[MS-OVBA]:

Office VBA File Format Structure

Intellectual Property Rights Notice for Open Specifications Documentation

- **Technical Documentation.** Microsoft publishes Open Specifications documentation ("this documentation") for protocols, file formats, data portability, computer languages, and standards support. Additionally, overview documents cover inter-protocol relationships and interactions.
- **Copyrights**. This documentation is covered by Microsoft copyrights. Regardless of any other terms that are contained in the terms of use for the Microsoft website that hosts this documentation, you can make copies of it in order to develop implementations of the technologies that are described in this documentation and can distribute portions of it in your implementations that use these technologies or in your documentation as necessary to properly document the implementation. You can also distribute in your implementation, with or without modification, any schemas, IDLs, or code samples that are included in the documentation. This permission also applies to any documents that are referenced in the Open Specifications documentation.
- **No Trade Secrets**. Microsoft does not claim any trade secret rights in this documentation.
- **Patents**. Microsoft has patents that might cover your implementations of the technologies described in the Open Specifications documentation. Neither this notice nor Microsoft's delivery of this documentation grants any licenses under those patents or any other Microsoft patents. However, a given Open Specifications document might be covered by the Microsoft Open Specifications Promise or the Microsoft Community Promise. If you would prefer a written license, or if the technologies described in this documentation are not covered by the Open Specifications Promise or Community Promise, as applicable, patent licenses are available by contacting iplg@microsoft.com.
- **License Programs**. To see all of the protocols in scope under a specific license program and the associated patents, visit the Patent Map.
- **Trademarks**. The names of companies and products contained in this documentation might be covered by trademarks or similar intellectual property rights. This notice does not grant any licenses under those rights. For a list of Microsoft trademarks, visit www.microsoft.com/trademarks.
- **Fictitious Names**. The example companies, organizations, products, domain names, email addresses, logos, people, places, and events that are depicted in this documentation are fictitious. No association with any real company, organization, product, domain name, email address, logo, person, place, or event is intended or should be inferred.

Reservation of Rights. All other rights are reserved, and this notice does not grant any rights other than as specifically described above, whether by implication, estoppel, or otherwise.

Tools. The Open Specifications documentation does not require the use of Microsoft programming tools or programming environments in order for you to develop an implementation. If you have access to Microsoft programming tools and environments, you are free to take advantage of them. Certain Open Specifications documents are intended for use in conjunction with publicly available standards specifications and network programming art and, as such, assume that the reader either is familiar with the aforementioned material or has immediate access to it.

Support. For questions and support, please contact dochelp@microsoft.com.

Revision Summary

Date	Revision History	Revision Class	Comments
6/27/2008	1.0	New	Initial Availability
8/15/2008	1.01	Editorial	Revised and edited the technical content
1/16/2009	1.02	Editorial	Revised and edited the technical content
7/13/2009	1.03	Major	Changes made for template compliance
8/28/2009	1.04	Editorial	Revised and edited the technical content
11/6/2009	1.05	Editorial	Revised and edited the technical content
2/19/2010	2.0	Minor	Updated the technical content
3/31/2010	2.01	Editorial	Revised and edited the technical content
4/30/2010	2.02	Editorial	Revised and edited the technical content
6/7/2010	2.03	Editorial	Revised and edited the technical content
6/29/2010	2.04	Editorial	Changed language and formatting in the technical content.
7/23/2010	2.04	None	No changes to the meaning, language, or formatting of the technical content.
9/27/2010	2.04	None	No changes to the meaning, language, or formatting of the technical content.
11/15/2010	2.05	Editorial	Changed language and formatting in the technical content.
12/17/2010	2.05	None	No changes to the meaning, language, or formatting of the technical content.
3/18/2011	2.05	None	No changes to the meaning, language, or formatting of the technical content.
6/10/2011	2.05	None	No changes to the meaning, language, or formatting of the technical content.
1/20/2012	2.6	Minor	Clarified the meaning of the technical content.
4/11/2012	2.6	None	No changes to the meaning, language, or formatting of the technical content.
7/16/2012	2.6	None	No changes to the meaning, language, or formatting of the technical content.
10/8/2012	2.7	Minor	Clarified the meaning of the technical content.
2/11/2013	2.7.1	Editorial	Changed language and formatting in the technical content.
7/30/2013	2.7.1	None	No changes to the meaning, language, or formatting of the technical content.
11/18/2013	2.7.1	None	No changes to the meaning, language, or formatting of the technical content.
2/10/2014	2.7.1	None	No changes to the meaning, language, or formatting of the technical content.

Date	Revision History	Revision Class	Comments
4/30/2014	3.0	Major	Significantly changed the technical content.
7/31/2014	3.1	Minor	Clarified the meaning of the technical content.
10/30/2014	3.2	Minor	Clarified the meaning of the technical content.
3/16/2015	4.0	Major	Significantly changed the technical content.
9/4/2015	4.1	Minor	Clarified the meaning of the technical content.
7/15/2016	4.1	None	No changes to the meaning, language, or formatting of the technical content.
9/14/2016	4.1	None	No changes to the meaning, language, or formatting of the technical content.
6/20/2017	4.2	Minor	Clarified the meaning of the technical content.
9/19/2017	5.0	Major	Significantly changed the technical content.
12/12/2017	5.1	Minor	Clarified the meaning of the technical content.

Table of Contents

1 Introduction 8
1.1 Glossary 8
1.2 References 11
1.2.1 Normative References 11
1.2.2 Informative References 11
1.3 Structure Overview (Synopsis) 12
1.3.1 Project Information 12
1.3.2 Project References 12
1.3.3 Project Items 12
1.3.4 Byte Ordering 13
1.4 Relationship to Protocols and Other Structures 13
1.5 Applicability Statement 14
1.6 Versioning and Localization 14
1.7 Vendor-Extensible Fields 14

2 Structures 15
2.1 Conventions 15
2.1.1 ABNF Rules 15
2.1.1.1 Common ABNF Rules 15
2.1.1.2 ANYCHAR 15
2.1.1.3 EQ 15
2.1.1.4 FLOAT 15
2.1.1.5 GUID 16
2.1.1.6 HEXINT32 16
2.1.1.7 INT32 16
2.1.1.8 LibidReference 16
2.1.1.9 ModuleIdentifier 17
2.1.1.10 NWLN 17
2.1.1.11 PATH 17
2.1.1.12 ProjectReference 17
2.1.1.13 QUOTEDCHAR 18
2.1.1.14 VBABOOL 18
2.1.1.15 VbaIdentifier 18
2.1.2 Pseudocode 18
2.2 File Structure 19
2.2.1 Project Root Storage 19
2.2.2 VBA Storage 19
2.2.3 _VBA_PROJECT Stream 20
2.2.4 dir Stream 20
2.2.5 Module Stream 20
2.2.6 SRP Streams 20
2.2.7 PROJECT Stream 20
2.2.8 PROJECTwm Stream 20
2.2.9 PROJECTlk Stream 20
2.2.10 Designer Storages 20
2.2.11 VBFrame Stream 21
2.3 Record Types 21
2.3.1 PROJECT Stream: Project Information 21
2.3.1.1 ProjectProperties 21
2.3.1.2 ProjectId 21
2.3.1.3 ProjectModule 22
2.3.1.4 ProjectDocModule 22
2.3.1.5 ProjectStdModule 22
2.3.1.6 ProjectClassModule 22
2.3.1.7 ProjectDesignerModule 22

2.3.1.8 ProjectPackage 23
2.3.1.9 ProjectHelpFile 23
2.3.1.10 ProjectExeName32 23
2.3.1.11 ProjectName 23
2.3.1.12 ProjectHelpId 23
2.3.1.13 ProjectDescription 24
2.3.1.14 ProjectVersionCompat32 24
2.3.1.15 ProjectProtectionState 24
2.3.1.16 ProjectPassword 25
2.3.1.17 ProjectVisibilityState 25
2.3.1.18 HostExtenders 26
2.3.1.19 ProjectWorkspace 26
2.3.1.20 ProjectWindowRecord 27
2.3.2 PROJECTlk Stream: ActiveX Control Information 28
2.3.2.1 LICENSEINFO Record 28
2.3.3 PROJECTwm Stream: Module Name Information 29
2.3.3.1 NAMEMAP Record 29
2.3.4 VBA Storage: Visual Basic for Applications Project Information 29
2.3.4.1 _VBA_PROJECT Stream: Version Dependent Project Information 29
2.3.4.2 dir Stream: Version Independent Project Information 30
2.3.4.2.1 PROJECTINFORMATION Record 31
2.3.4.2.1.1 PROJECTSYSKIND Record 32
2.3.4.2.1.2 PROJECTLCID Record 33
2.3.4.2.1.3 PROJECTLCIDINVOKE Record 33
2.3.4.2.1.4 PROJECTCODEPAGE Record 33
2.3.4.2.1.5 PROJECTNAME Record 34
2.3.4.2.1.6 PROJECTDOCSTRING Record 34
2.3.4.2.1.7 PROJECTHELPFILEPATH Record 35
2.3.4.2.1.8 PROJECTHELPCONTEXT Record 36
2.3.4.2.1.9 PROJECTLIBFLAGS Record 36
2.3.4.2.1.10 PROJECTVERSION Record 36
2.3.4.2.1.11 PROJECTCONSTANTS Record 37
2.3.4.2.2 PROJECTREFERENCES Record 38
2.3.4.2.2.1 REFERENCE Record 38
2.3.4.2.2.2 REFERENCENAME Record 38
2.3.4.2.2.3 REFERENCECONTROL Record 39
2.3.4.2.2.4 REFERENCEORIGINAL Record 41
2.3.4.2.2.5 REFERENCEREGISTERED Record 42
2.3.4.2.2.6 REFERENCEPROJECT Record 42
2.3.4.2.3 PROJECTMODULES Record 43
2.3.4.2.3.1 PROJECTCOOKIE Record 44
2.3.4.2.3.2 MODULE Record 44
2.3.4.2.3.2.1 MODULENAME Record 46
2.3.4.2.3.2.2 MODULENAMEUNICODE Record 46
2.3.4.2.3.2.3 MODULESTREAMNAME Record 46
2.3.4.2.3.2.4 MODULEDOCSTRING Record 47
2.3.4.2.3.2.5 MODULEOFFSET Record 48
2.3.4.2.3.2.6 MODULEHELPCONTEXT Record 48
2.3.4.2.3.2.7 MODULECOOKIE Record 49
2.3.4.2.3.2.8 MODULETYPE Record 49
2.3.4.2.3.2.9 MODULEREADONLY Record 49
2.3.4.2.3.2.10 MODULEPRIVATE Record 49
2.3.4.3 Module Stream: Visual Basic Modules 50
2.3.5 VBFrame Stream: Designer Information 50
2.3.5.1 DesignerProperties 51
2.3.5.2 DesignerCaption 51
2.3.5.3 DesignerHeight 51
2.3.5.4 DesignerLeft 52

