES table, the IEN column is the DA\_RETURN\_CODES\_ID column.

For subfiles, one IEN column is projected in SQLI for each of the subfile's parents. This allows the projected table to store the IEN for each "parent" file entry as these entries exist in VA FileMan. This allows end-users to reassemble the relationships in SQL for a subfile table that exist in VA FileMan.

### Find the Primary Key for a Given Table

Use the "F" index in the SQLI\_TABLE\_ELEMENT file (#1.5216), and search for the single entry with a type of "P":

**S PKEY=$O(^DMSQ("E","F",tableien,"P",""))**

Figure 3‑12: Sample code searching for a primary key (type of "P") for a given table

This returns a single entry in that represents the primary key of the table in question. In the case of the DA\_RETURN\_CODES table, the primary key is as follows:

> **W $O(^DMSQ("E","F",97,"P",""))**

255

Figure 3‑13: Sample code to obtain the primary key for the DA\_RETURN\_CODES table

There is only one entry in the SQLI\_TABLE\_ELEMENT file (#1.5216) for a table's primary key. The way a primary key is projected in SQLI is that one or more corresponding entries in the SQLI\_PRIMARY\_KEY file (#1.5218) contain the actual parts of the primary key. They all point back to the single entry in the SQLI\_TABLE\_ELEMENT file (#1.5216) to compose a single, combined primary key. Each SQLI\_PRIMARY\_KEY file (#1.5218) entry's P\_SEQUENCE field identifies the order in which that part of the primary key should be assembled.

The following example (Figure 3‑14) looks at the primary key projected for the DA\_RETURN\_CODES table. Use the SQLI\_PRIMARY\_KEY file (#1.5218)'s "B" index to discover how many parts are in the DA RETURN CODES file's (#3.22) primary key, based on its primary key table element:

Global ^DMSQ("P","B",255

 DMSQ("P","B",255

^DMSQ("P","B",255,159) =

Global ^

Figure 3‑14: Sample showing the number of parts of a primary key for the DA RETURN CODES file

In this case, the primary key is a single-part key. That entry looks like the following:

NUMBER: 159 P\_TBL\_ELEMENT: DA\_RETURN\_CODES\_PK

 P\_COLUMN: DA\_RETURN\_CODES\_ID P\_SEQUENCE: 1

 P\_START\_AT: 0 P\_END\_IF: '{K}

Figure 3‑15: Sample of a single-part key

Each part of the primary key, as stored in the SQLI\_PRIMARY\_KEY file (#1.5218), points to the column upon which that part of the primary key is based. In this case, this part of the primary key (which is the only part) is based on the IEN column for the table.

#### Primary Key for a Projected Subfile

The DA RETURN CODES file (#3.22) contains a word-processing field, which is stored like a subfile by VA FileMan. Therefore its primary key has more than one part.

If the IEN in the SQLI\_TABLE file (#1.5215) for the DA\_RET\_CODES\_DESCRIPTION file is 98, then the entry in the SQLI\_TABLE\_ELEMENT file (#1.5216) for its primary key can be obtained as follows:

> **W $O(^DMSQ("E","F",98,"P",""))**

257

Figure 3‑16: Sample code for obtaining the primary key for the SQLI\_TABLE\_ELEMENT file

The matching entries in the SQLI\_PRIMARY\_KEY file (#1.5218) are as follows:

Global ^DMSQ("P","B",257

 DMSQ("P","B",257

^DMSQ("P","B",257,160) =

^DMSQ("P","B",257,161) =

Figure 3‑17: Sample entries in the SQLI\_PRIMARY\_KEY file (1 of 2)

These entries look like the following:

NUMBER: 160

P\_TBL\_ELEMENT: DA\_RET\_CODES\_DESCRIPTION\_PK

 P\_COLUMN: DA\_RETURN\_CODES\_ID P\_SEQUENCE: 1

 P\_START\_AT: 0 P\_END\_IF: '{K}

NUMBER: 161

P\_TBL\_ELEMENT: DA\_RET\_CODES\_DESCRIPTION\_PK

 P\_COLUMN: DA\_RET\_CODES\_DESCRIPTION\_ID P\_SEQUENCE: 2

 P\_START\_AT: 0 P\_END\_IF: '{K}

Figure 3‑18: Sample entries in the SQLI\_PRIMARY\_KEY file (2 of 2)

These are the two parts to the DA\_RET\_CODES\_DESCRIPTION table's primary key.

P\_COLUMN for sequence 1 of the primary key points to the IEN column in the subfile table that stores the IEN of what, in VA FileMan, would be the subfile's parent entry. P\_COLUMN for sequence 2 of the primary key points to the IEN column in the subfile table that stores the IEN of what, in VA FileMan, would be the IEN of the subfile entry.

Therefore, the primary key for the subfile's table combines the IEN of entries in each VA FileMan file level above the subfile's table, plus the IEN column of the subfile's table itself.

#### $ORDERING to Loop Through a File's Data Entries

The P\_START\_AT and P\_ENDIF fields in the SQLI\_PRIMARY\_KEY file (#1.5218) provide the initial value for a $ORDER loop through a file's actual data entries and the expression to complete the loop.

The following example (Figure 3‑19) assumes that the table only contains a single element in the primary key (i.e., the table is for a top-level VA FileMan file). The loop would need to be more complex to loop through entries for a subfile.

;IEN = internal entry number of record to retrieve

;PSTARTAT = P\_START\_AT value for table's single-part primary key.

;PENDIF = P\_END\_IF value for table's single-part primary key.

;DMG = global storage for entries in this table. It is assumed

; to be a top-level table, with a single-part primary key.

;

S IEN=PSTARTAT,EXIT=$P(PENDIF,"{K}")\_"IEN"\_$P(PENDIF,"{K}",2)

F S IEN=$O(@($P(DMG,"{K}")\_IEN\_")")) D I @EXIT Q

.I @EXIT Q

.;code to retrieve entry would go here

.W !,IEN

Figure 3‑19: Sample code for a simple loop of entries in a subfile for the primary key

### Assembling Record Locations

You can assemble the global location of any record given the following pieces of information:

* Each primary key entry in the SQLI\_PRIMARY\_KEY file (#1.5218) for the table.
* For each primary key entry, the C\_GLOBAL value of the corresponding column.
* The column values for each column upon which the primary key is based.

Combine in order of P\_SEQUENCE the C\_GLOBAL value for each column that is part of a table's primary key. You end up with a string that that is a full global reference, with placeholders for each IEN. For example:

^DPT({K},.373,{K})

Figure 3‑20: Sample full global reference location of a record with placeholders for each IEN

The following sample routine loops through each column in a table's primary key in order of P\_SEQUENCE, retrieves the C\_GLOBAL value for each column, and assembles the global reference for file entries for that table:

; DMT: table number in question

; DMK: placeholder string

; DMEP: primary key element

; DM: primary key column sequence (P\_SEQUENCE)

; DMC: column for a part of the primary key

; DMCG: C\_GLOBAL value for column

; DMG: accumulated global root

;

S DMK="{K}",DMG=""

S DMEP=$O(^DMSQ("E","F",DMT,"P",""))

S DM=0 F S DM=$O(^DMSQ("P","C",DMEP,DM)) Q:DM="" D

. S DMS=DM,DMC=$O(^DMSQ("P","C",DMEP,DM,""))

. S DMCG=^DMSQ("C",DMC,1),DMG=DMG\_DMCG\_DMK

S DMG=DMG\_")" W DMG

Figure 3‑21: Sample routine that loops through each column in a table's primary key to assemble the global reference for file entries for that table

The string you generate will look exactly like the value in the SQLI\_TABLE file (#1.5215)'s T\_GLOBAL field.

To determine the storage location of a particular entry in that table, replace the Placeholders:{K}s with the value of each part of the primary key for the entry. In the above example, the first {K} would be replaced by the part of the subfile's primary key whose P\_SEQUENCE is 1, and the second {K} with the part of subfile's primary key whose P\_SEQUENCE is 2.

### Retrieving Column Values

Each VA FileMan field type except computed has a fixed global storage location within each corresponding VA FileMan entry. Appending the value in a column's C\_GLOBAL field to the storage location of the record in question yields the node that the corresponding field is stored in.

* For fields using normal storage, SQLI provides the ^-delimited piece of the data node in the C\_PIECE field.
* For fields using extract storage, SQLI provides the extract from and extract to positions for the data node in the C\_EXTRACT\_FROM and C\_EXTRACT\_THRU fields.

Data you retrieve from VA FileMan data globals is in internal VA FileMan format. Sometimes you can use this data without conversions of any kind. However:

1. Domain conversions are provided when the internal VA FileMan format differs from the base column format (see the "Column Value Conversions" topic that follows).
2. Output formats are provided for columns whose external format differs from the base column format (see the "Column Value Conversions" topic that follows).

**Retrieving Column Values through a DBS Call**

The SQLI\_COLUMN file (#1.5217) provides code in the C\_FM\_EXEC field to retrieve the external field value a DBS call, for columns derived from the following VA FileMan field types:

1. Computed
2. Pointer
3. Variable Pointer

This code is useful for resolving the external value for pointer field types. A pointer field in one file can point to a pointer field in another file and so forth, resulting a long pointer chain until you finally reach a non-pointer field to access the external value of the original pointer field.

Also, a DBS call is also the only way to retrieve the value for computed fields, which have no permanent storage. A value of 1 in the C\_VIRTUAL field indicates which columns are based on computed fields. For such columns, use the M code in the C\_FM\_EXEC field to retrieve the computed field value.

### Column Value Conversions

SQLI provides column conversions for some columns. Base-to-internal conversions are provided in the SQLI\_DOMAIN file (#1.5212). Base-to-external conversions are provided in the SQLI\_OUTPUT\_FORMAT file (#1.5214).

#### Domain Conversions (Base to Internal)

Some domains created by SQLI provide conversions between VA FileMan internal {I} format to SQL base {B} data format. No conversion is provided when the SQL base and VA FileMan internal form for a column are the same.

Specifically, for columns whose domains are date-time valued (FM\_DATE and FM\_MOMENT), the domains in the SQLI\_DOMAIN file (#1.5212) provide conversions in the DM\_BASE\_EXEC and DM\_INT\_EXEC fields. Also, the FM\_BOOLEAN domain provides conversions in the DM\_INT\_EXPR and DM\_BASE\_EXPR fields.

You should always check the SQLI\_DOMAIN file (#1.5212) when processing columns to determine if a domain conversion is provided.

#### Output Format Conversions (Base to External)

Given the base column value derived from a VA FileMan field, entries in the SQLI\_OUTPUT\_FORMAT file (#1.5214) provide M code to generate the external value to present to the end-user for the column in question.

Columns do *not* need an output format if the *base* column data format is the same as its *external* data format. Output formats are therefore provided only for columns derived from Pointer and Set of Codes VA FileMan field types.

Output formats that affect a column can be designated for individual columns, for all columns in a given SQLI\_DOMAIN file (#1.5212) domain, and for all columns whose domain is a given SQLI\_DATA\_TYPE file (#1.5211) data type.

The order of precedence for which output format to use, if there is more than one, is as follows:

1. C\_OUTPUT\_FORMAT in the column's SQLI\_COLUMN file (#1.5217) entry
2. DM\_OUTPUT\_FORMAT in the associated domain's SQLI\_DOMAIN file (#1.5212) entry
3. D\_OUTPUT\_FORMAT in the associated data type's SQLI\_DATA\_TYPE file (#1.5211) entry

You should always check the SQLI\_OUTPUT\_FORMAT file (#1.5214) when processing columns to determine if an output format conversion is provided.

### Foreign Keys

Your M-to-SQL product may or may not support foreign keys. If it does, you can use the foreign keys projected by SQLI to make it easier for the end-user to recreate certain relationships that are explicit in the original VA FileMan data.

SQLI projects foreign keys in the following standard situations:

| **Situation** | **Foreign Key(s) Provided** |
| --- | --- |
| Column based on pointer field | In the table containing the pointer field column, one for the pointed-to file, named *pointer\_field\_name*\_FK. The join is from the pointer field to the pointed-to table. |
| Table projected for subfile or word-processing field | In the subfile or word-processing field's table, one for each parent table, each named *parent\_table*\_PFK. Each join links the subfile to its original VA FileMan parent. |

Table 3‑2: Standard situations where SQLI provides foreign keys

One advantage of foreign key syntax over joins is that rows are not lost when the value of a join column is null. For example, foreign key syntax (e.g., NEW\_PERSON\_FK@NAME) can be used in the select clause to obtain the value of the column NAME from the NEW\_PERSON table, rather than doing a join to NEW\_PERSON in a where clause. A row is returned even if the NAME column of the corresponding row in the NEW\_PERSON file (#200) is null.