2.3.5.5 DesignerTop 52
2.3.5.6 DesignerWidth 52
2.3.5.7 DesignerEnabled 52
2.3.5.8 DesignerHelpContextId 52
2.3.5.9 DesignerRTL 52
2.3.5.10 DesignerShowModal 53
2.3.5.11 DesignerStartupPosition 53
2.3.5.12 DesignerTag 53
2.3.5.13 DesignerTypeInfoVer 53
2.3.5.14 DesignerVisible 54
2.3.5.15 DesignerWhatsThisButton 54
2.3.5.16 DesignerWhatsThisHelp 54
2.4 Algorithms 54
2.4.1 Compression and Decompression 54
2.4.1.1 Structures 55
2.4.1.1.1 CompressedContainer 55
2.4.1.1.2 DecompressedBuffer 55
2.4.1.1.3 DecompressedChunk 56
2.4.1.1.4 CompressedChunk 56
2.4.1.1.5 CompressedChunkHeader 56
2.4.1.1.6 CompressedChunkData 57
2.4.1.1.7 TokenSequence 57
2.4.1.1.8 CopyToken 58
2.4.1.2 State Variables 59
2.4.1.3 Algorithms 59
2.4.1.3.1 Decompression Algorithm 59
2.4.1.3.2 Decompressing a CompressedChunk 60
2.4.1.3.3 Decompressing a RawChunk 60
2.4.1.3.4 Decompressing a TokenSequence 61
2.4.1.3.5 Decompressing a Token 61
2.4.1.3.6 Compression algorithm 62
2.4.1.3.7 Compressing a DecompressedChunk 62
2.4.1.3.8 Compressing a TokenSequence 63
2.4.1.3.9 Compressing a Token 64
2.4.1.3.10 Compressing a RawChunk 65
2.4.1.3.11 Byte Copy 65
2.4.1.3.12 Extract CompressedChunkSize 66
2.4.1.3.13 Pack CompressedChunkSize 66
2.4.1.3.14 Pack CompressedChunkSignature 66
2.4.1.3.15 Extract CompressedChunkFlag 67
2.4.1.3.16 Pack CompressedChunkFlag 67
2.4.1.3.17 Extract FlagBit 67
2.4.1.3.18 Set FlagBit 67
2.4.1.3.19 CopyToken Algorithms 68
2.4.1.3.19.1 CopyToken Help 68
2.4.1.3.19.2 Unpack CopyToken 69
2.4.1.3.19.3 Pack CopyToken 69
2.4.1.3.19.4 Matching 70
2.4.2 Contents Hash 71
2.4.3 Data Encryption 73
2.4.3.1 Encrypted Data Structure 73
2.4.3.2 Encryption 74
2.4.3.3 Decryption 76
2.4.4 Password Hash 77
2.4.4.1 Password Hash Data Structure 77
2.4.4.2 Encode Nulls 79
2.4.4.3 Decode Nulls 79
2.4.4.4 Password Hash Algorithm 80

2.4.4.5 Password Hash Validation 80
3 Structure Examples 82
3.1 VBA Storage Information Example 82
3.1.1 _VBA_PROJECT Example 82
3.1.2 dir Stream Example 82
3.1.2.1 Project Information Example 82
3.1.2.2 Project Reference Information Example 85
3.1.2.3 Module Information Example 91
3.1.2.3.1 PROJECT MODULES Example 91
3.1.2.3.2 Module Record Examples 92
3.1.2.3.2.1 ThisWorkbook Document Module Record Example 92
3.1.2.3.2.2 Sheet1 Document Module Record Example 94
3.1.2.3.2.3 UserForm1 Designer Module Record Example 96
3.1.3 ThisWorkbook Decompressed Module Stream Example 97
3.1.4 Sheet1 Decompressed Module Stream Example 98
3.1.5 UserForm1 Decompressed Module Stream Example 98
3.1.6 PROJECT Stream Example 99
3.1.7 VBFrame Stream Example 102
3.2 Compression/Decompression Examples 103
3.2.1 No Compression Example 103
3.2.2 Normal Compression Example 103
3.2.3 Maximum Compression Example 104
4 Security Considerations 105
4.1 Project Integrity Verification 105
4.2 Encryption Method 105
5 Appendix A: Product Behavior 106
6 Change Tracking 108
7 Index 109

1 Introduction

This document specifies the Office VBA File Format Structure. This file format applies to VBA projects. VBA projects are a collection of embedded macros and custom forms for use in Office documents that can be used to extend a host application to provide custom behavior. This specification describes a storage that contains a VBA project.

Sections 1.7 and 2 of this specification are normative. All other sections and examples in this specification are informative.

1.1 Glossary

This document uses the following terms:

absolute path: A string that identifies the location of a file and that begins with a drive identifier and root directory or network share and ends with the complete file name. Examples are C:\Documents\Work\example.txt and \\netshare\Documents\Work\example.txt.

ActiveX control: A reusable software control, such as a check box or button, that uses ActiveX technology and provides options to users or runs macros or scripts that automate a task. See also ActiveX object.

ActiveX control library: A collection of controls that incorporate ActiveX technology and can be called by a Microsoft Visual Basic for Applications (VBA) project.

aggregatable server: A COM server that can be contained by another COM server and can allow its interfaces to be used as if they were defined by the containing server.

Automation server: An application that enables its objects, methods, and properties to be controlled by other applications through OLE Automation.

Automation type library: A file or a component within a file that contains OLE Automation standard descriptions of exposed objects, properties, and methods for an application.

big-endian: Multiple-byte values that are byte-ordered with the most significant byte stored in the memory location with the lowest address.

class identifier (CLSID): A **GUID** that identifies a software component; for instance, a DCOM object class or a COM class.

class module: A module that contains the definition for a new object. Each instance of a class creates a new object, and procedures that are defined in the module become properties and methods of the object.

code page: An ordered set of characters of a specific script in which a numerical index (code-point value) is associated with each character. Code pages are a means of providing support for character sets and keyboard layouts used in different countries. Devices such as the display and keyboard can be configured to use a specific code page and to switch from one code page (such as the United States) to another (such as Portugal) at the user's request.

compilation constant: A Microsoft Visual Basic identifier that is defined by using the #Const compiler directive or defined in the host application, and then used by other compiler directives to determine when or if certain blocks of Visual Basic code are compiled.

designer: A visual design surface for adding and arranging controls on a user form and writing code for those controls.

designer module: A VBA module that extends the methods and properties of an ActiveX control that has been registered with the project.

digest: The fixed-length output string from a one-way hash function that takes a variable-length input string and is probabilistically unique for every different input string. Also, a cryptographic checksum of a data (octet) stream.

document module: A type of VBA project item that specifies a module for embedded macros and programmatic access operations that are associated with a document.

embedded macro: A macro that is saved with a document.

extended type library: A component that contains Automation standard descriptions of exposed objects, properties, and methods that are implemented by an **aggregatable server** and supplemented by another **Automation server**.

floating-point number: A number that is represented by a mantissa and an exponent according to a given base. The mantissa is typically a value between "0" and "1". To find the value of a floating-point number, the base is raised to the power of the exponent, and the mantissa is multiplied by the result.

globally unique identifier (GUID): A term used interchangeably with universally unique identifier (UUID) in Microsoft protocol technical documents (TDs). Interchanging the usage of these terms does not imply or require a specific algorithm or mechanism to generate the value. Specifically, the use of this term does not imply or require that the algorithms described in [RFC4122] or [C706] must be used for generating the **GUID**. See also universally unique identifier (UUID).

hash: A fixed-size result that is obtained by applying a one-way mathematical function, which is sometimes referred to as a hash algorithm, to an arbitrary amount of data. If the input data changes, the hash also changes. The hash can be used in many operations, including authentication and digital signing.

Help file: A file that contains the documentation for a specific product or technology.

Help topic identifier: A unique identifier for an article that contains Help content.

host extender: An Automation type that is provided by a host application to extend the functionality of an **Automation server**.

language code identifier (LCID): A 32-bit number that identifies the user interface human language dialect or variation that is supported by an application or a client computer.

license key: An array of bytes that enables access to a control according to the usage policies for that control.

little-endian: Multiple-byte values that are byte-ordered with the least significant byte stored in the memory location with the lowest address.

module: A collection of routines and data structures that performs a specific task or implements a specific abstract data type. Modules usually consist of two parts, a module header and a module body. A module header is a set of name/value attribute pairs that specify the linguistic characteristics of the module. A module body is the VBA source code, a set of declarations followed by procedures. VBA supports two types of modules, **procedural modules** and class modules.

multibyte character set (MBCS): An alternative to **Unicode** for supporting character sets, like Japanese and Chinese, that cannot be represented in a single byte. Under MBCS, characters are encoded in either one or two bytes. In two-byte characters, the first byte, or "lead" byte, signals that both it and the following byte are to be interpreted as one character. The first byte comes from a range of codes reserved for use as lead bytes. Which ranges of bytes can be lead bytes depends on the **code page** in use. For example, Japanese **code page** 932 uses the range 0x81 through 0x9F as lead bytes, but Korean **code page** 949 uses a different range.

OLE compound file: A form of structured storage, as described in [MS-CFB]. A compound file allows independent storages and streams to exist within a single file.

parent window: A primary window that provides window management functionality for a set of child windows.

procedural module: A collection of subroutines and functions.

project package: An item in a VBA project that specifies a Designer class that can be extended in a designer module.

reference: A link in a project to another project, a .NET Framework assembly, or a compatible Component Object Model (COM) library. Adding a reference to a project enables use of the referenced item in a project, but does not copy it to the current project folder.

relative path: A path that is implied by the active working directory or is calculated based on a specified directory. If users enter a command that refers to a file and the full path is not entered, the active working directory is the relative path of the referenced file.

right-to-left: A reading and display order that is optimized for right-to-left languages.

run length encoding: A lossless compression method that replaces a contiguous series (run) of identical values in a data stream with a pair of values that represent the length of the series and the value itself. For example, a data stream that contains 57 consecutive entries with the value "10" could replace them all with the shorter pair of values "57", "10".

SHA-1: An algorithm that generates a 160-bit hash value from an arbitrary amount of input data, as described in [RFC3174]. SHA-1 is used with the Digital Signature Algorithm (DSA) in the Digital Signature Standard (DSS), in addition to other algorithms and standards.

storage: An element of a compound file that is a unit of containment for one or more storages and streams, analogous to directories in a file system, as described in [MS-CFB].

stream: An element of a compound file, as described in [MS-CFB]. A stream contains a sequence of bytes that can be read from or written to by an application, and they can exist only in storages.

twiddled type library: A modified **Automation type library** in which all controls are marked as extensible. A twiddled type library is generated automatically by the Visual Basic Editor when a user adds one or more controls to a document.

twip: A unit of measurement that is used in typesetting and desktop publishing. It equals one-twentieth of a printer's point, or 1/1440 of an inch.

Unicode: A character encoding standard developed by the Unicode Consortium that represents almost all of the written languages of the world. The **Unicode** standard [UNICODE5.0.0/2007] provides three forms (UTF-8, UTF-16, and UTF-32) and seven schemes (UTF-8, UTF-16, UTF-16 BE, UTF-16 LE, UTF-32, UTF-32 LE, and UTF-32 BE).

UTF-16: A standard for encoding Unicode characters, defined in the Unicode standard, in which the most commonly used characters are defined as double-byte characters. Unless specified otherwise, this term refers to the UTF-16 encoding form specified in [UNICODE5.0.0/2007] section 3.9.

VBA environment: An execution context that can host multiple VBA projects simultaneously and can be used to run those projects and source code, and track code dependencies.

VBA host application: An application that supports a VBA interpreter and can therefore run macros that are written in the VBA language.

VBA identifier: A VBA language token that is used to identify the name of an entity, such as a class, module, project, property, field, or variable.

VBA project: A collection of the modules, class modules, and user forms that are needed to create an application. Modules, class modules, and user forms can be imported into and exported from a project.

Visual Basic for Applications (VBA): A macro-based programming language that derives from Visual Basic and can be used to customize and extend an application. Unlike Visual Basic, VBA code and macros can be run only from within a host application that supports VBA.

MAY, SHOULD, MUST, SHOULD NOT, MUST NOT: These terms (in all caps) are used as defined in [RFC2119]. All statements of optional behavior use either MAY, SHOULD, or SHOULD NOT.

1.2 References

Links to a document in the Microsoft Open Specifications library point to the correct section in the most recently published version of the referenced document. However, because individual documents in the library are not updated at the same time, the section numbers in the documents may not match. You can confirm the correct section numbering by checking the Errata.

1.2.1 Normative References

We conduct frequent surveys of the normative references to assure their continued availability. If you have any issue with finding a normative reference, please contact dochelp@microsoft.com. We will assist you in finding the relevant information.

[C706] The Open Group, "DCE 1.1: Remote Procedure Call", C706, August 1997, https://www2.opengroup.org/ogsys/catalog/c706

[MS-CFB] Microsoft Corporation, "Compound File Binary File Format".

[MS-OAUT] Microsoft Corporation, "OLE Automation Protocol".

[MS-OFORMS] Microsoft Corporation, "Office Forms Binary File Formats".

[MS-VBAL] Microsoft Corporation, "VBA Language Specification".

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997, http://www.rfc-editor.org/rfc/rfc2119.txt

[RFC3174] Eastlake III, D., and Jones, P., "US Secure Hash Algorithm 1 (SHA1)", RFC 3174, September 2001, http://www.ietf.org/rfc/rfc3174.txt

[RFC4234] Crocker, D., Ed., and Overell, P., "Augmented BNF for Syntax Specifications: ABNF", RFC 4234, October 2005, http://www.rfc-editor.org/rfc/rfc4234.txt

1.2.2 Informative References

[MC-CPB] Microsoft Corporation, "Code Page Bitfields", http://msdn.microsoft.com/en-us/library/dd317754.aspx

[MS-DOC] Microsoft Corporation, "Word (.doc) Binary File Format".

[MS-OSHARED] Microsoft Corporation, "Office Common Data Types and Objects Structures".

[MS-XLSB] Microsoft Corporation, "Excel (.xlsb) Binary File Format".

[MS-XLS] Microsoft Corporation, "Excel Binary File Format (.xls) Structure".

1.3 Structure Overview (Synopsis)

This file format defines an instance of a **VBA project**. The file format structure is a collection of records that define the VBA project. Each record defines part of one of three aspects of the project: project information, project **references**, and project items.

1.3.1 Project Information

Records providing project information about the **VBA project** itself are contained within the following five **streams**:

- The _VBA_PROJECT Stream (section 2.3.4.1) provides basic information about the VBA project, including the version information required to load the remainder of the structure.
- Project Information (section 2.3.4.2.1) in the dir Stream (section 2.3.4.2) contains information such as the name of the VBA project and help information.
- Project Properties (section 2.3.1.1) in the PROJECT Stream (section 2.3.1) contain additional information about the VBA project.
- The PROJECTwm Stream (section 2.3.3) contains information for mapping **module** names between **multibyte character set (MBCS)** and **UTF-16**.
- The PROJECTlk Stream (section 2.3.2) contains information about **ActiveX controls** used throughout the VBA project.

1.3.2 Project References

Records within Reference Information (section 2.3.4.2.2) in the dir Stream (section 2.3.4.2) define **references** to external resources that are used by the **VBA project**. Each **REFERENCE** (section 2.3.4.2.2.1) in Reference Information (section 2.3.4.2.2) corresponds to a reference to an external resource that can interact via OLE Automation as described in [MS-OAUT].

The three types of external references are as follows:

- A **REFERENCECONTROL** (section 2.3.4.2.2.3) specifies a reference to external **ActiveX controls** that are used by the VBA project.
- A **REFERENCEREGISTERED** (section 2.3.4.2.2.5) specifies a reference to external **Automation type libraries** that are used by the VBA project.
- A **REFERENCEPROJECT** (section 2.3.4.2.2.6) specifies a reference to external VBA projects that are used by the VBA project.

1.3.3 Project Items

The **VBA project** contains a series of project items for **embedded macros**. Each project item is defined by a combination of records. The five types of project items are as follows:

- A **project package** specifies a **designer** class that can be extended in a **designer module**.
- A **document module** specifies a **module** for embedded macros and programmatic access associated with a document.
    - A **procedural module** specifies a module for embedded macros.

- A **class module** that specifies a module that defines a class.
- A designer module specifies a module for extending a designer.

The **PROJECT** Stream (section 2.3.1) provides the type of every project item.

Document modules, procedural modules, class modules, and designer modules are items that can contain source code as described in [MS-VBAL] section 4.2 and other user-configurable settings. Within the dir Stream (section 2.3.4.2), a **MODULE** Record (section 2.3.4.2.3.2) exists for each such project item, where the **MODULENAME** (section 2.3.4.2.3.2.1) is the same as each **<ModuleIdentifier>** in the **PROJECT** Stream (section 2.3.1).

ProjectDesignerModule (section 2.3.1.7) specifies a project item that extends a designer. In addition to the source code, a Designer Storage (section 2.2.10) named **MODULESTREAMNAME** (section 2.3.4.2.3.2.3) will be present in the Project Root Storage (section 2.2.1) which contains additional, designer-specific information about the project item. The **VBFrame** Stream (section 2.3.5) specifies the **VBA**-specific information about the designer.

1.3.4 Byte Ordering

Some computer architectures number bytes in a binary word from left to right, which is referred to as **big-endian**. The byte numbering used for packet diagrams in this specification is big-endian. Other architectures number the bytes in a binary word from right to left, which is referred to as **little-endian**. The byte numbering used for enumerations, objects, and records in this specification is little-endian.

Using big-endian and little-endian methods, the number 0x12345678 would be stored as shown in the following table:

Byte order	Byte 0	Byte 1	Byte 2	Byte 3
Big-endian	0x12	0x34	0x56	0x78
Little-endian	0x78	0x56	0x34	0x12

1.4 Relationship to Protocols and Other Structures

This file format specifies several streams and storages in an **OLE compound file** as described in [MS-CFB]. It is related to the structures defined in the following references:

- [MS-DOC] includes an application of Microsoft® Visual Basic® for Applications (**VBA**) for **embedded macros**.
- [MS-XLS] includes an application of VBA for embedded macros.
- [MS-XLSB] includes an application of VBA for embedded macros.
- [MS-OSHARED] contains an application of the hashing algorithm specified in section 2.4.2 for securing VBA for embedded macros.
- [MS-OFORMS] specifies **ActiveX controls** that can be embedded in VBA as **designers**.
- OLE Automation Protocol, as described in [MS-OAUT], that can be used to execute embedded macros in VBA.

- The VBA language, as described in [MS-VBAL], specifies the source code language that is used for embedded macros in this format.

1.5 Applicability Statement

This document specifies a persistence format for **embedded macros** within a host document, and is not appropriate for stand-alone use. Embedded macros permit programmatic customization for the applications that use this structure.

This persistence format provides interoperability with applications that create or read documents conforming to this structure<1>.

1.6 Versioning and Localization

This document covers versioning issues in the following areas:

- **Structure Versions:** There is only one version of the Office VBA File Format Structure.
- **Localization:** This structure defines no locale-specific processes or data.

This file format contains performance caches that are not interoperable between versions. A version identifier (_VBA_PROJECT_Stream.Version, section 2.2.3) is defined to keep track of the exact version that saved a **VBA project**. When this version number matches the version used by Office, performance caches, specified by _VBA_PROJECT.PerformanceCache (section 2.2.3), SRP Streams (section 2.2.6), and Module Stream.PeformanceCache (section 2.3.4.3), will be used instead of the interoperable representation within the file. To be interoperable, this version number MUST be set to 0xFFFF so that performance caches are ignored.

1.7 Vendor-Extensible Fields

This file format provides a mechanism for vendor extension through custom **designers**. For details on using designers, see VBFrame Stream (section 2.3.5). No mechanism is provided for generating a unique **class identifier (CLSID)** for a designer.

2 Structures

2.1 Conventions

This section uses the following conventions and common definitions for pseudocode and ABNF rule definitions.

2.1.1 ABNF Rules

This section specifies ABNF rules common throughout section 2.

2.1.1.1 Common ABNF Rules

The following ABNF rules are used by section 2 and are included for reference. For more information, see [RFC4234] Appendix B.