To find all of the foreign keys for a given table, use the "F" index of the SQLI\_TABLE\_ELEMENT file (#1.5216), and search for all entries with a type of "F":

**S COL="" F S COL=$O(^DMSQ("E","F",tableien,"F",COL)) Q:COL']""**

Figure 3‑22: Sample code finding all foreign keys for a given table

**Pointer Fields**

In the case of foreign keys set up to mimic the relationship provided by *pointer* fields, the name of the foreign key is the pointer field's name followed by "\_FK". For example:

 Pointer field column: TEMPORARY\_STATE

 Pointer field from table: NEW\_PERSON

 Pointer field to table: STATE

 Foreign key name: TEMPORARY\_STATE\_FK

**Subfiles and Parent Foreign Keys**

Tables derived from *subfiles*, including those for word-processing fields, have foreign keys projected by SQLI to each table that is a higher file level (up to the top-level file that is the highest parent of the subfile). These foreign keys within a subfile's table are named with the pointed-to table name followed by "\_PFK" (parent foreign key). For example:

 Subfile table: NEW\_PERSON\_ALERT\_DATE\_TIME

 Parent table: NEW\_PERSON

 Foreign key name: NEW\_PERSON\_PFK

Every foreign key to a given table has the same domain as the primary key of that table. While not supported by SQL, this convention makes entity relationships more explicit and should help vendors maintain referential integrity constraints during mapping.

# VA FileMan and SQL

### VA FileMan, SQL, and the Relational Model

The following table lists the equivalent terminology between VA FileMan (projected as a relational database), SQL, and the Relational Model:

| **VA FileMan** | **SQL** | **Relational Model** |
| --- | --- | --- |
| File or Multiple | Table | Relation |
| Field | Column | Attribute |
| Label | Name | Name |
| Field Type | Domain | Domain |
| Record | Row | Tuple |

Table 4‑1: Terminology between VA FileMan, SQL, and the Relational Model

### VA FileMan File Definition Structures

The entities that together form a VA FileMan file definition (data dictionary) are contained at the following locations:

| **Data Dictionary Element** | **Location** |
| --- | --- |
| Dictionary of Files | ^DIC(Filenumber, |
| Attribute Dictionary | ^DD(Filenumber, |
| Field Definition Nodes | ^DD(Filenumber, fieldnumber, |
| File Header | Zero subscript of the file's global root |

Table 4‑2: VA FileMan DD elements and their locations

You should not need to access any of this information directly. All relevant information about file definitions needed for projecting VA FileMan data is published by SQLI.

|  |  |
| --- | --- |
| Note | For more information on file definition structures, please refer to the "Global File Structure" chapter in the *VA FileMan Programmer Manual*. |

### VA FileMan Field Types

The following table lists each of the nine possible VA FileMan field types.

|  |  |
| --- | --- |
| Note | More information on the specifics of each field type can be found in the *VA FileMan Advanced User Manual*. |

| **Field Type** | **Description** |
| --- | --- |
| **Computed** | Value is computed on-the-fly (no permanent storage) |
| **Date** | Time can be mandatory, optional, or not allowed |
| **Free Text** | Free Text, up to 250 characters in length |
| **MUMPS** | Contains MUMPS code |
| **Numeric** | Can be integer or decimal-valued |
| **Pointer** | Points to .01 field of an entry in another file (value is IEN of pointed-to entry) |
| **Set of codes** | Restricts a user to just a few possible values. Codes have an internal and external format. |
| **Variable Pointer** | Like a pointer field, except that the pointer may be to an entry in one of several files. |
| **Word-processing** | This is a memo-type field, with no size limit, implemented in a subfile-like structure. It stores multiple lines of text, and has no size limit. |

Table 4‑3: VA FileMan field types

### VA FileMan Subfiles (Multiples)

VA FileMan entries can contain "multiple-valued" fields, known as multiples or subfiles. A subfile is essentially a file-within-a-file. For example, a PATIENT file (#2) entry might have an "Appointments" multiple-valued field. This file-within-a-file can contain one or more entries for the patient's appointments. Multiples can themselves contain multiple-valued fields.

Viewed from within VA FileMan, multiples are hierarchical. Data storage for an entry's multiple field is contained descendant from the same subscript as data for the entry itself. However, it is possible to conceptually "flatten" multiples and project them as if they are standalone tables, especially since they are defined in a similar fashion to standalone files in VA FileMan's attribute dictionary. SQLI handles multiples in this fashion.

### Mapping VA FileMan Fields to SQL Data Types

VA FileMan field types do *not* correspond exactly to the SQL concept of data types, but are projected in ways that ultimately result in categorization by data type.

You can determine the original VA FileMan field type of a column through the associated domain's DM\_FILEMAN\_FIELD\_TYPE field. This is a set of codes field, the value of which represents the original VA FileMan field type of the column (and domain) in question.

#### IEN Columns

SQLI provides a column for the original IEN of each VA FileMan record. The name for the IEN column is based on the table name followed by "\_ID". For example, the PATIENT file (#2) has a single column primary key, PATIENT\_ID.

#### Computed Fields

Projection of Computed fields is complicated mildly by the fact that SQL DDL syntax supports only base data, while Data Manipulation Language supports expressions. Columns for VA FileMan computed fields are flagged with the C\_VIRTUAL field in the SQLI\_COLUMN file (#1.5217). You can retrieve their computed value with the code in each column's C\_FM\_EXEC field, which uses DBS calls.

A number of different computed field return value types are possible: Multiline, Boolean-valued, Free text, Date, and Numeric.

|  |  |
| --- | --- |
| Note | Multiline computed fields are *not* supported by the DBS or by SQLI; a character error message is returned by the SQLI-provided M code as the value for a multiline computed field. |

#### Date Fields

Code is provided in the two VA FileMan-specific date domains, FM\_DATE and FM\_MOMENT, to convert between internal VA FileMan formatted dates and date/times, and column "base format" $HOROLOG dates and date/times. The code is in the DM\_INT\_EXEC and DM\_BASE\_EXEC fields.

#### Free Text, Numeric, and MUMPS Fields

No conversion is needed for the Free Text, Numeric, or MUMPS field types; internal, base, and external formats are identical.

#### Pointer Fields

The Pointer field type conforms to SQL's Foreign Key constraint, and is projected as such in SQLI. VA FileMan, however, allows direct reference to a pointer field, returning the text value of the primary identifier of the row reached by recursively following the pointer chain until the identifier is not itself a pointer. This usage is projected in SQLI by giving pointers an integer domain and an output format that uses the DBS to return the resolved value. For example:

OF\_NAME: FOREIGN\_FORMAT\_PTOF OF\_DATA\_TYPE: INTEGER

 OF\_COMMENT: Output format for pointer to FOREIGN\_FORMAT

 OF\_EXT\_EXPR: $S('{B}:"",1:$$GET^DMSQU(.44,{B}\_",",.01))

Figure 4‑1: VistA Pointer field types

Substitute the base value of the column for {B}, and the expression returns the resolved external text value of the pointer field.

#### Set of Codes Fields

An output format is provided for *each* distinct Set of Codes "set" to display the long form of the base column value (which should be the code only). These output format entries are pointed to from SQLI\_COLUMN file (#1.5217) entries. For example:

OF\_NAME: M\_MERGE\_O\_OVERWRITE OF\_DATA\_TYPE: CHARACTER

 OF\_COMMENT: Set output format

 OF\_EXT\_EXPR: $P($P(";m:MERGE;o:OVERWRITE;",";"\_{B}\_":",2),";")

Figure 4‑2: VistA Set of Code field types

Substitute the base value of the field (which the same as its VA FileMan internal form for Set of Codes field types) for {B}, and the expression returns the external value of the code.

#### Variable Pointer Fields

The Variable Pointer data type is not relationally atomic, the only true violation of the relational model in VA FileMan. In SQLI, a column for a variable pointer field has a character domain, and an output format that returns the VA FileMan display value from whichever of the VA FileMan files each entry actually points to.

**Summary: How SQLI Translates VA FileMan Field Types into SQL Columns**

| **FM Field Type** | **FM Internal Format** | **SQL Domain, Data Type, Base Format** | **SQL External Format** |
| --- | --- | --- | --- |
| **Computed** | Date valued: | CHARACTER domain, data type. |  |
| Multiline-valued: | Base format: same as FM internal format. | Same as base format. |
| Free Text: |  |  |
| Boolean-valued: |  |  |
| Numeric-valued: | See Numeric FM Field Type. |  |
| **Date** | yyymmdd.hhmmssyyy: #yrs. since 1700mm: month (00-12)dd: day (00-31)hh: hour (00-23)mm: minute (01-59)ss: seconds (01-59) | Date only: FM\_DATE domain; DATE data type.Date w/Time optional: FM\_MOMENT domain, MOMENT data type. Date w/Time required: FM\_DATE\_TIME domain, MOMENT data type.Base format is date/time in $HOROLOG format.  | User-friendly version of date. For example:JUL 31, 1997 |
| **Free Text** | Free text. | CHARACTER domain, data type. Base format: same as FM internal format. | Same as base format. |
| **MUMPS** | Free text. | FM\_MUMPS domain, CHARACTER data type.Base format: same as FM internal format. | Same as base format. |
| **Numeric** | Numeric. | NUMERIC or INTEGER domain and data type.Base format: same as FM internal format. | Same as base format. |
| **Pointer** | Integer IEN of the pointed-to entry. | POINTER domain.INTEGER data type. | External .01 field value of pointed-to entry (pointer chain must be followed) (provided by an output format). |
| **Set of Codes** | Internally stored "code", typically shorter than the external form. | SET\_OF\_CODES domain; CHARACTER data type.Base format: same as FM internal format. | External value that the code stands for (provided by an output format). |
| **Variable Pointer** | IEN;global file root For example:4;DIC(42, | VARIABLE\_POINTER domain; CHARACTER data type.Base format: External .01 field value of pointed-to entry at end of pointer chain. | External .01 field value of pointed-to entry (pointer chain must be followed) (provided by an output format). |
| **Word-processing** | Memo-type field, no size limit, stored in a subfile. | WORD\_PROCESSING domain and data type.Base format: A set of rows in a table, one row per textline. | Optionally make available as a memo field; otherwise, same as base format. |

Table 4‑4: SQLI translation from VA FileMan field types to SQL columns

#### Word-processing Fields

VA FileMan Word-processing fields are stored similarly to multiples, and are projected by SQLI in two ways:

1. As a standalone table (each line of text is one entry in the table).
2. As columns for vendors who support a HUGE\_CHARACTER or MEMO data type.

If you have an appropriate MEMO-like data type, you could place word-processing text into a column of this data type, and decide whether or not to make the word-processing tables available to your users.

The main problem with memo data types is that they usually come with a size constraint, and consume additional resources when you increase the maximum size. VA FileMan word-processing fields, on the other hand, are unlimited in size. Thus, you could choose a default size such as 32K for your memo-type columns. In case truncation occurs, you should return an error for word-processing fields whose contents exceed your default size.

### VA FileMan Indexes

VA FileMan regular-type cross references are projected by SQLI as tables. Other types of cross-references (Trigger, KWIC, MUMPS, Mnemonic, Soundex, and Bulletin) are not projected. Cross-references are primarily for vendor optimization, and should not be made available as tables to end-users.

Tables derived from cross-references use names based on the name of the indexed table followed by "\_Xs\_" where "s" is the index subscript, followed by the name of the column indexed (PATIENT\_XB\_NAME, PATIENT\_XSSN\_SOCIAL\_SEC\_NUMBER, etc.) Compression is used such that all names are no longer than 30 characters. For example:

PATIENT\_CANCER\_STATUS\_CODE (*table name*)

PATIENT\_CANC\_STAT\_CODE\_XB\_NAME (*"B" index table name - compressed*)

Figure 4‑3: Sample naming convention of tables derived from cross-reference

A table is projected for a cross-reference if its T\_MASTER\_TABLE field is populated. For multiples, there are two kinds of references, both of which are projected as tables by SQLI: regular and whole-file cross-references.