ABNF Syntax:

```
CR     = %x0D

DIGIT  = %x30-39

DQUOTE = %x22

HEXDIG = DIGIT / "A" / "B" / "C" / "D" / "E" / "F"

HTAB   = %x09

LF     = %x0A

SP     = %x20

VCHAR  = %x21-7E

WSP    = SP / HTAB
```

2.1.1.2 ANYCHAR

Specifies any character value that is not a carriage-return, line-feed, or null.

ABNF syntax:

```
ANYCHAR = %x01-09 / %x0B / %x0C / %x0E-FF
```

2.1.1.3 EQ

Defines syntax for separating a property name from a value.

ABNF syntax:

```
EQ = *WSP "=" *WSP
```

2.1.1.4 FLOAT

Specifies a **floating-point number**.

ABNF syntax:

```
FLOAT = [SIGN] ( ( 1*DIGIT "."  1*DIGIT [EXP] ) /
        ( "."  1*DIGIT [EXP] ) /
        ( 1*DIGIT ["."] [EXP] ) )

EXP   = "e"  [SIGN]  1*DIGIT

SIGN  = "+"  / "-"
```

2.1.1.5 GUID

Specifies a **GUID**.

ABNF syntax:

```
GUID = "{" 8HEXDIG "-" 4HEXDIG "-" 4HEXDIG "-" 4HEXDIG "-" 12HEXDIG "}"
```

2.1.1.6 HEXINT32

Specifies a hexadecimal-encoded signed integer. MUST be between −2147483648 and 2147483647.

ABNF syntax:

```
HEXINT32 = "&H" 8HEXDIG
```

2.1.1.7 INT32

Specifies a signed integer. MUST be between −2147483648 and 2147483647.

ABNF syntax:

```
INT32 = ["-"] 1*DIGIT
```

2.1.1.8 LibidReference

Specifies the identifier of an **Automation type library**.

ABNF syntax:

```
LibidReference     = "*\" LibidReferenceKind LibidGuid
                     "#" LibidMajorVersion "." LibidMinorVersion
                     "#" LibidLcid
                     "#" LibidPath
                     "#" LibidRegName

LibidReferenceKind = %x47 / %x48

LibidGuid          = GUID

LibidMajorVersion  = 1*4HEXDIG

LibidMinorVersion  = 1*4HEXDIG

LibidLcid          = 1*8HEXDIG
```

```
LibidPath          = *(%x01-22 / %x24-FF)

LibidRegName       = *255(%x01-FF)
```

<LibidReferenceKind>:

Value	Meaning
%x47	<LibidPath> specifies a Windows file path.
%x48	<LibidPath> specifies a Macintosh path.

<LibidGuid>: The **GUID** of the Automation type library.

<MajorVersion>: An unsigned integer that specifies the major version of the Automation type library.

<LibidMinorVersion>: An unsigned integer that specifies the minor version of the Automation type library.

<LibidLcid>: The **LCID** of the Automation type library.

<LibidPath>: The path to the Automation type library.

<LibidRegName>: The Automation type library's display name.

2.1.1.9 ModuleIdentifier

Specifies the name of a **module**. SHOULD be an identifier as specified by [MS-VBAL] section 3.3.5. MAY<2> be any string of characters. MUST be less than or equal to 31 characters long.

2.1.1.10 NWLN

Specifies a new line.

ABNF syntax:

```
NWLN = (CR LF) / (LF CR)
```

2.1.1.11 PATH

An array of characters that specifies a path to a file. MUST be less than 260 characters.

ABNF syntax:

```
PATH = DQUOTE *259QUOTEDCHAR DQUOTE
```

2.1.1.12 ProjectReference

Specifies the identifier of a **VBA project**.

ABNF syntax:

```
ProjectReference = "*\" ProjectKind ProjectPath
```

```
ProjectKind      = %x41-44

ProjectPath      = *(%x01-FF)
```

<ProjectKind>:

Value	Meaning
%x41	The referenced VBA project is standalone and <ProjectPath> specifies a Windows file path.
%x42	The referenced VBA project is standalone and <ProjectPath> specifies a Macintosh path.
%x43	The referenced VBA project is embedded and <ProjectPath> specifies a Windows file path.
%x44	The referenced VBA project is embedded and <ProjectPath> specifies a Macintosh path.

<ProjectPath>: The path to the VBA project.

2.1.1.13 QUOTEDCHAR

Specifies a single character.

ABNF syntax:

```
QUOTEDCHAR = WSP / NQCHAR / ( DQUOTE DQUOTE )

NQCHAR     = %x21 / %x23-FF
```

<DQUOTE DQUOTE>: Specifies a single double-quotation (") character.

2.1.1.14 VBABOOL

Specifies a Boolean value.

Value	Meaning
"0"	FALSE
"-1"	TRUE

ABNF syntax:

```
VBABOOL = "0" / "-1"
```

2.1.1.15 VbaIdentifier

Specifies a VBA Language identifier as specified by [MS-VBAL] section 3.3.5.

2.1.2 Pseudocode

All array indexing in pseudocode in this document is zero-based.

2.2 File Structure

Specifies a **VBA project** and contained project items. All data is stored in a structured storage as specified in [MS-CFB]. The **storages** and **streams** MUST be organized according to a hierarchy rooted at the Project Root Storage (section 2.2.1) as depicted in the following figure.

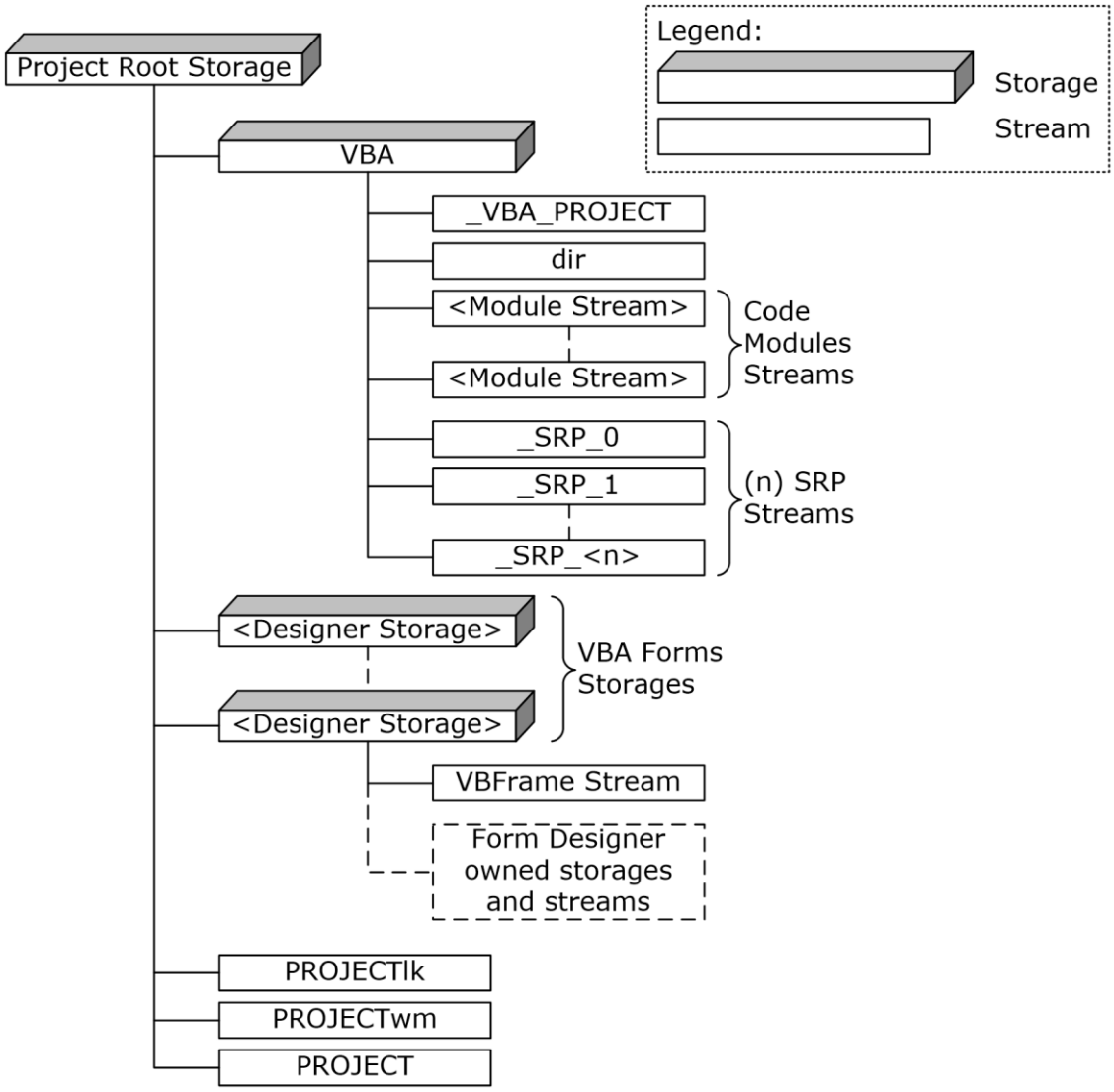


Figure 1: VBA storage hierarchy

2.2.1 Project Root Storage

A single root **storage**. MUST contain VBA Storage (section 2.2.2) and PROJECT Stream (section 2.2.7). Optionally contains **PROJECTwm** Stream (section 2.2.8), **PROJECTlk** Stream (section 2.2.9), and Designer Storages (section 2.2.10).

2.2.2 VBA Storage

A **storage** that specifies **VBA project** and **module** information. MUST have the name "VBA" (case-insensitive). MUST contain **_VBA_PROJECT** Stream (section 2.3.4.1) and **dir Stream** (section

2.3.4.2). MUST contain a Module Stream (section 2.2.5) for each module in the VBA project. Optionally contains **SRP** Streams (section 2.2.6).

2.2.3 _VBA_PROJECT Stream

A **stream** that specifies the version-dependent project information. MUST have the name "_VBA_PROJECT" (case-insensitive). MUST contain data as specified by **_VBA_PROJECT** Stream (section 2.3.4.1).

2.2.4 dir Stream

A **stream** that specifies **VBA project** properties, project **references**, and **module** properties. MUST have the name "dir" (case-insensitive). MUST contain data as specified by **dir** Stream (section 2.3.4.2).

2.2.5 Module Stream

A **stream** that specifies the source code of **modules** in the **VBA project**. The name of this stream is specified by **MODULESTREAMNAME** (section 2.3.4.2.3.2.3). MUST contain data as specified by Module Stream (section 2.3.4.3).