The following example shows the various parts of the table projected for a simple cross-reference for a top level file (the PATIENT file [#2]):

NUMBER: 4650 T\_NAME: PATIENT\_XB\_NAME

 T\_SCHEMA: SQLI T\_COMMENT: Index of PATIENT by NAME

 T\_MASTER\_TABLE: PATIENT T\_VERSION\_FM: 1

 T\_UPDATE: MAY 05, 1997 T\_GLOBAL: ^DPT("B",{K},{K})

Figure 4‑4: Table projected for "B" index of the PATIENT file (#2)

>**D ^%G**

Global ^DMSQ("E","F",4650

 DMSQ("E","F",4650

^DMSQ("E","F",4650,"C",53797) =

^DMSQ("E","F",4650,"C",53798) =

^DMSQ("E","F",4650,"P",53796) =

NUMBER: 53796 E\_NAME: PATIENT\_XB\_NAME\_PK

 E\_DOMAIN: PATIENT\_XB\_NAME\_ID E\_TABLE: PATIENT\_XB\_NAME

 E\_TYPE: Primary key

 E\_COMMENT: Primary key header for PATIENT\_XB\_NAME

NUMBER: 53797 E\_NAME: NAME

 E\_DOMAIN: CHARACTER E\_TABLE: PATIENT\_XB\_NAME

 E\_TYPE: Column

 E\_COMMENT: Index Primary Key #1 for PATIENT\_XB\_NAME.NAME

NUMBER: 53798 E\_NAME: PATIENT\_ID

 E\_DOMAIN: INTEGER E\_TABLE: PATIENT\_XB\_NAME

 E\_TYPE: Column

 E\_COMMENT: Index Primary Key #2 for PATIENT\_XB\_NAME.PATIENT\_ID

Figure 4‑5: Table elements projected for PATIENT\_XB\_NAME

>**D ^%G**

Global ^DMSQ("C","B",53797:53798

 DMSQ("C","B",53797:53798

^DMSQ("C","B",53797,43834) =

^DMSQ("C","B",53798,43835) =

Global ^

NUMBER: 43834 C\_TABLE\_ELEMENT: NAME

C\_GLOBAL: ^DPT("B",

NUMBER: 43835 C\_TABLE\_ELEMENT: PATIENT\_ID

C\_PARENT: NAME C\_GLOBAL: ,

Figure 4‑6: Columns projected for PATIENT\_XB\_NAME

>**D ^%G**

Global ^DMSQ("P","C",53796

 DMSQ("P","C",53796

^DMSQ("P","C",53796,1,8529) =

^DMSQ("P","C",53796,2,8530) =

NUMBER: 8429 P\_TBL\_ELEMENT: PATIENT\_XB\_NAME\_PK

P\_COLUMN: NAME P\_SEQUENCE: 1

NUMBER: 8530 P\_TBL\_ELEMENT: PATIENT\_XB\_NAME\_PK

P\_COLUMN: PATIENT\_ID P\_SEQUENCE: 2

Figure 4‑7: Primary key projected for PATIENT\_XB\_NAME

****

Figure 4‑8: Partial index listing

In the example above, the primary key is a two-part key, based on two columns: the "NAME" and "PATIENT\_ID" columns. The global path to "entries" in the index table is *^DPT("B",{K},{K})*.

|  |  |
| --- | --- |
| Note | One part of the key is not IEN-based, but instead is the indexed value. |

For indexes whose indexed value exceeds 30 characters, a "key format" is provided that provides the transformation between the actual indexed column's field values, and the truncated-to-30 character version of the column values that appears in the index. For more information, see the description of the SQLI\_KEY\_FORMAT file (#1.5213).

# File References

In the descriptions of SQLI files that follow, each file description contains:

1. Global root of the SQLI file.
2. VA FileMan data dictionary number of the SQLI file.
3. All available cross references for traversing the SQLI file's entries.
4. A listing of each field, with the field name, type, location, and description.
5. Additional information about the purpose of the file and its fields.
6. A description of the format of any code fragments supplied by this file.

|  |  |
| --- | --- |
| Note | In the tables on the following pages, SQLI field names followed by an asterisk (e.g., "S\_NAME\*") are never NULL when the SQLI files are populated by SQLI. This documentation convention is used to indicate that such fields are key fields for each SQLI file. |

### SQLI\_SCHEMA File

**Global Root:** ^DMSQ("S",

**VA FileMan Number:** 1.521

**Indexes:**

B: ^DMSQ("S","B",$E(S\_NAME,1,30),ien)=""

Figure 5‑1: SQLI\_SCHEMA file—Index

| **Field Name** | **Type** | **Node;Piece** | **Description** |
| --- | --- | --- | --- |
| S\_NAME\* | Free Text | 0;1 | Schema name (valid SQL identifier). |
| S\_SECURITY | Free Text | 1;1 | Not yet implemented; for future use. M routine to check security privileges on a particular schema. |
| S\_DESCRIPTION | Free Text | 0;2 | A short description of the mapped application group. |

Table 5‑1: SQLI\_SCHEMA file—Fields

**Purpose:** The SQLI\_SCHEMA file (#1.521) provides a place for SQLI to associate tables with a schema name. This allows each VA FileMan file to be automatically mapped to a schema.

Currently, SQLI automatically projects all tables as part of one schema, "SQLI". SQLI does not provide facilities for dividing VA FileMan files into separate schemas.

### SQLI\_KEY\_WORD File

**Global Root:** ^DMSQ("K",

**VA FileMan Number:** 1.52101

**Indexes:**

B: ^DMSQ("K","B",$E(KEY\_WORD,1,30),ien)=""

Figure 5‑2: SQLI\_KEY\_WORD file—Index

| **Field Name** | **Type** | **Node;Piece** | **Description** |
| --- | --- | --- | --- |
| KEY\_WORD | Free Text | 0;1 | SQL, ODBC, or vendor keyword to reserve. |

Table 5‑2: SQLI\_KEY\_WORD file—Field

**Purpose:** This file is the collection point for keywords that should not be used for SQL entity names. You can add any keywords specific to your own SQL implementation through the KW^DMSQD entry point.

The SQLI\_KEY\_WORD file (#1.52101) may *not* be populated with any key words at all. So you (the M-to-SQL vendor) should use the KW^DMSQD entry point to populate this SQLI\_KEY\_WORD file (#1.52101):

1. Any keywords specific to your (vendor) M-to-SQL product
2. The standard set of reserved keywords for SQL as defined by the ANSI standard for SQL
3. The keywords for ODBC as defined by Microsoft

In your instructions to sites using your SQLI mapper, make sure that adding your keywords to the SQLI\_KEY\_WORD file (#1.52101) is done *prior* to the site generating their first SQLI projection.

### SQLI\_DATA\_TYPE File

**Global Root:** ^DMSQ("DT",

**VA FileMan Number:** 1.5211

**Indexes:**

B: ^DMSQ("DT","B",$E(D\_NAME,1,30),ien)=""

Figure 5‑3: SQLI\_DATA\_TYPE file—Indexes

| **Field Name** | **Type** | **Node;Piece** | **Description** |
| --- | --- | --- | --- |
| D\_NAME\* | Free Text | 0;1 | Data type name (should be a valid SQL identifier). |
| D\_COMMENT | Free Text | 0;2 | Brief description. |
| D\_OUTPUT\_STRATEGY | Mumps | *Extract Storage*Node 1,1-245 | Not yet implemented; for future use. Intended for future data types (pictures, formatted word-processing, etc.) that VA FileMan might support in the future.  |
| D\_OUTPUT\_FORMAT | Pointer to SQLI\_OUTPUT\_FORMAT | 0;3 | Not implemented in the first version of SQLI. Pointer to an Output Format to use for columns whose domains point to this data type. |

Table 5‑3: SQLI\_DATA\_TYPE file—Fields

**Purpose:** The SQLI\_DATA\_TYPE file (#1.5211) is a simple list of SQL standard data types (BOOLEAN, CHARACTER, DATE, INTEGER, MEMO, MOMENT, NUMERIC, TIME) with one additional type, PRIMARY\_KEY. This allows the custom VA FileMan domains in the SQLI\_DOMAIN file (#1.5212) to always be associated with a specific base SQL data type.

SQL data types determine the SQL rules for comparing values from different domains, and the operators that may be used on them. So each domain in the SQLI\_DOMAIN file (#1.5212) has an explicit SQL data type that SQL vendors should use.

|  |  |
| --- | --- |
| Note | The PRIMARY\_KEY data type (and domain) is unique to SQLI. It is used to relate primary keys to foreign keys unambiguously. |

### SQLI\_DOMAIN File

**Global Root:** ^DMSQ("DM",

**VA FileMan Number:** 1.5212

**Indexes:**

B: ^DMSQ("DM","B",$E(DM\_NAME,1,30),ien)=""

C: ^DMSQ("DM","C",$E(DM\_TABLE,1,30),ien)=""

D: ^DMSQ("DM","D",$E(DM\_FILEMAN\_FIELD\_TYPE,1,30),ien)=""

E: ^DMSQ("DM","E",$E(DM\_DATA\_TYPE,1,30),ien)=""

Figure 5‑4: SQLI\_DOMAIN file—Indexes

| **Field Name** | **Type** | **Node;Piece** | **Description** |
| --- | --- | --- | --- |
| DM\_NAME\* | Free Text | 0;1 | Domain name (valid SQL identifier). |
| DM\_DATA\_TYPE\* | Pointer to SQLI\_DATA\_TYPE | 0;2 | Pointer to the SQL data type to use for this domain. |
| DM\_COMMENT | Free Text | 0;3 | Brief description. |
| DM\_TABLE | Pointer to SQLI\_TABLE | 0;4 | If this domain is for a primary or foreign key, points to the table of the primary key. |
| DM\_WIDTH | Numeric | 0;5 | Maximum width of external value. |
| DM\_SCALE | Numeric | 0;6 | Default number of decimal places, for NUMERIC data types only. |
| DM\_OUTPUT\_FORMAT | Pointer to SQLI\_OUTPUT\_FORMAT | 0;7 | Not implemented in the first version of SQLI. Pointer to an Output Format to use for columns that use this domain. |
| DM\_INT\_EXPR | Mumps | *Extract Storage*Node 1,1-245 | M expression to convert base value to internal (VA FileMan) format. |
| DM\_INT\_EXEC | Mumps | *Extract Storage*Node 2,1-245 | M execute statement to convert base value to internal (VA FileMan) format. |
| DM\_BASE\_EXPR | Mumps | *Extract Storage*Node 3,1-245 | M expression to convert internal (VA FileMan) value to base format. |
| DM\_BASE\_EXEC | Mumps | *Extract Storage*Node 4,1-245 | M execute statement to convert internal (VA FileMan) value to base format. |
| DM\_FILEMAN\_FIELD\_TYPE | Set of codes | 0;8 | 'F' FOR FREE TEXT 'N' FOR NUMERIC 'P' FOR POINTER 'D' FOR DATE 'W' FOR WORD-PROCESSING 'K' FOR MUMPS 'C' FOR CALCULATED 'B' FOR BOOLEAN 'S' FOR SET 'V' FOR VARIABLE POINTEROriginal VA FileMan field type for all elements using this domain, for domains derived from VA FileMan fields. Boolean means Boolean Computed. |

Table 5‑4: SQLI\_DOMAIN file—Fields

**Purpose:** Each entry in the SQLI\_DOMAIN file (#1.5212) is a custom domain, which defines a set of values from which all objects of this domain must be drawn. In SQLI, all table elements (columns, primary keys, and foreign keys) have a domain that restricts them to their domain set.

Each domain points to a data type (from the SQLI\_DATA\_TYPE file [#1.5211]) which should be used as the SQL data type for this domain. Other fields in the SQLI\_DOMAIN file (#1.5212) also constrain the set of possible values for the domain. For more information see Mapping VA FileMan Fields to SQL Data Types earlier in this chapter.

##### Code Fragment Formats

 DM\_INT\_EXPR: $S({B}="":0,1:{B})
*(provide {B}, evaluates to internal FileMan form)*

 DM\_BASE\_EXPR: $S({I}:{I},1:"")
(*provide {I}, evaluates to base form)*

 DM\_INT\_EXEC: S %H={B} D YMD^%DTC S {I}=X
*(provide {B}, get {I} back)*

 DM\_BASE\_EXEC: N %H,X S X={I} D H^%DTC S {B}=%H
*(provide {I}, get {B} back)*

### SQLI\_KEY\_FORMAT File

**Global Root:** ^DMSQ("KF",

**VA FileMan Number:** 1.5213

**Indexes:**

B: ^DMSQ("KF","B",$E(KF\_NAME,1,30),ien)=""

C: ^DMSQ("KF","C",$E(KF\_DATA\_TYPE,1,30),ien)=""

Figure 5‑5: SQLI\_KEY\_FORMAT file—Indexes

| **Field Name** | **Type** | **Node;Piece** | **Description** |
| --- | --- | --- | --- |
| KF\_NAME\* | Free Text | 0;1 | Key format name. |
| KF\_DATA\_TYPE\* | Pointer to SQLI\_DATA\_TYPE | 0;2 | Pointer to data type used by associated primary key (should always point to PRIMARY\_KEY data type). |
| KF\_COMMENT | Free Text | 0;3 | Brief description. |
| KF\_INT\_EXPR | Mumps | *Extract Storage*Node 1,1-245 | M expression to convert internal value **{I}** of indexed field to index primary key value **{K}**. |
| KF\_INT\_EXEC | Mumps | *Extract Storage*Node 2,1-245 | M executable code to set internal value **{I}** of indexed field to index primary key value **{K}**. |

Table 5‑5: SQLI\_KEY\_FORMAT file—Fields

**Purpose:** Use the conversions provided in the SQLI\_KEY\_FORMAT file (#1.5213) to translate between a column's value and the part of a primary key that uses that column. In most cases, a conversion from column value to key value is not needed.

Currently, the main situation in which a conversion is provided is for the VA FileMan indexes that are projected as tables. The index subscript is considered part of the primary key of the projected table for an index. Currently, the (regular) index subscript for a VA FileMan file is based on the field value, but is subject to truncation to 30 characters. So the value of the part of the key based on a column could differ from the value of the column itself. A standard key format is supplied and linked to all parts of primary keys that use index subscripts, whose indexed fields' maximum length exceeds 30 characters.

**Code Fragment Formats**

 KF\_INT\_EXPR: $E({I},1,30)
*(provide {I}, key is returned)*

 KF\_INT\_EXEC: S {K}=$E({I},1,30)
*(provide {I}, get {K} back)*

### SQLI\_OUTPUT\_FORMAT File

**Global Root:** ^DMSQ("OF",

**VA FileMan Number:** 1.5214

**Indexes:**

B: ^DMSQ("OF","B",$E(OF\_NAME,1,30),ien)=""

Figure 5‑6: SQLI\_OUTPUT\_FORMAT file—Index

| **Field Name** | **Type** | **Node;Piece** | **Description** |
| --- | --- | --- | --- |
| OF\_NAME\* | Free Text | 0;1 | Output format name. |
| OF\_DATA\_TYPE\* | Pointer to SQLI\_DATA\_TYPE | 0;2 | Pointer to the data type for which this output format applies. |
| OF\_COMMENT | Free Text | 0;3 | Brief description. |
| OF\_EXT\_EXPR | Mumps | *Extract Storage*Node 1,1-245 | M expression to convert base value to external value. |
| OF\_EXT\_EXEC | Mumps | *Extract Storage*Node 2,1-245 | Will not be implemented for the first version of SQLI (patch DI\*21\*38). M executable code to convert base value to external value. |

Table 5‑6: SQLI\_OUTPUT\_FORMAT file—Fields

**Purpose:** Given the base column value derived from a VA FileMan field, entries in the SQLI\_OUTPUT\_FORMAT file (#1.5214) provide M code to generate the external value to present to the end-user for the column in question.

Columns do *not* need an output format if the base column data format is the same as its external data format. Output formats are therefore provided only for columns derived from Pointer and Set of Codes VA FileMan field types.

When looking for whether an output format is provided for a column, use the column's output format if one exists. Next, check the column's domain for an output format only if one is not found for the column. Finally, check the domain's data type for an output format if one is not found for the domain.

##### Code Fragment Formats

 OF\_EXT\_EXPR: $S('{B}:"",1:$$GET^DMSQU(9.4,{B}\_",",.01))
*(substitute base value for all {B} placeholders;
evaluates to external format of data).*

### SQLI\_TABLE File

**Global Root:** ^DMSQ("T",

**VA FileMan Number:** 1.5215

**Indexes:**

B: ^DMSQ("T","B",$E(T\_NAME,1,30),ien)=""

C: ^DMSQ("T","C",$E(T\_FILE,1,30),ien)=""

D: ^DMSQ("T","D",$E(T\_GLOBAL,1,30),ien)=""

E: ^DMSQ("T","E",$E(T\_MASTER\_TABLE,1,30),ien)=""

Figure 5‑7: SQLI\_TABLE file—Indexes

| **Field Name** | **Type** | **Node;Piece** | **Description** |
| --- | --- | --- | --- |
| T\_NAME\* | Free Text | 0;1 | Table name (valid SQL identifier). |
| T\_SCHEMA\* | Pointer to SQLI\_SCHEMA | 0;2 | Pointer to table's schema. |
| T\_COMMENT | Free Text | 0;3 | Brief description. |
| T\_MASTER\_TABLE | Pointer to SQLI\_TABLE | 0;4 | Only populated if this table is projected for an index (it points to the indexed table.)  |
| T\_VERSION\_FM | Numeric | 0;5 | Reserved for future use. |
| T\_ROW\_COUNT | Numeric | 0;6 | Estimated number of rows in the table. This field is not populated by the SQLI projection, but instead by the ALLS^DMSQS and STATS^DMSQS entry points. |
| T\_FILE | Numeric | 0;7 | VA FileMan data dictionary number of file, subfile, or word-processing field the table is derived from. It is null for tables that project indexes. |
| T\_UPDATE | Date | 0;8 | Date table projection last updated. |
| T\_GLOBAL | Free Text | *extract storage*node 1, 1-245 | Global location of file entries. For documentation purposes only; use the C\_GLOBAL values in the SQLI\_COLUMN file (#1.5217) to determine the global location of file entries in code. Placeholders:{K}s in T\_GLOBAL field values signify each part of the primary key. |

Table 5‑7: SQLI\_TABLE file—Fields

**Purpose:** Entries in the SQLI\_TABLE file (#1.5215) project VA FileMan files, multiple fields, word-processing fields, and indexes as tables.

### SQLI\_TABLE\_ELEMENT File

**Global Root:** ^DMSQ("E",

**VA FileMan Number:** 1.5216

**Indexes:**

B: ^DMSQ("E","B",$E(E\_NAME,1,30),ien)=""

C: ^DMSQ("E","C",$E(E\_DOMAIN,1,30),ien)=""

D: ^DMSQ("E","D",$E(E\_TABLE,1,30),ien)=""

E: ^DMSQ("E","E",$E(E\_TYPE,1,30),ien)=""

F: ^DMSQ("E","F",E\_TABLE,E\_TYPE,ien)=""

G: ^DMSQ("E","G",E\_TABLE,E\_NAME,ien)=""

Figure 5‑8: SQLI\_TABLE\_ELEMENT file—Indexes

| **Field Name** | **Type** | **Node;Piece** | **Description** |
| --- | --- | --- | --- |
| E\_NAME\* | Free Text | 0;1 | Table element name (a valid SQL identifier). Foreign keys are distinguished by the suffix \_FK or \_PFK, primary keys by \_PK. |
| E\_DOMAIN\* | Pointer to SQLI\_DOMAIN | 0;2 | Pointer to the domain to use for the table element. |
| E\_TABLE\* | Pointer to SQLI\_TABLE | 0;3 | Pointer to the table the element is part of. |
| E\_TYPE\* | Set of codes | 0;4 | Type of table element:'C' FOR COLUMN'F' FOR FOREIGN KEY'P' FOR PRIMARY KEY |
| E\_COMMENT | Free Text | 0;5 | Brief description. |

Table 5‑8: SQLI\_TABLE\_ELEMENT file—Fields

**Purpose:** In SQL Data Definition Language (DDL), a table is defined by the DDL command:

CREATE TABLE <table-name> (table-element-commalist)

Figure 5‑9: DDL command to define a table

There is one entry in the SQLI\_TABLE\_ELEMENT file (#1.5216) for each table element (columns, primary keys, and foreign keys) that should be the included in a CREATE TABLE command for each table projected in SQLI.

Entries in this file contain the two essential elements of an attribute in the relational model: attribute-name (E\_NAME) and domain (E\_DOMAIN). Elements not defined in the relational model, but necessary for physical mapping and formatting of table elements are contained in SQLI\_COLUMN (#1.5217), SQLI\_PRIMARY\_KEY (#1.5218), and SQLI\_FOREIGN\_KEY (#1.5219) files.

### SQLI\_COLUMN File

**Global Root:** ^DMSQ("C",

**VA FileMan Number:** 1.5217

**Indexes:**

B: ^DMSQ("C","B",$E(C\_TABLE\_ELEMENT,1,30),ien)=""

C: ^DMSQ("C","C",$E(C\_PARENT,1,30),ien)=""

D: ^DMSQ("C","D",C\_FILE,C\_FIELD,ien)=""

E: ^DMSQ("C","E",$E(C\_OUTPUT\_FORMAT,1,30),ien)=""

Figure 5‑10: SQLI\_COLUMN file—Indexes

| **Field Name** | **Type** | **Node;Piece** | **Description** |
| --- | --- | --- | --- |
| C\_TBL\_ELEMENT\* | Pointer to SQLI\_TABLE\_ELEMENT | 0;1 | Pointer to the table element entry that this column is associated with. |
| C\_FILE | Numeric | 0;5 | Corresponding VA FileMan file number, if column was derived from a data dictionary field. |
| C\_WIDTH | Numeric | 0;2 | Maximum display width of column. |
| C\_SCALE | Numeric | 0;3 | Default number of decimal points for NUMERIC data type only. If scale is specified as 0, the column is projected as INTEGER. |
| C\_FIELD | Numeric | 0;6 | Corresponding VA FileMan field number, if column was derived from a data dictionary field. |
| C\_NOT\_NULL | Set of codes | 0;7 | 1 if column is required in VA FileMan; 0 if not. |
| C\_SECURE | Set of codes | 0;8 | Not yet implemented; for future use. |
| C\_VIRTUAL | Set of codes | 0;9 | 1 if column is derived from a computed field, 0 if not. If true, the corresponding field value must be retrieved using a DBS call (one is provided for this in the C\_FM\_EXEC field.) |
| C\_PARENT | Pointer to SQLI\_COLUMN(#1.5217) | 0;10 | Populated if the global reference in the C\_GLOBAL field is not a global root. Points to the column containing the next higher piece of the global reference (in C\_GLOBAL) to which the current file level's key value and C\_GLOBAL string should be appended to create the full global reference to the column's data.1. Null for computed field columns (no permanent storage).
2. Null for IEN columns of top-level files (already at the highest level).
3. Null for the first index subscript column of an index table.
 |
| C\_GLOBAL | Mumps | *Extract Storage*node 1,1-245 | For columns with permanent storage, partial global reference for the node where the column's data is stored.  |
| C\_PIECE | Numeric | 0;11 | For normally stored VA FileMan fields: The ^-delimited piece of the VA FileMan node field is stored in. |
| C\_EXTRACT\_FROM | Numeric | 0;12 | For extract-storage type VA FileMan fields: The first character extract position of the VA FileMan node the field is stored in. |
| C\_EXTRACT\_THRU | Numeric | 0;13 | For extract-storage type VA FileMan fields: The last character extract position of the VA FileMan node the field is stored in. |
| C\_COMPUTE\_EXEC | Mumps | *Extract Storage*node 2,1-245 | The internal M code VA FileMan uses to calculate a computed field's value. Warning: This code may depend on the existence of a full FileMan context; the code in C\_FM\_EXEC is a safer alternative. |
| C\_FM\_EXEC | Mumps | *Extract Storage*node 3, 1-245 | M code to retrieve value of computed and pointer fields. Uses the DBS $$GET1^DIQ call to retrieve the field value. |
| C\_POINTER | Mumps | *Extract Storage*node 4,1-245 | For columns derived from set of codes fields, this field contains the pairs of internal and external forms of each code separated by semicolons. The internal and external forms of a code are separated by colons. For example:y:YES;n:NO;For columns derived from pointer fields, this field contains the global root of the referenced file. For example:DIC(4, |
| C\_OUTPUT\_FORMAT | Pointer to SQLI\_OUTPUT\_FORMAT | 0;4 | Pointer to the output format to use for this column, if one is needed, if the external format of the data differs from the base format. |

Table 5‑9: SQLI\_COLUMN file—Fields

**Purpose:** The SQLI\_COLUMN file (#1.5217) contains the formatting and physical structure specifications for each column table element in projected tables. Each entry in the SQLI\_COLUMN file (#1.5217) has a single corresponding SQLI\_TABLE\_ELEMENT file (#1.5216) entry that provides the relational specifications (name and domain) for the column.