2.2.6 SRP Streams

Streams that specify an implementation-specific and version-dependent performance cache. MUST be ignored on read. MUST NOT be present on write.

The name of each of these streams is specified by the following ABNF grammar:

```
SRPStreamName = "__SRP_" 1*25DIGIT
```

2.2.7 PROJECT Stream

A **stream** that specifies **VBA project** properties. MUST have the name "PROJECT" (case-insensitive). MUST contain data as specified by **PROJECT** Stream (section 2.3.1).

2.2.8 PROJECTwm Stream

A **stream** that specifies names of **modules** represented in both **MBCS** and **UTF-16** encoding. MUST have the name "PROJECTwm" (case-insensitive). MUST contain data as specified by **PROJECTwm** Stream (section 2.3.3).

2.2.9 PROJECTlk Stream

A **stream** that specifies license information for **ActiveX controls** used in the **VBA project**. MUST have the name "PROJECTlk" (case-insensitive). MUST contain data as specified by **PROJECTlk** Stream (section 2.3.2).

2.2.10 Designer Storages

A **designer storage** MUST be present for each **designer module** in the **VBA project**. The name is specified by **MODULESTREAMNAME** (section 2.3.4.2.3.2.3). MUST contain **VBFrame** Stream (section 2.3.5). If the designer is an Office Form **ActiveX control**, then this storage MUST contain storages and **streams** as specified by [MS-OFORMS] section 2.

2.2.11 VBFrame Stream

A **stream** that specifies **designer module** properties. MUST contain data as specified by **VBFrame** Stream (section 2.3.5). Name of this stream MUST start with the **UTF-16** character 0x0003 followed by the UTF-16 string "VBFrame" (case-insensitive).

2.3 Record Types

2.3.1 PROJECT Stream: Project Information

The PROJECT **stream** specifies properties of the **VBA project**.

This stream is an array of bytes that specifies properties of the VBA project. MUST contain **MBCS** characters encoded using the **code page** specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4).

ABNF syntax:

```
VBAPROJECTText     = ProjectProperties NWLN
                     HostExtenders
                    [NWLN ProjectWorkspace]
```

2.3.1.1 ProjectProperties

Specifies project-wide properties.

ABNF syntax:

```
ProjectProperties  = ProjectId
                     *ProjectItem
                     [ProjectHelpFile]
                     [ProjectExeName32]
                      ProjectName
                      ProjectHelpId
                     [ProjectDescription]
                     [ProjectVersionCompat32]
                      ProjectProtectionState
                      ProjectPassword
                      ProjectVisibilityState

ProjectItem        = ( ProjectModule /
                       ProjectPackage ) NWLN
```

2.3.1.2 ProjectId

Specifies the **class identifier (CLSID)** for the **VBA project**.

ABNF syntax:

```
ProjectId          = "ID=" DQUOTE ProjectCLSID DQUOTE NWLN

ProjectCLSID       = GUID
```

<ProjectCLSID>: Specifies the class identifier (CLSID) of the VBA project's **Automation type library**. MUST be "{00000000-0000-0000-0000-000000000000}" when **ProjectPassword** (section 2.3.1.16) specifies a password **hash**.

2.3.1.3 ProjectModule

Specifies a **module** that contains **VBA** language source code as specified in [MS-VBAL] section 4.2.

ABNF syntax:

```
ProjectModule      = ( ProjectDocModule /
                       ProjectStdModule /
                       ProjectClassModule /
                       ProjectDesignerModule )
```

<ProjectModule>: Specifies the name and type of a specific module. MUST have a corresponding **MODULE Record** (section 2.3.4.2.3.2) in the **dir Stream** (section 2.3.4.2).

2.3.1.4 ProjectDocModule

Specifies a **module** that extends a **document module**.

ABNF syntax:

```
ProjectDocModule   = "Document=" ModuleIdentifier %x2f DocTlibVer

DocTlibVer         = HEXINT32
```

<DocTlibVer>: Specifies the document module's **Automation server** version as specified by [MS-OAUT].

2.3.1.5 ProjectStdModule

Specifies a **procedural module**.

ABNF syntax:

```
ProjectStdModule   = "Module=" ModuleIdentifier
```

2.3.1.6 ProjectClassModule

Specifies a **class module**.

ABNF syntax:

```
ProjectClassModule = "Class=" ModuleIdentifier
```

2.3.1.7 ProjectDesignerModule

Specifies a **designer module**.

ABNF syntax:

```
ProjectDesignerModule = "BaseClass=" ModuleIdentifier
```

2.3.1.8 ProjectPackage

Specifies the **class identifier (CLSID)** for a **designer** extended by one or more **modules**.

ABNF syntax:

```
ProjectPackage     = "Package=" GUID
```

2.3.1.9 ProjectHelpFile

Specifies a path to a **Help file** associated with this **VBA project**. MUST be the same value as specified in **PROJECTHELPFILEPATH** (section 2.3.4.2.1.7). MUST be present if **PROJECTHELPFILEPATH** specifies a value.

ABNF syntax:

```
ProjectHelpFile    = "HelpFile=" PATH NWLN
```

2.3.1.10 ProjectExeName32

Specifies a path. MUST be ignored.

ABNF syntax:

```
ProjectExeName32   = "ExeName32=" PATH NWLN
```

2.3.1.11 ProjectName

Specifies the short name of the **VBA project**.

ABNF syntax:

```
ProjectName        = "Name=" DQUOTE ProjectIdentifier DQUOTE NWLN

ProjectIdentifier  = 1*128QUOTEDCHAR
```

<ProjectIdentifier>: Specifies the name of the VBA project. MUST be less than or equal to 128 characters long. MUST be the same value as specified in **PROJECTNAME** (section 2.3.4.2.1.5). SHOULD be an identifier as specified by [MS-VBAL] section 3.3.5. MAY<3> be any string of characters.

2.3.1.12 ProjectHelpId

Specifies a **Help topic identifier** in **ProjectHelpFile** (section 2.3.1.9) associated with this **VBA project**.

ABNF syntax:

```
ProjectHelpId      = "HelpContextID=" DQUOTE TopicId DQUOTE NWLN

TopicId            = INT32
```

<TopicId>: Specifies a Help topic identifier. MUST be the same value as specified in **PROJECTHELPCONTEXT** (section 2.3.4.2.1.8).

2.3.1.13 ProjectDescription

Specifies the description of the **VBA project**.

ABNF syntax:

```
ProjectDescription = "Description=" DQUOTE DescriptionText DQUOTE NWLN

DescriptionText    = *2000QUOTEDCHAR
```

<DescriptionText>: MUST be the same value as specified in **PROJECTDOCSTRING** (section 2.3.4.2.1.6).

2.3.1.14 ProjectVersionCompat32

Specifies the storage format version of the **VBA project**. MAY be missing<4>.

ABNF syntax:

```
ProjectVersionCompat32 = "VersionCompatible32=" DQUOTE "393222000" DQUOTE
                         NWLN
```

2.3.1.15 ProjectProtectionState

Specifies whether access to the **VBA project** was restricted by the user, the **VBA host application**, or the **VBA** project editor.

ABNF syntax:

```
ProjectProtectionState   = "CMG=" DQUOTE EncryptedState DQUOTE NWLN

EncryptedState           = 22*28HEXDIG
```

<EncryptedState>: Specifies whether access to the VBA project was restricted by the user, the VBA host application, or the VBA project editor, obfuscated by Data Encryption (section 2.4.3.2).

The **Data** parameter for Data Encryption (section 2.4.3.2) SHOULD be four bytes that specify the protection state of the VBA project. MAY<5> be 0x00000000. The **Length** parameter for Data Encryption (section 2.4.3.2) MUST be 4.

Values for **Data** are defined by the following bits:

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
A	B	C	Reserved																												

A - fUserProtected (1 bit): Specifies whether the user elected to protect the VBA project.

B - fHostProtected (1 bit): Specifies whether the VBA host application elected to protect the VBA project.

C - fVBEProtected (1 bit): Specifies whether the VBA project editor elected to protect the VBA project.

Reserved (29 bits): MUST be 0. MUST be ignored.

2.3.1.16 ProjectPassword

Specifies the password **hash** of the **VBA project**.

The syntax of ProjectPassword is defined as follows.

```
ProjectPassword     = "DPB=" DQUOTE EncryptedPassword DQUOTE NWLN

EncryptedPassword   = 16*HEXDIG
```

<EncryptedPassword>: Specifies the password protection for the VBA project.

A VBA project without a password MUST use 0x00 for the **Data** parameter for Data Encryption (section 2.4.3.2) and the **Length** parameter MUST be 1.

A VBA project with a password SHOULD specify the password hash of the VBA project, obfuscated by Data Encryption (section 2.4.3.2). The **Data** parameter for Data Encryption (section 2.4.3.2) MUST be an array of bytes that specifies a Hash Data Structure (section 2.4.4.1) and the **Length** parameter for Data Encryption MUST be 29. The Hash Data Structure (section 2.4.4.1) specifies a hash key and password hash encoded to remove null bytes as specified by section 2.4.4.

A VBA project with a password MAY<6> specify the plain text password of the VBA project, obfuscated by Data Encryption (section 2.4.3.2). In this case, the **Data** parameter Data Encryption (section 2.4.3.2) MUST be an array of bytes that specifies a null terminated password string encoded using **MBCS** using the **code page** specified by **PROJECTCODEPAGE** (section 2.3.4.2.1.4), and a **Length** parameter equal to the number of bytes in the password string including the terminating null character.

When the data specified by **<EncryptpedPassword>** is a password hash, **ProjectId.ProjectCLSID** (section 2.3.1.2) MUST be "{00000000-0000-0000-0000-000000000000}".

2.3.1.17 ProjectVisibilityState

Specifies whether the **VBA project** is visible.

ABNF syntax:

```
ProjectVisibilityState      = "GC=" DQUOTE
                              EncryptedProjectVisibility
                              DQUOTE NWLN

EncryptedProjectVisibility  = 16*22HEXDIG
```

<EncryptedProjectVisibility>: Specifies whether the VBA project is visible, obfuscated by Data Encryption (section 2.4.3.2).

The **Data** parameter for Data Encryption (section 2.4.3.2) is one byte that specifies the visibility state of the VBA project. The **Length** parameter for Data Encryption (section 2.4.3.2) MUST be 1.

Values for **Data** are:

Value	Meaning
0x00	VBA project is NOT visible. **<ProjectProtectionState>.fVBEProtected** (section 2.3.1.15) MUST be TRUE.
0xFF	VBA project is visible.