##### Code Fragment Formats

 C\_GLOBAL: *(ien columns, top-level file)* ^DIZ(662000,

 *(ien columns, subfile)* ,"EX",

 *(VA FileMan field columns)* ,0)

 *(Note: this field does not actually hold code, but instead holds a global reference.)*

 C\_COMPUTE\_EXEC: S X=$S($D(^DIA(DIA,D0,3)):^(3),1:"<deleted>")
*(raw code from DD to set X to computed field value; may require VA FileMan environment context that SQLI can't provide - in the above example, the value of D0.)*

 C\_FM\_EXEC: S {V}=$$GET^DMSQU(9.4901,"{K3},{K2},{K1},",.03)
*(uses DBS call to set the variable you substitute in {V} to the external value of the computed or pointer field. You must substitute appropriate iens for all Placeholders:{K}s to identify the entry in question.)*

### SQLI\_PRIMARY\_KEY File

**Global Root:** ^DMSQ("P",

**VA FileMan Number:** 1.5218

**Indexes:**

B: ^DMSQ("P","B",$E(P\_TBL\_ELEMENT,1,30),ien)=""

C: ^DMSQ("P","C",P\_TBL\_ELEMENT,P\_SEQUENCE,ien)=""

D: ^DMSQ("P","D",$E(P\_COLUMN,1,30),ien)=""

Figure 5‑11: SQLI\_PRIMARY\_KEY file—Indexes

| **Field Name** | **Type** | **Node;Piece** | **Description** |
| --- | --- | --- | --- |
| P\_TBL\_ELEMENT\* | Pointer to SQLI\_TABLE\_ELEMENT | 0;1 | Associates this part of a table's primary key with the single entry in the SQLI\_TABLE\_ELEMENT file (#1.5216) that organizes the entire primary key. |
| P\_COLUMN\* | Pointer to SQLI\_COLUMN | 0;2 | Pointer to the column on which this part of a table's primary key is based. |
| P\_SEQUENCE\* | Numeric(integer) | 0;3 | Sequence number of this part of the table's primary key. Use to determine what order to combine primary key columns to assemble the global path to an entry. |
| P\_START\_AT | Free Text | 0;4 | M literal to initialize initial subscript value for a $ORDER loop through this part of the list of primary keys of a table. |
| P\_END\_IF | Mumps | *Extract Storage*node 1,1-245 | M expression which returns true when the $ORDER loop started at P\_START\_AT reaches the end of this part of the list of primary keys of a table. |
| P\_ROW\_COUNT | Integer | 0;5 | Estimated number entries for this part of the primary key.For a multi-part key for the projection of a subfile, this would be set to the estimated number of entries at the file level of this part of the key.Populate this field with ALLS^DMSQS or STATS^DMSQS, after SQLI generation. |
| P\_PRESELECT | Mumps | *Extract Storage*node 2,1-245 | Not implemented; for future use.Code to possibly reference files in other UCIs with extended reference syntax. |
| P\_KEY\_FORMAT | Pointer to SQLI\_KEY\_FORMAT | 0;6 | Conversion to use when the primary key value is different from the column it is based on. For primary keys of index tables, a conversion is provided to deal with the truncation of index subscripts to 30 characters. |

Table 5‑10: SQLI\_PRIMARY\_KEY file—Fields

**Purpose:** Each entry in the SQLI\_PRIMARY\_KEY file (#1.5218) represents one part of the primary key of a projected table.

The P\_COLUMN field points to the table column on which this part of the primary key is derived from.

The entire primary key of a table is composed of one or more entries in the SQLI\_PRIMARY\_KEY file (#1.5218). These entries are organized into a single key by the fact that they all point to the same single entry in the SQLI\_TABLE\_ELEMENT file (#1.5216) representing the entire primary key, via the P\_TBL\_ELEMENT field.

##### Code Fragment Formats

 P\_START\_AT: 0
*(value to start a $ORDER loop at, to go through a file's entries. Not necessarily = 0; the $ORDER loop through a list of primary keys of a table starts at 0 and ends at '{K} for all regular (data) tables. Other tables (indexes) will start at null and end if null. So you can assume 'null' if P\_START\_AT and P\_END\_IF fields aren't set.*

 P\_END\_IF: '{K}
*(substitute for {K} the current ien; use to terminate a $ORDER loop through a file's entries. Not necessarily = "'{K}" - see P\_START\_AT above.)*

###  SQLI\_FOREIGN\_KEY File

**Global Root:** ^DMSQ("F",

**VA FileMan Number:** 1.5219

**Indexes:**

B: ^DMSQ("F","B",$E(F\_TBL\_ELEMENT,1,30),ien)=""

Figure 5‑12: SQLI\_FOREIGN\_KEY file—Index

| **Field Name** | **Type** | **Node;Piece** | **Description** |
| --- | --- | --- | --- |
| F\_TBL\_ELEMENT\* | Pointer to SQLI\_TABLE\_ELEMENT | 0;1 | Associates this part of a table's foreign key with the single entry in the SQLI\_TABLE\_ELEMENT file (#1.5216) that organizes the entire foreign key. |
| F\_PK\_ELEMENT\* | Pointer to SQLI\_PRIMARY\_KEY | 0;2 | Pointer to the part of the primary key of the referenced table, that this part of the foreign key corresponds with. |
| F\_CLM\_ELEMENT\* | Pointer to SQLI\_COLUMN | 0;3 | Pointer to the column in the current table whose value should be "joined" with the associated part of the primary key of the referenced table. |

Table 5‑11: SQLI\_FOREIGN\_KEY file—Fields

**Purpose:** Each entry in the SQLI\_FOREIGN\_KEY file (#1.5219) represents one part of a foreign key of a projected table.

As with primary keys, the entire foreign key of a table is composed of one or more entries in the SQLI\_FOREIGN\_KEY file (#1.5219). These entries are organized into a single key by pointing to the same SQLI\_TABLE\_ELEMENT file (#1.5216) entry, which then represents the entire foreign key.

A foreign key "pre-specifies" an explicit join between two tables. Foreign keys are projected for a table by SQLI when a join is already explicit in VA FileMan. SQLI provides foreign keys for:

1. Pointer fields. For columns derived from pointer fields, a foreign key is provided for each pointer field.
2. Subfiles. For table derived from subfiles, one foreign key is provided linking the subfile table to each of its "parent" tables (i.e., one to every table that represents a file level above the subfile.)

### SQLI\_ERROR\_TEXT File

**Global Root:** ^DMSQ("ET",

**VA FileMan Number:** 1.52191

**Indexes:**

B: ^DMSQ("ET","B",$E(ERROR\_TEXT,1,30),ien)=""

Figure 5‑13: SQLI\_ERROR\_TEXT file—Index

| **Field Name** | **Type** | **Node;Piece** | **Description** |
| --- | --- | --- | --- |
| ERROR\_TEXT | Free Text | 0;1 | SQLI error message |

Table 5‑12: SQLI\_ERROR\_TEXT file—Field

**Purpose:** The SQLI\_ERROR\_TEXT" file (#1.52191) holds a list of SQLI error messages generated during the last SQLI projection. It is used by entries in the SQLI\_ERROR\_LOG file (#1.52192), to indicate which type of SQLI error occurred during SQLI generation.

Entries in this file are purged at the start of each SQLI generation. The file is then populated with only those errors that occur during the particular SQLI generation.

### SQLI\_ERROR\_LOG File

**Global Root:** ^DMSQ("EX",

**VA FileMan Number:** 1.52192

**Indexes:**

B: ^DMSQ("EX","B",$E(FILEMAN\_FILE,1,30),ien)=""

C: ^DMSQ("EX","C",$E(ERROR,1,30),ien)=""

D: ^DMSQ("EX","D",$E(ERROR\_DATE,1,30),ien)=""

E: ^DMSQ("EX","E",$E(FILEMAN\_ERROR,1,30),ien)=""

Figure 5‑14: SQLI\_ERROR\_LOG file—Indexes

| **Field Name** | **Type** | **Node;Piece** | **Description** |
| --- | --- | --- | --- |
| FILEMAN\_FILE | Numeric | 0;1 | VA FileMan file number being processed when error occurred.  |
| FILEMAN\_FIELD | Numeric | 0;2 | VA FileMan field number being processed when error occurred. |
| ERROR | Pointer to SQLI\_ERROR\_TEXT | 0;3 | Pointer to type of error. |
| ERROR\_DATE | Date | 0;4 | Date of SQLI generation. |
| FILEMAN\_ERROR | Pointer to VA FileMan DIALOG file (#.84) | 0;5 | If the error was generated during a DBS call, and the DBS itself returned a particular error, this points to the DIALOG file (#.84) reference returned by the DBS call. |

Table 5‑13: SQLI\_ERROR\_LOG file—Fields

**Purpose:** The SQLI\_ERROR\_LOG file (#1.52192) is a log of all errors encountered when running the SQLI generation.

You can print out the errors stored in this log directly through VA FileMan. You can also use the supplied utility, MAIN^DMSQE, to print out the errors sorted by category of error.

# Application Program Interfaces (APIs)—Supported References

SQLI provides a set of supported M routine application program interfaces (APIs). Some APIs are intended for the use of M-to-SQL vendors; others are for general use. The supported APIs are as follows:

| **API Entry Point** | **Description** |
| --- | --- |
| SETUP^DMSQ | Generate SQLI projection (non-interactive) |
| ALLF^DMSQF | Generate SQLI projection (interactive) |
| KW^DMSQD | Load keywords into the SQLI\_KEY\_WORD file (#1.52101) |
| ALLS^DMSQS | Generate cardinality of all tables |
| STATS^DMSQS | Generate cardinality of one table |
| $$CN^DMSQU | Internal SQLI naming algorithm (column) |
| $$FNB^DMSQU | Internal SQLI naming algorithm (table) |
| $$SQLI^DMSQU | Internal SQLI naming algorithm (identifier) |
| $$SQLK^DMSQU | Internal SQLI naming algorithm (identifier) |

Table 6‑1: SQLI APIs

For a full description of each entry point, see the "SQLI Technical Information" chapter of the *VA FileMan SQLI Site Manual*.

In addition, all of SQLI's files, fields, and cross-references as distributed in patch DI\*21\*38 can be referenced directly without integration agreements. This enables M-to-SQL vendors to create SQLI mapping utilities using the SQLI file structures. Specifically, these are the files in the 1.52 to 1.53 number range, all stored in ^DMSQ.

# Other Issues

### Domain Cardinality

Most domains have no known or absolutely determinable domain cardinality. Column types for which domain cardinality can be determined are:

1. Columns for Set of Codes fields: Take the C\_POINTER field from the column derived from the FileMan Set of codes field. $L(C\_POINTER,":")-1 yields the cardinality for this column.
2. Columns for Pointer fields: Use the P\_ROW\_COUNT value of the primary key of the pointed-to table, or the T\_ROW\_COUNT of the pointed-to table. This assumes that P\_ROW\_COUNT and T\_ROW\_COUNT have been populated for the table in question using either STATS^DMSQS or ALLS^DMSQS APIs.

### SQLI and Schemas

This version of SQLI projects all VA FileMan files as part of a single schema, "SQLI".

If SQLI were to project the same VA FileMan file as part of *more than one* schema, it would need to project distinct, separate entries for the file in the SQLI\_TABLE file (#1.5215) for each schema. So to project the PATIENT file in four different schemas, four different SQLI\_TABLE file (#1.5215) entries would be projected, as well as four complete sets of table elements (columns, primary keys, and foreign keys).

Ordinarily it's best not to project a given file in more than one schema; in any case, SQLI currently does not support projecting the same file in multiple schemas.

### SQL Identifier Naming Algorithms

By using consistent naming algorithms for files and fields, SQLI ensures that SQL table names for national files and fields between VA sites are the same. In addition, the algorithms enforce syntactical correctness and uniqueness of identifiers, and the exclusion of keywords from the naming of identifiers.

The following conventions are followed for table and table element names:

1. Names are 1 to 30 characters long.
2. Must start with a letter from A to z.
3. May contain only the letters A through z, digits 0 through 9 and the underline character "\_".
4. No repeating or trailing underlines are used.
5. Names are case insensitive ("a" means the same as "A").
6. SQL and vendor-specific keywords may not be used as names.
7. Table names must be unique within each schema.
8. Table element names (column, primary key, foreign key) must be unique within each table.
9. If the name is too long it is compressed by removing vowels.

Under very unusual circumstances, the naming algorithms can produce a different field or file name between sites. The known circumstances that could produce a difference are as follows:

1. The names of local files or fields result in a conflict with the naming of a national file or field.
2. A difference in the excluded keyword list maintained in SQLI\_KEY\_WORD file (#1.52101) between sites results in a naming conflict at one site, and no conflict at another.
3. National packages not loaded at a particular site avoid a naming conflict that otherwise would occur.

#### Which Objects Are Processed Through Naming Algorithms?

Tables and table element (column, primary key, and foreign key) names are generated through dynamic naming algorithms. Names for domains, data types, and output formats are manually assigned SQL-compatible names, but are not processed through the SQLI naming algorithms.

### VA Business Rules and Insert/Update/Delete Operations

You may want to update VA FileMan files from SQL. Explicit support for vendors to implement Insert, Update, and Delete operations is not implemented in the first version of SQLI (patch DI\*21\*38).

A caution for implementing these types of access to VA FileMan data is that business rules are quite often not stored in VA FileMan data dictionaries. A significant portion of the business rules in VistA applications reside in application code. Updating that does *not* go through application software cannot execute business rules stored solely in application code, and can cause data corruption by circumventing business rules.