The default is 0xFF.

2.3.1.18 HostExtenders

Specifies a list of **host extenders**.

ABNF syntax:

```
HostExtenders    =  "[Host Extender Info]" NWLN
                        *HostExtenderRef

HostExtenderRef =  ExtenderIndex  "=" ExtenderGuid ";"
                      LibName ";" CreationFlags NWLN

ExtenderIndex    = HEXINT32

ExtenderGuid     = GUID

LibName          = "VBE" / *(%x21-3A / %x3C-FF)

CreationFlags    = HEXINT32
```

<HostExtenderRef>: Specifies a **reference** to an **aggregatable server**'s **Automation type library**.

<ExtenderIndex>: Specifies the index of the host extender entry. MUST be unique to the list of HostExtenders.

<ExtenderGuid>: Specifies the **GUID** of the Automation type library to extend.

<LibName>: Specifies a host-provided Automation type library name. "VBE" specifies a built in name for the VBA Automation type library.

<CreationFlags>: Specifies a host-provided flag as follows:

Value	Meaning
0x00000000	MUST NOT create a new **extended type library** for the aggregatable server if one is already available to the **VBA environment**.
0x00000001	MUST create a new extended type library for the aggregatable server.

2.3.1.19 ProjectWorkspace

Specifies a list of **module** editor window states.

ABNF syntax:

```
ProjectWorkspace = "[Workspace]" NWLN
                    *ProjectWindowRecord
```

2.3.1.20 ProjectWindowRecord

Specifies the coordinates and state of a **module** editor window.

ABNF syntax:

```
ProjectWindowRecord = ModuleIdentifier "=" ProjectWindowState NWLN

ProjectWindowState  = CodeWindow [ ", " DesignerWindow ]

CodeWindow          = ProjectWindow

DesignerWindow      = ProjectWindow

ProjectWindow       = WindowLeft ", "
                      WindowTop ", "
                      WindowRight ", "
                      WindowBottom ", "
                      WindowState

WindowLeft          = INT32

WindowTop           = INT32

WindowRight         = INT32

WindowBottom        = INT32

WindowState         = ["C"] ["Z"] ["I"]
```

<ModuleIdentifier>: Specifies the name of the module. MUST have a corresponding **ProjectModule** (section 2.3.1.3).

<CodeWindow>: Specifies the coordinates and the state of a window used to edit the source code of a module.

<DesignerWindow>: Specifies the coordinates and the state of a window used to edit the **designer** associated with a module.

<WindowLeft>: Specifies the distance of the left edge of a window relative to a **parent window**.

<WindowTop>: Specifies the distance of the top edge of a window relative to a parent window.

<WindowRight>: Specifies the distance of the right edge of a window relative to a parent window.

<WindowBottom>: Specifies the distance of the bottom edge of a window relative to a parent window.

<WindowState>: Specifies the window state.

Values are defined as follows:

Value	Meaning
C	Closed.
Z	Zoomed to fill the available viewing area.
I	Minimized to an icon.

2.3.2 PROJECTlk Stream: ActiveX Control Information

Specifies license information for **ActiveX controls**.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Version																Count															
...																LicenseInfoRecords (variable)															
...																															

Version (2 bytes): An unsigned integer that specifies the version of this structure. MUST be 0x0001.

Count (4 bytes): An unsigned integer that specifies the number of elements in **LicenseInfoRecords**.

LicenseInfoRecords (variable): An array of **LICENSEINFO** (section 2.3.2.1).

2.3.2.1 LICENSEINFO Record

Specifies the information saved for each **ActiveX control** in the **VBA project**.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
ClassID (16 bytes)																															
...																															
...																															
SizeOfLicenseKey																															
LicenseKey (variable)																															
...																															
LicenseRequired																															

ClassID (16 bytes): A **GUID** that specifies the **class identifier (CLSID)** of an ActiveX control.

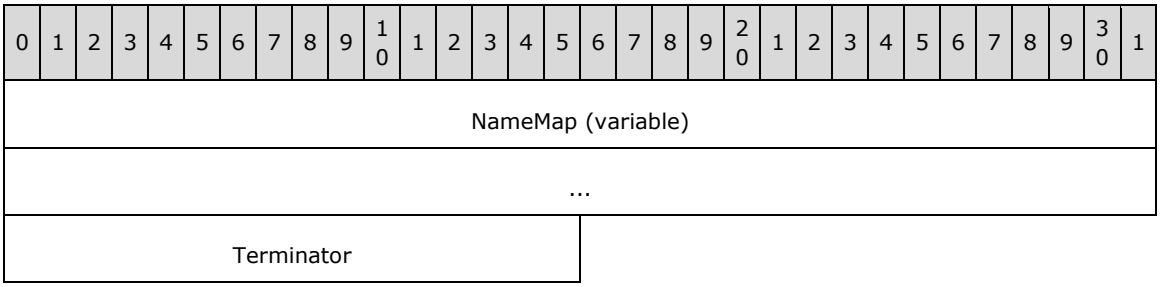
SizeOfLicenseKey (4 bytes): An unsigned integer that specifies the length of **LicenseKey** in bytes.

LicenseKey (variable): An array of **SizeOfLicenseKey** bytes that specifies the **license key** for the ActiveX control.

LicenseRequired (4 bytes): An unsigned integer that specifies a Boolean value. Specifies that the ActiveX control can be instantiated only by using a license-aware object creation method. SHOULD be 0x00000001 when the value of **SizeOfLicenseKey** is not zero. Otherwise SHOULD be 0x00000000<7>.

2.3.3 PROJECTwm Stream: Module Name Information

Specifies a map from **MBCS module** names to **Unicode** module names.

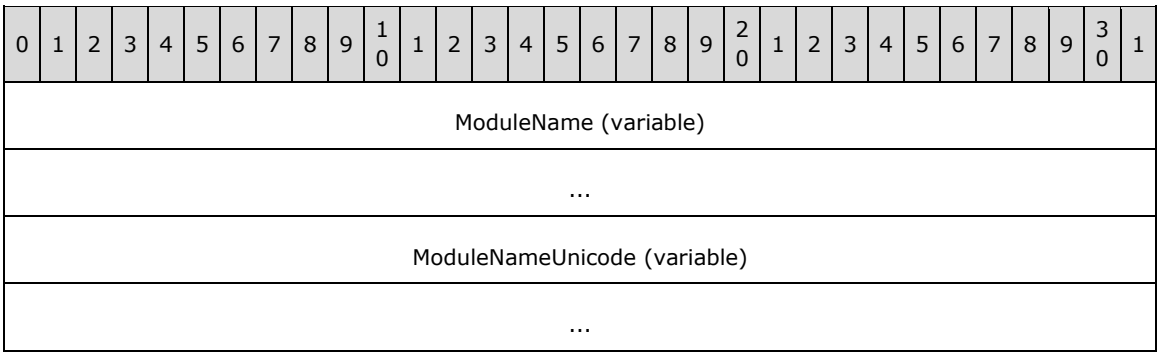


NameMap (variable): An array of **NAMEMAP** Record (section 2.3.3.1). The length of **NameMap** MUST be two bytes less than the size of the **PROJECTwm** Stream (section 2.2.8). Array items MUST appear in the same order as they appear in the **PROJECTMODULES** Record (section 2.3.4.2.3).

Terminator (2 bytes): An unsigned integer that specifies the end of the stream. MUST be 0x0000.

2.3.3.1 NAMEMAP Record

Maps a **MBCS module** name to a **Unicode** module name.



ModuleName (variable): A null-terminated string that specifies a module name. MUST contain MBCS characters encoded using the **code page** specified by **PROJECTCODEPAGE** (section 2.3.4.2.1.4). MUST match a module name specified by **MODULENAME** (section 2.3.4.2.3.2.1). The first byte MUST NOT be 0x00.

ModuleNameUnicode (variable): A null-terminated string that specifies a module name. MUST contain **UTF-16** encoded characters. The first two bytes MUST NOT be 0x0000. MUST contain the UTF-16 encoding of **ModuleName**.

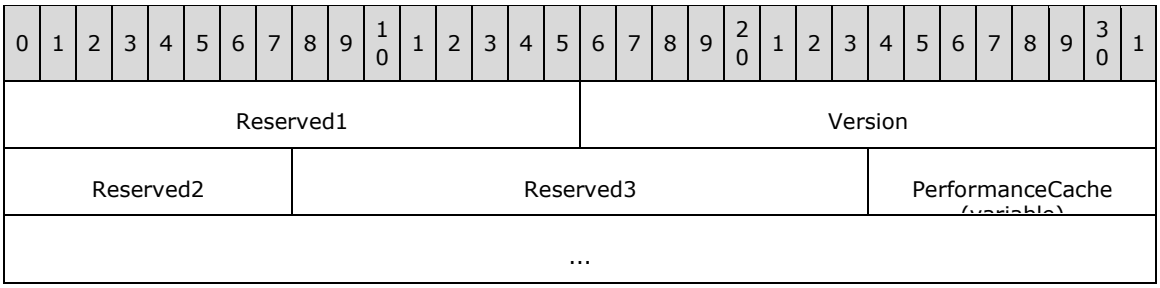
2.3.4 VBA Storage: Visual Basic for Applications Project Information

The VBA **storage** contains the **_VBA_PROJECT** Stream (section 2.3.4.1), the **dir** Stream (section 2.3.4.2), and **Module** Streams (section 2.3.4.3) for the **VBA project**. It also contains optional **SRP** Streams (section 2.2.6) that MUST be ignored.

2.3.4.1 _VBA_PROJECT Stream: Version Dependent Project Information

The _VBA_PROJECT **stream** contains the version-dependent description of a **VBA project**.

The first seven bytes of the stream are version-independent and therefore can be read by any version.



Reserved1 (2 bytes): MUST be 0x61CC. MUST be ignored.

Version (2 bytes): An unsigned integer that specifies the version of **VBA** used to create the VBA project. MUST be ignored on read. MUST be 0xFFFF on write.