### SQLI Implementation Notes

1. **.001 Number Fields**. The optional .001 number field for a file, if defined, represents the IEN of entries. Such fields are *not* projected as columns by SQLI. You can access this value using the TABLE\_ID column (the IEN column), which SQLI does project for all tables.
2. **Asterisked Files.** Any files or subfiles whose names start with an asterisk are not projected in SQLI. Note: Adding an asterisk to the beginning of a field name is a VA Programming SAC convention to mark the field as obsolete.
3. **Dangling Pointers**. It is possible that a VA FileMan field may contain a pointer to a file not actually present at a given site. If so, the field is projected as a normal pointer field would be, but without the corresponding output format that permits navigation along a pointer chain to resolve the external value of the pointer. Such fields are flagged in the SQLI\_ERROR\_LOG file (#1.52192) during SQLI generation as "Pointer to Absent Files". Foreign keys for such fields are not constructed.
4. **Field Attributes *Not* Projected**. Along with number, the following field attributes are projected by SQLI: Label, field length, type, specifier, global subscript location, pointer, multiple-valued, and the first line of the field's description. Other field attributes, including output transforms and pointer screens, are not projected.

|  |  |
| --- | --- |
| Note | For more information about field attributes, please refer to the "Global File Structure" chapter in the *VA FileMan Programmer Manual*. |

1. **File Attributes *Not* Projected**. Only file name and number are projected. Other file attributes, such as Special Lookup and Screens, are not.

|  |  |
| --- | --- |
| Note | For more information about file attributes, please refer to the "Global File Structure" chapter in the *VA FileMan Programmer Manual*. |

1. **Files *Not* in ^DIC**. Only files with entries in ^DIC (the dictionary of files) are projected. This means only VA FileMan-compatible files are projected.
2. **Internal VA FileMan Tables *Not* Projected**. Certain tables used by VA FileMan internally (numbered below two) are not projected. Errors are logged during SQLI projection in the SQLI\_ERROR\_LOG file (#1.52192). VA FileMan DD numbers in this category include: .001, .1, .12, .15, .21, .3, 1.001, and 1.01.
3. **Multiline Computed Fields**. Values are not returned for multiline computed fields, since DBS calls *cannot* retrieve multiline computed fields. An example of a multiline computed field is a backward extended pointer reference.
4. **Non-regular Cross-references**. Only regular VA FileMan cross-references are projected. VA FileMan Trigger, KWIC (Key Word in Context), MUMPS, Mnemonic, Soundex, and Bulletin type indexes are absent from SQLI. Cross-references are only projected for possible optimizations by M-to-SQL vendors.
5. **Output Transforms**. Output transforms are not projected. If formatting needs to be applied, it can be applied at the SQL vendor column level. For more elaborate output transforms that may call routines for processing, the logic will need to be reproduced in the context of the query. Depending on your M-to-SQL product's capability, the external value of a field (after the output transform is applied) could be returned by a user-defined function that invokes the VA FileMan $$EXTERNAL^DILF API call.
6. **Variable Pointers**. Variable pointers are projected as text only. Their text value is resolved, but presented as text.

## Glossary

|  |  |
| --- | --- |
| BASE VALUE | The stored value of a column in SQL, not transformed in any way. |
| CARDINALITY | The cardinality of a table is its number of rows; the cardinality of a domain is the number of possible values in the domain. |
| COLUMN | A set of values for a particular value sequence in a row, for each row in a table (akin to a VA FileMan field). All values in a column must be of the same data type or domain. |
| DATA TYPE | A set of possible values. SQL has its own set of standard data types; SQL vendors often implement additional data types. |
| DATA DICTIONARY | A file that defines a file's structure, to include a file's fields and relationships to other files. |
| DBA | Database Administrator for an SQL system. The DBA has, by default, full privileges to every object in the database. |
| DBS | Database Server. DBS is a non-interactive VA FileMan API. It makes no writes to the screen. It provides client/server access to VA FileMan data. DBS calls of particular interest to M-to-SQL vendors using SQLI include $$GET1^DIQ, FIELD^DID, and $$EXTERNAL^DILFD. |
| DCL | Data Control Language. The set of SQL statements through which access to the database is controlled. |
| DDL | Data Definition Language. The set of SQL statements through which objects are created and modified in the database. |
| DML | Data Manipulation Language. The set of SQL statements through which data is modified. |
| DOMAIN | A set of permissible values. A domain is based on a data type, but may contain further constraints on what values are valid for the domain. |
| EXTRACT STORAGE | When the storage location for a particular VA FileMan field is designated to be by position on a global node, instead of being character-delimited. |
| FIELD TYPE | The type of VA FileMan field. There are nine FileMan field types. VA FileMan field types loosely correspond to the concept of *data type*.  |
| FOREIGN KEY | A foreign key acts as a ready-to-use join between two tables. It matches a set of columns in one table to the primary key in another table.  |
| HIERARCHICAL DATABASE | A database structure in which files can own or belong to each other. Often referred to as a parent-child structure. |
| IEN | Internal entry number. This is the numeric subscript beneath a file's global root under which all of the data for a given VA FileMan file entry is stored.  |
| IEN COLUMN | A column SQLI projects to contain the IEN of a VA FileMan entry. |
| JOIN | In SQL, a join is when two or more tables are combined into a single table based on column values in an SQL SELECT statement.  |
| M-TO-SQL PRODUCT | Software that can view structured M globals as relational tables through SQL. |
| MULTIPLE-VALUED FIELD | A VA FileMan filed that allows more than one value for a single entry. See also Subfile. |
| ODBC | Open Database Connectivity. ODBC is Microsoft's solution to enable client access to heterogeneous databases. |
| OUTER JOIN | A join between two tables, where rows from one table are present in the joined table, even when there are no corresponding rows from the other table. |
| OUTPUT FORMATS | Output formats are provided by SQLI to convert column base values into a format suitable for external use by end-users. |
| PRIMARY KEY | A designated set of columns in a table whose values uniquely identify any row in the table. |
| QUERY | An SQL command that extracts information from an SQL database. |
| RELATIONAL DATABASE | A database that is a collection of tables, and whose operations follow the relational model. |
| ROW | A sequence of values in a table, representing one logical record. |
| SCHEMA | A schema defines a portion of an SQL database as being owned by a particular user. |
| SQL | Structured Query Language, the predominant language and set of facilities for working with relational data. The current ANSI (American National Standards Institute) standard for SQL is X3.135-1992. |
| SQLI MAPPER | Software written by an M-to-SQL vendor that maps the vendor's SQL data dictionaries directly to VA FileMan data, using the information projected by SQLI. |
| SUBFILE | The data structure of a multiple-valued field. In many respects, a subfile has the same characteristics as a file. |
| TABLE | A collection of rows, where each row is the equivalent of a record. A base table (one not derived from another table) is the SQL equivalent of a database file. |
| TABLE ELEMENT | a column, primary key, or foreign key that is part of a table. |
| VIEW | A user-defined subset of tables, based on a SELECT statement, containing only selected rows and columns.  |
| .01 FIELD | A field that exists for every VA FileMan file, and that is used as the primary lookup value for a record. |

|  |  |
| --- | --- |
| Note | For a comprehensive list of commonly used infrastructure- and security-related terms and definitions, please visit the ISS Glossary Web page at the following Web address:<http://vista.med.va.gov/iss/glossary.asp>For a list of commonly used acronyms, please visit the ISS Acronyms Web site at the following Web address:<http://vista/med/va/gov/iss/acronyms/index.asp> |

##

## Appendix A—Quick Reference Card

| **File#** | **File Name** | **Node** | **Fields (Keys In Boxes)** | **Cross References** |
| --- | --- | --- | --- | --- |
| 1.521 | SQLI\_SCHEMA | ^DMSQ("S",D0,0) | (#.01) S\_NAME [1F] | S\_NAME(B) |
|  |  |  | (#2) S\_DESCRIPTION [2F] |  |
|  |  | ^DMSQ("S",D0,1) | (#1) S\_SECURITY [1F] \**for future use* |
| 1.52101 | SQLI\_KEY\_WORD | ^DMSQ("K",D0,0) | (#.01) KEY\_WORD [1F] | KEY\_WORD(B) |
|  |  |  |  |  |
| 1.5211 | SQLI\_DATA\_TYPE | ^DMSQ("DT",D0,0) | (#.01) D\_NAME [1F] | D\_NAME(B) |
|  |  |  | (#1) D\_COMMENT [2F] |  |
|  |  |  | (#3) D\_OUTPUT\_FORMAT [3P] \**for future use* |
|  |  | ^DMSQ("DT",D0,1) | (#2) D\_OUTPUT\_STRATEGY [E1,245K] \**for future use* |
| 1.5212 | SQLI\_DOMAIN | ^DMSQ("DM",D0,0) | (#.01) DM\_NAME [1F] | DM\_NAME(B) |
|  |  |  | (#1) DM\_DATA\_TYPE [2P] | DM\_DATA\_TYPE(E) |
|  |  |  | (#2) DM\_COMMENT [3F] |  |
|  |  |  | (#3) DM\_TABLE [4P] | DM\_TABLE(C) |
|  |  |  | (#4) DM\_WIDTH [5N] |  |
|  |  |  | (#5) DM\_SCALE [6N] |  |
|  |  |  | (#6) DM\_OUTPUT\_FORMAT [7P] \**for future use* |
|  |  |  | (#11) DM\_FILEMAN\_FIELD\_TYPE [8S] | DM\_FILEMAN\_FIELD\_TYPE(D) |
|  |  | ^DMSQ("DM",D0,1) | (#7) DM\_INT\_EXPR [E1,245K] |  |
|  |  | ^DMSQ("DM",D0,2) | (#8) DM\_INT\_EXEC [E1,245K] |  |
|  |  | ^DMSQ("DM",D0,3) | (#9) DM\_BASE\_EXPR [E1,245K] |  |
|  |  | ^DMSQ("DM",D0,4) | (#10) DM\_BASE\_EXEC [E1,245K] |  |
| 1.5213 | SQLI\_KEY\_FORMAT | ^DMSQ("KF",D0,0) | (#.01) KF\_NAME [1F] | KF\_NAME(B) |
|  |  |  | (#1) KF\_DATA\_TYPE [2P] | KF\_DATA\_TYPE(C) |
|  |  |  | (#2) KF\_COMMENT [3F] |  |
|  |  | ^DMSQ("KF",D0,1) | (#3) KF\_INT\_EXPR [E1,245K] |  |
|  |  | ^DMSQ("KF",D0,2) | (#4) KF\_INT\_EXEC [E1,245K] |  |
| 1.5214 | SQLI\_OUTPUT\_FORMAT | ^DMSQ("OF",D0,0) | (#.01) OF\_NAME [1F] | OF\_NAME(B) |
|  |  |  | (#1) OF\_DATA\_TYPE [2P] |  |
|  |  |  | (#2) OF\_COMMENT [3F] |  |
|  |  | ^DMSQ("OF",D0,1) | (#3) OF\_EXT\_EXPR [E1,245K] |  |
|  |  | ^DMSQ("OF",D0,2) | (#4) OF\_EXT\_EXEC [E1,245K] \**for future use* |
| 1.5215 | SQLI\_TABLE | ^DMSQ("T",D0,0) | (#.01) T\_NAME [1F] | T\_NAME(B) |
|  |  |  | (#1) T\_SCHEMA [2P] |  |
|  |  |  | (#2) T\_COMMENT [3F] |  |
|  |  |  | (#3) T\_MASTER\_TABLE [4P] | T\_MASTER\_TABLE(E) |
|  |  |  | (#4) T\_VERSION\_FM [5N] |  |
|  |  |  | (#5) T\_ROW\_COUNT [6N] |  |
|  |  |  | (#6) T\_FILE [7N] | T\_FILE(C) |
|  |  |  | (#7) T\_UPDATE [8D] |  |
|  |  | ^DMSQ("T",D0,1) | (#8) T\_GLOBAL [E1,245K] | T\_GLOBAL(D) |
| 1.5216 | SQLI\_TABLE\_ELEMENT | ^DMSQ("E",D0,0) | (#.01) E\_NAME [1F] | E\_NAME(B) |
|  |  |  | (#1) E\_DOMAIN [2P] | E\_DOMAIN(C) |
|  |  |  | (#2) E\_TABLE [3P] | E\_TABLE(D) |
|  |  |  | (#3) E\_TYPE [4S] | E\_TYPE(E) |
|  |  |  | (#4) E\_COMMENT [5F] | E\_TABLE,E\_NAME(G) |
|  |  |  |  | E\_TABLE,E\_TYPE(F) |
| 1.5217 | SQLI\_COLUMN | ^DMSQ("C",D0,0) | (#.01) C\_TABLE\_ELEMENT [1P] | C\_TABLE\_ELEMENT(B) |
|  |  |  | (#2) C\_WIDTH [2N] |  |
|  |  |  | (#3) C\_SCALE [3N] |  |
|  |  |  | (#16) C\_OUTPUT\_FORMAT [4P] | C\_OUTPUT\_FORMAT(E) |
|  |  |  | (#1) C\_FILE [5N] | C\_FILE,C\_FIELD(D) |
|  |  |  | (#4) C\_FIELD [6N] |  |
|  |  |  | (#5) C\_NOT\_NULL [7S] |  |
|  |  |  | (#6) C\_SECURE [8S] |  |
|  |  |  | (#7) C\_VIRTUAL [9S] |  |
|  |  |  | (#8) C\_PARENT [10P] | C\_PARENT(C) |
|  |  |  | (#10) C\_PIECE [11N] |  |
|  |  |  | (#11) C\_EXTRACT\_FROM [12N] |  |
|  |  |  | (#12) C\_EXTRACT\_THRU [13N] |  |
|  |  | ^DMSQ("C",D0,1) | (#9) C\_GLOBAL [E1,245K] |  |
|  |  | ^DMSQ("C",D0,2) | (#13) C\_COMPUTE\_EXEC [E1,245K] |  |
|  |  | ^DMSQ("C",D0,3) | (#14) C\_FM\_EXEC [E1,245K] |  |
|  |  | ^DMSQ("C",D0,4) | (#15) C\_POINTER [E1,245K] |  |
| 1.5218 | SQLI\_PRIMARY\_KEY | ^DMSQ("P",D0,0) | (#.01) P\_TBL\_ELEMENT [1P] | P\_TBL\_ELEMENT(B) |
|  |  |  | (#1) P\_COLUMN [2P] | P\_COLUMN(D) |
|  |  |  | (#2) P\_SEQUENCE [3N] | P\_TBL\_ELEMENT,P\_SEQUENCE(C) |
|  |  |  | (#3) P\_START\_AT [4F] |  |
|  |  |  | (#5) P\_ROW\_COUNT [5N] |  |
|  |  |  | (#7) P\_KEY\_FORMAT [6P] |  |
|  |  | ^DMSQ("P",D0,1) | (#4) P\_END\_IF [E1,245K] |  |
|  |  | ^DMSQ("P",D0,2) | (#6) P\_PRESELECT [E1,245K] \**for future use* |
| 1.5219 | SQLI\_FOREIGN\_KEY | ^DMSQ("F",D0,0) | (#.01) F\_TBL\_ELEMENT [1P] | F\_TBL\_ELEMENT(B) |
|  |  |  | (#1) F\_PK\_ELEMENT [2P] |  |
|  |  |  | (#2) F\_CLM\_ELEMENT [3P] |  |
| 1.52191 | SQLI\_ERROR\_TEXT | ^DMSQ("ET",D0,0) | (#.01) ERROR\_TEXT [1F] | ERROR\_TEXT (B) |
| 1.52192 | SQLI\_ERROR\_LOG | ^DMSQ("EX",D0,0) | (#.01) FILEMAN\_FILE [1N] | FILEMAN\_FILE(B) |
|  |  |  | (#1) FILEMAN\_FIELD [2N] |  |
|  |  |  | (#2) ERROR [3P]  | ERROR(C) |
|  |  |  | (#3) ERROR\_DATE [4D] | ERROR\_DATE(D) |
|  |  |  | (#4) FILEMAN\_ERROR [5P] | FILEMAN\_ERROR(E) |

Table A-1: SQLI Quick Reference Card

## Index

$

$ORDERING to Loop Through a File's Data Entries, 3-9

A

About

Table Elements, 3-5

Acronyms (ISS)

Home Page Web Address, Glossary, 3

Algorithms

SQL Identifier Naming Algorithms, 7-1

Which Objects Are Processed Through Naming Algorithms, 7-2

ALLS^DMSQS, 7-1

APIs

ALLS^DMSQS, 7-1

STATS^DMSQS, 7-1

Appendix A—Quick Reference Card, A, 1

Application Program Interfaces (APIs), 6-1

Assembling Record Locations, 3-10

Assumptions About the Reader, xiv

Asterisked Files, 7-2

B

Base to External Conversions, 3-12

Base to Internal Conversions, 3-12

Building an SQLI Mapper, 2-1

Business Rules, 7-2

C

C\_COMPUTE\_EXEC Field, 5-23

C\_EXTRACT\_FROM Field, 3-11, 5-23

C\_EXTRACT\_THRU Field, 3-11, 5-23

C\_FIELD Field, 5-22

C\_FILE Field, 5-22

C\_FM\_EXEC Field, 3-2, 3-11, 4-3, 5-22, 5-23

C\_GLOBAL Field, 3-6, 3-10, 3-11, 4-8, 5-19, 5-23, 5-24

C\_NOT\_NULL Field, 5-22

C\_OUTPUT\_FORMAT Field, 3-12, 5-22, 5-24

C\_PARENT Field, 5-23

C\_PIECE Field, 3-11, 5-23

C\_POINTER Field, 5-24, 7-1

C\_SCALE Field, 5-22

C\_SECURE Field, 5-22

C\_TBL\_ELEMENT Field, 5-22

C\_VIRTUAL Field, 3-11, 4-3, 5-22

C\_WIDTH Field, 5-22

Callout Boxes, xiii

Cardinality

Domain, 7-1

Columns

IEN, 3-7, 4-3, 5-23

Processing, 3-6

Retrieving Column Values, 3-11

Through a DBS Call, 3-11

Value Conversions, 3-11

Compatibility

Kernel, 2-5

Computed Fields, 3-11, 4-3, 5-22

Contents, v

Conversions

Columns Value Conversions, 3-11

Domain Conversions (Base to Internal), 3-12

Output Format Conversions (Base to External), 3-12

Cross-references

Non-regular, 7-3

D

D\_COMMENT Field, 5-12

D\_NAME Field, 5-12

D\_OUTPUT\_FORMAT Field, 3-12, 5-12

D\_OUTPUT\_STRATEGY Field, 5-12

DA RETURN CODES File (#3.22), 3-3, 3-4, 3-8

DA\_RETURN\_CODES Table, 3-6

Dangling Pointers, 7-2

Data Dictionary

Data Dictionary Utilities Menu, xiv

Listings, xiv

Synchronization, 2-4

Data Storage of Entries, 3-9

Date Fields, 4-3

DBS Calls, 1-1, 3-11, 4-3, 4-4, 5-22, 5-23, 5-29

Delete

Operations, 7-2

SQL, 7-2

DIALOG File (#.84), 5-29

DM\_BASE\_EXEC Field, 3-12, 4-3, 5-14

DM\_BASE\_EXPR, 5-14

DM\_BASE\_EXPR Field, 3-12, 5-13

DM\_COMMENT Field, 5-13

DM\_DATA\_TYPE Field, 5-13

DM\_FILEMAN\_FIELD\_TYPE Field, 4-3, 5-14

DM\_INT\_EXEC Field, 3-12, 4-3, 5-13, 5-14

DM\_INT\_EXPR Field, 3-12, 5-13

DM\_NAME Field, 5-13

DM\_OUTPUT\_FORMAT Field, 3-12, 5-13

DM\_SCALE Field, 5-13

DM\_TABLE Field, 5-13

DM\_WIDTH Field, 5-13

Documentation

Revisions, iii

Symbols, xii

Domain Cardinality, 7-1

Domain Conversions (Base to Internal), 3-12

Domains

FM\_BOOLEAN, 3-12

FM\_DATE, 3-12

FM\_MOMENT, 3-12

E

E\_COMMENT Field, 5-20

E\_DOMAIN Field, 5-20

E\_NAME Field, 5-20

E\_TABLE Field, 5-20

E\_TYPE Field, 5-20

Elements

About Table Elements, 3-5

Entity-relationship Diagram, 2-3

Entry Data Storage, 3-9

Entry Locations, 3-10

Entry Points, 6-1

ERROR Field, 5-29

ERROR\_DATE Field, 5-29

ERROR\_TEXT Field, 5-28

EVS Anonymous Directories, xv

F

F\_CLM\_ELEMENT Field, 5-27

F\_PK\_ELEMENT Field, 5-27

F\_TBL\_ELEMENT Field, 5-27

Fields

.001 Number, 7-2

Attributes Not Projected, 7-3

C\_COMPUTE\_EXEC, 5-23

C\_EXTRACT\_FROM, 3-11, 5-23

C\_EXTRACT\_THRU, 3-11, 5-23

C\_FIELD, 5-22

C\_FILE, 5-22

C\_FM\_EXEC, 3-2, 3-11, 4-3, 5-22, 5-23

C\_GLOBAL, 3-6, 3-10, 3-11, 4-8, 5-23, 5-24

C\_NOT\_NULL, 5-22

C\_OUTPUT\_FORMAT, 3-12, 5-22, 5-24

C\_PARENT, 5-23

C\_PIECE, 3-11, 5-23

C\_POINTER, 5-24, 7-1

C\_SCALE, 5-22

C\_SECURE, 5-22

C\_TBL\_ELEMENT, 5-22

C\_VIRTUAL, 3-11, 4-3, 5-22

C\_WIDTH, 5-22

Computed, 3-11, 4-3, 5-22

D\_COMMENT, 5-12

D\_NAME, 5-12

D\_OUTPUT\_FORMAT, 3-12, 5-12

D\_OUTPUT\_STRATEGY, 5-12

Date, 4-3

DM\_BASE\_EXEC, 3-12, 4-3, 5-14

DM\_BASE\_EXPR, 3-12, 5-13

DM\_COMMENT, 5-13

DM\_DATA\_TYPE, 5-13

DM\_FILEMAN\_FIELD\_TYPE, 4-3, 5-14

DM\_INT\_EXEC, 3-12, 4-3, 5-13, 5-14

DM\_INT\_EXPR, 3-12, 5-13

DM\_NAME, 5-13

DM\_OUTPUT\_FORMAT, 3-12, 5-13

DM\_SCALE, 5-13

DM\_TABLE, 5-13

DM\_WIDTH, 5-13

E\_COMMENT, 5-20

E\_DOMAIN, 5-20

E\_NAME, 5-20

E\_TABLE, 5-20

E\_TYPE, 5-20

ERROR, 5-29

ERROR\_DATE, 5-29

ERROR\_TEXT, 5-28

F\_CLM\_ELEMENT, 5-27

F\_PK\_ELEMENT, 5-27

F\_TBL\_ELEMENT, 5-27

FILEMAN\_ERROR, 5-29

FILEMAN\_FIELD, 5-29

FILEMAN\_FILE, 5-29

Free Text, 4-3

How SQLI Translates VA FileMan Field Types into SQL Columns, 4-5

KEY\_WORD, 5-11

KF\_COMMENT, 5-15

KF\_DATA\_TYPE, 5-15

KF\_INT\_EXEC, 5-15

KF\_INT\_EXPR, 5-15

KF\_NAME, 5-15

Multiline Computed, 4-3, 7-3

Mumps, 4-3

Numeric, 4-3

OF\_COMMENT, 5-17

OF\_DATA\_TYPE, 5-17

OF\_EXT\_EXEC, 5-17

OF\_EXT\_EXPR, 5-17

OF\_NAME, 5-17

P\_COLUMN, 5-25, 5-26

P\_END\_IF, 5-25, 5-26

P\_ENDIF, 3-9

P\_KEY\_FORMAT, 5-26

P\_PRESELECT, 5-25

P\_ROW\_COUNT, 5-25, 7-1

P\_SEQUENCE, 3-2, 3-7, 3-8, 3-9, 3-10, 4-8, 5-25

P\_START\_AT, 3-8, 3-9, 5-25, 5-26

P\_START\_AT, 5-26

P\_START\_AT, 5-26

P\_TBL\_ELEMENT, 5-25, 5-26

PATIENT\_ID, 4-3

Pointer, 3-11, 3-13, 4-4, 5-17, 5-27, 7-1

S\_DESCRIPTION, 5-10

S\_NAME, 5-10

S\_SECURITY, 5-10

Set of Codes, 4-4, 5-17, 7-1

T\_COMMENT, 5-19

T\_FILE, 5-19

T\_GLOBAL, 3-10, 5-19

T\_MASTER\_TABLE, 4-7, 5-19

T\_NAME, 5-19

T\_ROW\_COUNT, 5-19, 7-1

T\_SCHEMA, 3-3, 5-19

T\_UPDATE, 5-19

T\_VERSION\_FM, 5-19

Types (VA FileMan), 4-2

Variable Pointer, 2-2, 3-11, 4-4

Word-processing, 2-2, 3-14, 4-6, 5-19

FieldS

DM\_INT\_EXPR, 3-12

Figures and Tables, ix

FILEMAN\_ERROR Field, 5-29

FILEMAN\_FIELD Field, 5-29

FILEMAN\_FILE Field, 5-29

Files

Asterisked, 7-2

Attributes *Not* Projected, 7-3

DA RETURN CODES (#3.22), 3-3, 3-4, 3-8

Definition Structures, 4-1

DIALOG (#.84), 5-29

NEW\_PERSON (#200), 3-13

Not in ^DIC, 7-3

PATIENT (#2), 4-2, 4-3, 4-7

References, 5-9

SQLI\_COLUMN (#1.5217), 3-2, 3-5, 3-6, 3-11, 3-12, 4-3, 4-4, 5-19, 5-21, 5-22, 5-23, 5-24, 5-25, 5-27

SQLI\_DATA\_TYPE (#1.5211), 3-12, 5-12, 5-14, 5-15, 5-17

SQLI\_DOMAIN (#1.5212), 3-11, 3-12, 5-12, 5-13, 5-14, 5-20

SQLI\_ERROR\_LOG (#1.52192), 5-28, 5-29, 7-2, 7-3

SQLI\_ERROR\_TEXT, 5-28

SQLI\_FOREIGN\_KEY (#1.5219), 3-5, 5-21, 5-27

SQLI\_KEY\_FORMAT (#1.5213), 4-8, 5-15, 5-26

SQLI\_KEY\_WORD (#1.52101), 2-4, 5-11, 6-1, 7-2

SQLI\_OUTPUT\_FORMAT (#1.5214), 3-11, 3-12, 5-13, 5-17, 5-24

SQLI\_PRIMARY\_KEY (#1.5218), 3-5, 3-7, 3-8, 3-9, 3-10, 5-21, 5-25, 5-26, 5-27

SQLI\_SCHEMA (#1.521), 5-10

SQLI\_SCHEMA File (#1.521), 3-3, 5-10, 5-19

SQLI\_TABLE (#1.5215), 3-3, 3-4, 3-8, 3-10, 5-13, 5-19, 5-20, 7-1

SQLI\_TABLE\_ELEMENT (#1.5216), 3-4, 3-5, 3-7, 3-8, 3-13, 5-20, 5-21, 5-24, 5-25, 5-26, 5-27

Find a Table Element's Column Entry, 3-6

Find the Primary Key for a Given Table, 3-7

Find the Projected Table for a File, 3-4

FM\_BOOLEAN Domain, 3-12

FM\_DATE Domain, 3-12

FM\_MOMENT Domain, 3-12

Foreign Keys, 3-5, 3-12, 3-13, 3-14, 4-4, 5-13, 5-27, 7-2

FORUM, iv

Free Text Fields, 4-3

G

Glossary, 1

Glossary (ISS)

Home Page Web Address, Glossary, 3