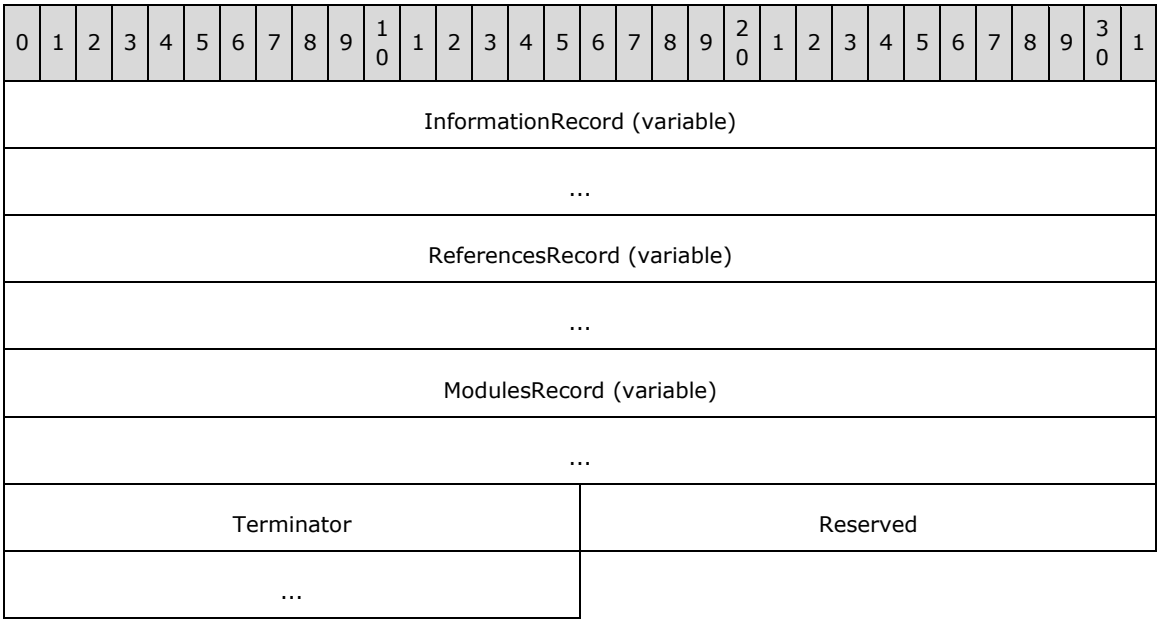
Reserved2 (1 byte): MUST be 0x00. MUST be ignored.

Reserved3 (2 bytes): Undefined. MUST be ignored.

PerformanceCache (variable): An array of bytes that forms an implementation-specific and version-dependent performance cache for the VBA project. The length of **PerformanceCache** MUST be seven bytes less than the size of **_VBA_PROJECT** Stream (section 2.3.4.1). MUST be ignored on read. MUST not be present on write.

2.3.4.2 dir Stream: Version Independent Project Information

The dir **stream** contains a series of bytes that specifies information for the **VBA project**, including project information, project **references**, and **modules**. The entire stream MUST be compressed as specified in Compression (section 2.4.1).



InformationRecord (variable): A **PROJECTINFORMATION** Record (section 2.3.4.2.1).

ReferencesRecord (variable): A **PROJECTREFERENCES** Record (section 2.3.4.2.2).

ModulesRecord (variable): A **PROJECTMODULES** Record (section 2.3.4.2.3).

Terminator (2 bytes): An unsigned integer that specifies the end of the version-independent information in this stream. MUST be 0x0010.

Reserved (4 bytes): MUST be 0x00000000. MUST be ignored.

2.3.4.2.1 PROJECTINFORMATION Record

Specifies version-independent information for the **VBA project**.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
SysKindRecord																															
...																															
...																LcidRecord															
...																															
...																															
LcidInvokeRecord																															
...																															
...																CodePageRecord															
...																															
...																NameRecord (variable)															
...																															
DocStringRecord (variable)																															
...																															
HelpFilePathRecord (variable)																															
...																															
HelpContextRecord																															
...																															
...																LibFlagsRecord															
...																															
...																															

VersionRecord
...
...
ConstantsRecord (variable)
...

SysKindRecord (10 bytes): A **PROJECTSYSKIND** Record (section 2.3.4.2.1.1).

LcidRecord (10 bytes): A **PROJECTLCID** Record (section 2.3.4.2.1.2).

LcidInvokeRecord (10 bytes): A **PROJECTLCIDINVOKE** Record (section 2.3.4.2.1.3).

CodePageRecord (8 bytes): A **PROJECTCODEPAGE** Record (section 2.3.4.2.1.4).

NameRecord (variable): A **PROJECTNAME** Record (section 2.3.4.2.1.5).

DocStringRecord (variable): A **PROJECTDOCSTRING** Record (section 2.3.4.2.1.6).

HelpFilePathRecord (variable): A **PROJECTHELPFILEPATH** Record (section 2.3.4.2.1.7).

HelpContextRecord (10 bytes): A **PROJECTHELPCONTEXT** Record (section 2.3.4.2.1.8).

LibFlagsRecord (10 bytes): A **PROJECTLIBFLAGS** Record (section 2.3.4.2.1.9).

VersionRecord (12 bytes): A **PROJECTVERSION** Record (section 2.3.4.2.1.10).

ConstantsRecord (variable): A **PROJECTCONSTANTS** Record (section 2.3.4.2.1.11). This field is optional.

2.3.4.2.1.1 PROJECTSYSKIND Record

Specifies the platform for which the **VBA project** is created.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Id																Size															
...																SysKind															
...																															

Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0001.

Size (4 bytes): An unsigned integer that specifies the size of **SysKind**. MUST be 0x00000004.

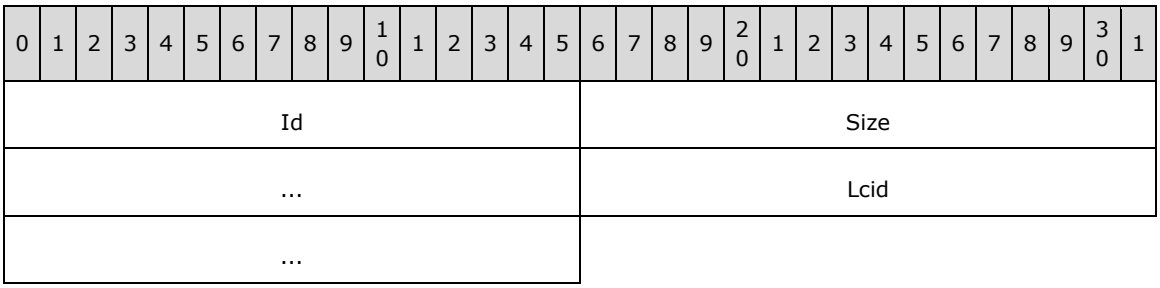
SysKind (4 bytes): An unsigned integer that specifies the platform for which the VBA project is created. MUST have one of the following values:

Value	Meaning
0x00000000	For 16-bit Windows Platforms.

Value	Meaning
0x00000001	For 32-bit Windows Platforms.
0x00000002	For Macintosh Platforms.
0x00000003	For 64-bit Windows Platforms.

2.3.4.2.1.2 PROJECTLCID Record

Specifies the **VBA project**'s **LCID**.



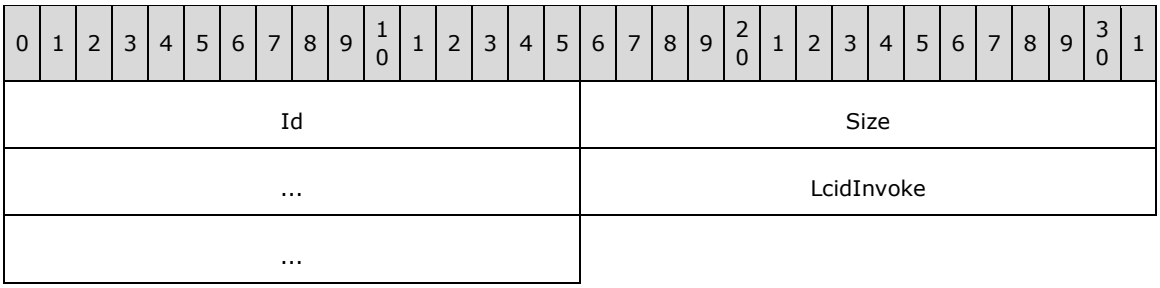
Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0002.

Size (4 bytes): An unsigned integer that specifies the size of **Lcid**. MUST be 0x00000004.

Lcid (4 bytes): An unsigned integer that specifies the LCID value for the VBA project. MUST be 0x00000409.

2.3.4.2.1.3 PROJECTLCIDINVOKE Record

Specifies an **LCID** value used for Invoke calls on an **Automation server** as specified in [MS-OAUT] section 3.1.4.4.



Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0014.

Size (4 bytes): An unsigned integer that specifies the size of **LcidInvoke**. MUST be 0x00000004.

LcidInvoke (4 bytes): An unsigned integer that specifies the LCID value used for Invoke calls. MUST be 0x00000409.

2.3.4.2.1.4 PROJECTCODEPAGE Record

Specifies the **VBA project**'s **code page**.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Id																Size															
...																CodePage															

Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0003.

Size (4 bytes): An unsigned integer that specifies the size of **CodePage**. MUST be 0x00000002.

CodePage (2 bytes): An unsigned integer that specifies the code page for the VBA project.

2.3.4.2.1.5 PROJECTNAME Record

Specifies a unique **VBA identifier** as the name of the **VBA project**.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Id																SizeOfProjectName															
...																ProjectName (variable)															
...																															

Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0004.

SizeOfProjectName (4 bytes): An unsigned integer that specifies the size in bytes of **ProjectName**. MUST be greater than or equal to 1. MUST be less than or equal to 128.

ProjectName (variable): An array of **SizeOfProjectName** bytes that specifies the VBA identifier name for the VBA project. MUST contain **MBCS** characters encoded using the **code page** specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4). MUST NOT contain null characters.

2.3.4.2.1.6 PROJECTDOCSTRING Record

Specifies the description for the **VBA project**.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Id																SizeOfDocString															
...																DocString (variable)															
...																															
Reserved																SizeOfDocStringUnicode															
...																DocStringUnicode (variable)															
...																															

Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0005.

SizeOfDocString (4 bytes): An unsigned integer that specifies the size in bytes of **DocString**. MUST be less than or equal to 2000.

DocString (variable): An array of **SizeOfDocString** bytes that specifies the description for the VBA project. MUST contain **MBCS** characters encoded using the **code page** specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4). MUST NOT contain null characters.