Guidelines

SQLI Mappers, 2-4

H

Help

At Prompts, xiv

Online, xiv

Home Pages

Adobe Acrobat Quick Guide Web Address, xv

Adobe Web Address, xv

Health Systems Design and Development (HSD&D) Web Address, xv

ISS Acronyms Home Page Web Address, Glossary, 3

ISS Glossary Home Page Web Address, Glossary, 3

SQLI Home Page Web Address, xv

VistA Documentation Library (VDL) Home Page Web Address, xv

How to

Obtain Technical Information Online, xiii

Use this Manual, xii

I

Identifier Naming Algorithms, 7-1

IEN Columns, 3-7, 4-3, 5-23

Implementation Notes, 7-2

Indexes

VA FileMan, 4-6

Information Provided by SQLI, 2-2

Insert

Operations, 7-2

SQL, 7-2

Internal VA FileMan Tables Not Projected, 7-3

Introduction, 1-1

ISS Acronyms

Home Page Web Address, Glossary, 3

ISS Glossary

Home Page Web Address, Glossary, 3

K

Kernel Compatibility, 2-5

KEY\_WORD Field, 5-11

Keys

Foreign, 3-12

Keywords, 5-11, 7-2

Populating, 2-4

KF\_COMMENT Field, 5-15

KF\_DATA\_TYPE Field, 5-15

KF\_INT\_EXEC Field, 5-15

KF\_INT\_EXPR Field, 5-15

KF\_NAME Field, 5-15

L

List File Attributes Option, xiv

M

Mappers

Building, 2-1

Guidelines, 2-4

Mapping

VA FileMan Fields to SQL Data Types, 4-3

Menus

Data Dictionary Utilities, xiv

Multiline Computed Fields, 4-3, 7-3

Multiple. *See Subfiles*

Mumps Fields, 4-3

N

Naming Algorithms, 7-1

NEW\_PERSON File (#200), 3-13

Non-regular Cross-references, 7-3

Notes

Implementation, 7-2

Numeric Fields, 4-3

O

Obtain Technical Information Online, How to, xiii

Obtaining Data Dictionary Listings, xiv

OF\_COMMENT Field, 5-17

OF\_DATA\_TYPE Field, 5-17

OF\_EXT\_EXEC Field, 5-17

OF\_EXT\_EXPR Field, 5-17

OF\_NAME Field, 5-17

Online

Documentation, xiv

Help Frames, xiv

Options

List File Attributes, xiv

ORDERING to Loop Through a File's Data Entries, 3-9

Organization of SQLI Information, 2-2

Orientation, xii

Other Issues, 7-1

Output Format Conversions (Base to External), 3-12

Output Transforms, 7-3

P

P\_COLUMN Field, 5-25, 5-26

P\_END\_IF, 3-9

P\_END\_IF Field, 5-25, 5-26

P\_ENDIF Field, 3-9

P\_KEY\_FORMAT Field, 5-26

P\_PRESELECT Field, 5-25

P\_ROW\_COUNT Field, 5-25, 7-1

P\_SEQUENCE Field, 3-2, 3-7, 3-8, 3-9, 3-10, 4-8, 5-25

P\_START\_AT, 3-9

P\_START\_AT Field, 3-8, 3-9, 5-25, 5-26

P\_TBL\_ELEMENT Field, 5-25, 5-26

Parent Foreign Keys, 3-14

Parsing the SQLI Projection, 3-1

Patches

Revisions, iv

PATIENT File (#2), 4-2, 4-3, 4-7

PATIENT\_ID Field, 4-3

Placeholders, 3-1

{B}, 3-2, 3-12, 4-4, 5-14, 5-18

{E}, 3-2

{I}, 3-2, 3-12, 5-14, 5-15

{K}, 3-8, 3-10, 4-7, 4-8, 5-15, 5-19, 5-24, 5-26

{K}, 3-2

{V}, 3-2, 5-24

Pointer Fields, 3-11, 3-13, 4-4, 5-17, 5-27, 7-1

Pointers

Dangling, 7-2

Variable, 7-3

Populating

Keywords, 2-4

SQLI\_KEY\_WORD File (#1.52101), 2-4

Primary Keys, 3-2, 3-5, 3-7, 3-8, 3-9, 3-7–3-9, 3-10, 3-14, 4-3, 4-8, 5-13, 5-15, 5-19, 5-25, 5-26, 5-27, 7-1, 7-2

For a Projected Subfile, 3-8

Processing Columns, 3-6

Processing Tables, 3-4

Programming SAC, 2-4, 2-5

Q

Question Mark Help, xiv

Quick Reference Card, A, 1

R

Reader, Assumptions About the, xiv

Record

Data Storage, 3-9

Locations, 3-10

Reference Materials, xv

Relational Model, 4-1

Retrieving Column Values, 3-11

Through a DBS Call, 3-11

Return Value Placeholder

{V}, 3-2

Revision History, iii

Documentation, iii

Patches, iv

S

S\_DESCRIPTION Field, 5-10

S\_NAME Field, 5-10

S\_SECURITY Field, 5-10

SAC

Programming, 2-5

Schemas, 3-3, 7-1

Set of Codes Fields, 4-4, 5-17, 7-1

SQL and VA FileMan Terminology, xiii

SQL Identifier Naming Algorithms, 7-1

SQL Training, xii

SQLI

Entity-Relationship Diagram, 2-3

Home Page Web Address, xv

Implementation Notes, 7-2

Information Provided, 2-2

Organization of Information, 2-2

Schemas, 7-1

SQLI Mapper

Building, 2-1

SQLI Mappers Guidelines, 2-4

SQLI\_COLUMN File (#1.5217), 3-2, 3-5, 3-6, 3-11, 3-12, 4-3, 4-4, 5-19, 5-21, 5-22, 5-23, 5-24, 5-25, 5-27

SQLI\_DATA\_TYPE File (#1.5211), 3-12, 5-12, 5-14, 5-15, 5-17

SQLI\_DOMAIN File (#1.5212), 3-11, 3-12, 5-12, 5-13, 5-14, 5-20

SQLI\_ERROR\_LOG File (#1.52192), 5-28, 5-29, 7-2, 7-3

SQLI\_ERROR\_TEXT, 5-28

SQLI\_FOREIGN\_KEY File (#1.5219), 3-5, 5-21, 5-27

SQLI\_KEY\_FORMAT File (#1.5213), 4-8, 5-15, 5-26

SQLI\_KEY\_WORD File (#1.52101), 2-4, 5-11, 6-1, 7-2

SQLI\_OUTPUT\_FORMAT File (#1.5214), 3-11, 3-12, 5-13, 5-17, 5-24

SQLI\_PRIMARY\_KEY File (#1.5218), 3-5, 3-7, 3-8, 3-9, 3-10, 5-21, 5-25, 5-26, 5-27

SQLI\_SCHEMA File (#1.521), 3-3, 5-10, 5-19

SQLI\_TABLE File (#1.5215), 3-3, 3-4, 3-8, 3-10, 5-13, 5-19, 5-20, 7-1

SQLI\_TABLE\_ELEMENT File (#1.5216), 3-4, 3-5, 3-7, 3-8, 3-13, 5-20, 5-21, 5-24, 5-25, 5-26, 5-27

Standards and Conventions, 2-4

Starting Point

SQLI\_SCHEMA File (#1.521), 3-3

STATS^DMSQS, 7-1

Subfiles, 3-7, 3-8, 3-9, 3-10, 3-13, 3-14, 4-2, 4-6, 5-19, 5-24, 5-25, 5-27

Summary

How SQLI Translates VA FileMan Field Types into SQL Columns, 4-5

Supported References, 6-1

Symbols Found in the Documentation, xii

Synchronization

DD, 2-4

T

T\_COMMENT Field, 5-19

T\_FILE Field, 5-19

T\_GLOBAL Field, 3-10, 5-19

T\_MASTER\_TABLE Field, 4-7, 5-19

T\_NAME Field, 5-19

T\_ROW\_COUNT Field, 5-19, 7-1

T\_SCHEMA Field, 3-3, 5-19

T\_UPDATE Field, 5-19

T\_VERSION\_FM Field, 5-19

Table Elements, 3-4

Tables

About Table Elements, 3-5

DA\_RETURN\_CODES, 3-6

Find a Table Element's Column Entry, 3-6

Find the Primary Key for a Given Table, 3-7

Finding the Projected Table for a File, 3-4

Internal VA FileMan Tables Not Projected, 7-3

Processing), 3-4

TaskMan guidelines, 2-5

Terminology

VA FileMan and SQL, xiii

Training

SQL, xii

Transforms

Output, 7-3

U

Update

Operations, 7-2

SQL, 7-2

URLs

Adobe Acrobat Quick Guide Web Address, xv

Adobe Home Page Web Address, xv

Health Systems Design and Development (HSD&D) Home Page Web Address, xv

Use this Manual, How to, xii

Using

Adobe Acrobat Reader, xv

The {B}, {E}, {I}, {K}, and {V} Placeholders, 3-1

V

VA Business Rules, 7-2

VA FileMan

Field Types, 4-2

Summary, 4-5

File Definition Structures, 4-1

Indexes, 4-6

SQL, 4-1

SQL Terminology, xiii

Subfiles (Multiples), 4-2

VA FileMan, SQL, and the Relational Model, 4-1

VA Programming Standards and Conventions, 2-4

Variable Pointer Fields, 2-2, 3-11, 4-4

Variable Pointers, 7-3

VistA Documentation Library (VDL)

Home Page Web Address, xv

W

Web Pages

Adobe Acrobat Quick Guide Web Address, xv

Adobe Home Page Web Address, xv

Health Systems Design and Development (HSD&D) Home Page Web Address, xv

ISS Acronyms Home Page Web Address, Glossary, 3

ISS Glossary Home Page Web Address, Glossary, 3

SQLI Home Page Web Address, xv

VistA Documentation Library (VDL) Home Page Web Address, xv

What is

SQLI?, 1-1

The Purpose of this Manual?, 1-1

VA FileMan, 1-1

Which Objects Are Processed Through Naming Algorithms, 7-2

Word-processing Fields, 2-2, 3-14, 4-6, 5-19