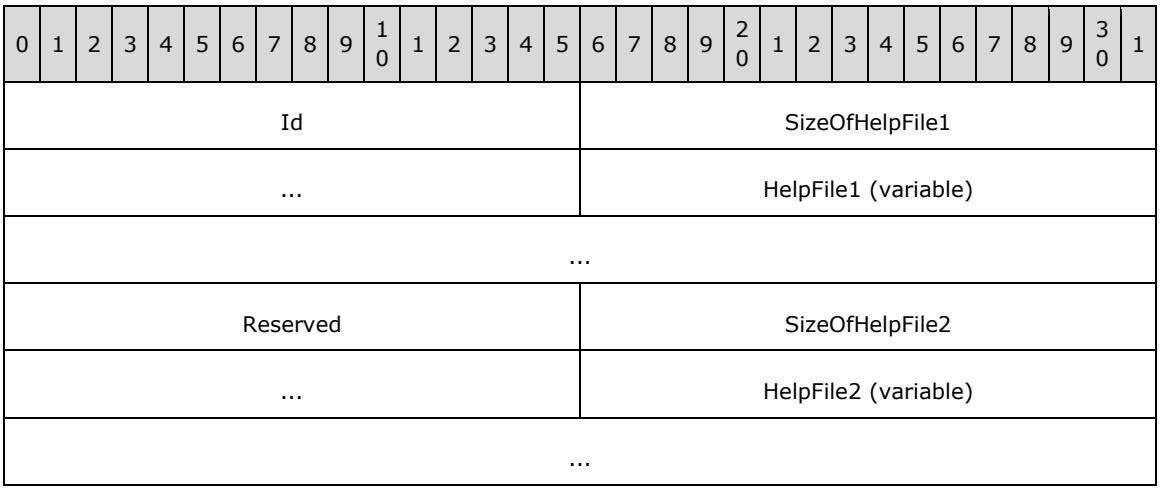
Reserved (2 bytes): MUST be 0x0040. MUST be ignored.

SizeOfDocStringUnicode (4 bytes): An unsigned integer that specifies the size in bytes of **DocStringUnicode**. MUST be even.

DocStringUnicode (variable): An array of **SizeOfDocStringUnicode** bytes that specifies the description for the VBA project. MUST contain **UTF-16** characters. MUST NOT contain null characters. MUST contain the UTF-16 encoding of **DocString**.

2.3.4.2.1.7 PROJECTHELPFILEPATH Record

Specifies the path to the **Help file** for the **VBA project**. **<ProjectHelpFile>** MUST be defined in **PROJECT** Stream (section 2.3.1) if **SizeOfHelpFile1** is greater than zero.



Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0006.

SizeOfHelpFile1 (4 bytes): An unsigned integer that specifies the size in bytes of **HelpFile1**. MUST be less than or equal to 260.

HelpFile1 (variable): An array of **SizeOfHelpFile1** bytes that specifies the path to the Help file for the VBA project. MUST contain **MBCS** characters encoded using the **code page** specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4). MUST NOT contain null characters.

Reserved (2 bytes): MUST be 0x003D. MUST be ignored.

SizeOfHelpFile2 (4 bytes): An unsigned integer that specifies the size in bytes of **HelpFile2**. MUST be equal to **SizeOfHelpFile1**.

HelpFile2 (variable): An array of **SizeOfHelpFile2** bytes that specifies the path to the Help file for the VBA project. MUST contain MBCS characters encoded using the code page specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4). MUST NOT contain null characters. MUST contain the same bytes as **HelpFile1**.

2.3.4.2.1.8 PROJECTHELPCONTEXT Record

Specifies the **Help topic identifier** for the **VBA project**.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Id																Size															
...																HelpContext															
...																															

Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0007.

Size (4 bytes): An unsigned integer that specifies the size of **HelpContext**. MUST be 0x00000004.

HelpContext (4 bytes): An unsigned integer that specifies the Help topic identifier in the **Help file** specified by **PROJECTHELPFILEPATH** (section 2.3.4.2.1.7).

2.3.4.2.1.9 PROJECTLIBFLAGS Record

Specifies the LIBFLAGS for the **VBA project**'s **Automation type library** as specified in [MS-OAUT] section 2.2.20.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Id																Size															
...																ProjectLibFlags															
...																															

Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0008.

Size (4 bytes): An unsigned integer that specifies the size of **ProjectLibFlags**. MUST be 0x00000004.

ProjectLibFlags (4 bytes): An unsigned integer that specifies LIBFLAGS for the VBA project's Automation type library as specified in [MS-OAUT] section 2.2.20. MUST be 0x00000000.

2.3.4.2.1.10 PROJECTVERSION Record

Specifies the version of the **VBA project**.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Id																Reserved															
...																VersionMajor															
...																VersionMinor															

Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0009.

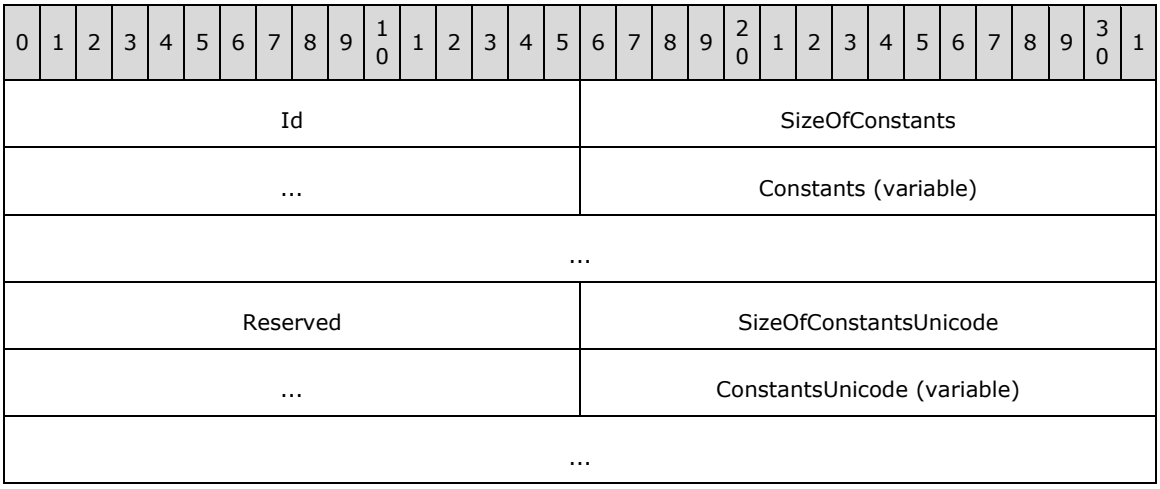
Reserved (4 bytes): MUST be 0x00000004. MUST be ignored.

VersionMajor (4 bytes): An unsigned integer specifying the major version of the VBA project.

VersionMinor (2 bytes): An unsigned integer specifying the minor version of the VBA project.

2.3.4.2.1.11 PROJECTCONSTANTS Record

Specifies the **compilation constants** for the **VBA project**.



Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x000C.

SizeOfConstants (4 bytes): An unsigned integer that specifies the size in bytes of **Constants**. MUST be less than or equal to 1015.

Constants (variable): An array of **SizeOfConstants** bytes that specifies the compilation constants for the VBA project. MUST contain **MBCS** characters encoded using the **code page** specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4). MUST NOT contain null characters.

MUST conform to the following ABNF grammar:

```
Constants     = Constant *( " : " Constant )

Constant      = ConstantName " = " ConstantValue

ConstantName  = VbaIdentifier

ConstantValue = ["-"] 1*5DIGIT
```

<ConstantName>: Specifies a unique **VBA identifier** for the constant.

<ConstantValue>: Specifies the numeric value for the constant. SHOULD be between −9999 and 32767. MAY be between −32768 and 32767 on read.<8>

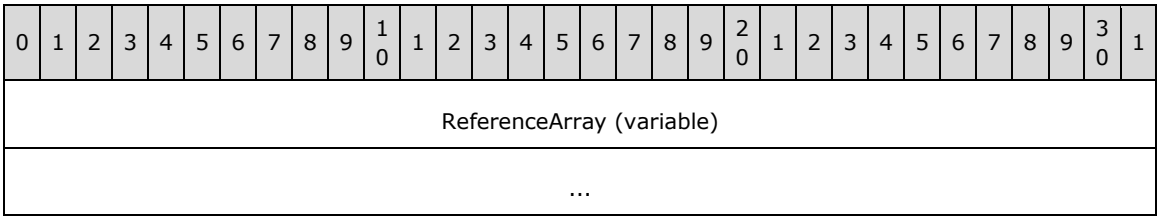
Reserved (2 bytes): MUST be 0x003C. MUST be ignored.

SizeOfConstantsUnicode (4 bytes): An unsigned integer that specifies the size in bytes of **ConstantsUnicode**. MUST be even.

ConstantsUnicode (variable): An array of **SizeOfConstantsUnicode** bytes that specifies the compilation constants for the VBA project. MUST contain **UTF-16** characters. MUST NOT contain null characters. MUST contain the UTF-16 encoding of **Constants**.

2.3.4.2.2 PROJECTREFERENCES Record

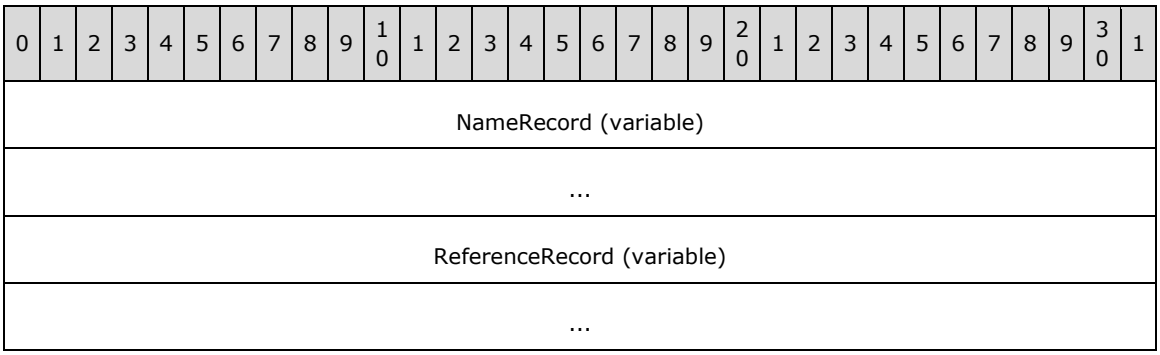
Specifies the external **references** of the **VBA project** as a variably sized array of **REFERENCE** (section 2.3.4.2.2.1). The termination of the array is indicated by the beginning of **PROJECTMODULES** (section 2.3.4.2.3), which is indicated by a **REFERENCE** (section 2.3.4.2.2.1) being followed by an unsigned 16-bit integer with a value of 0x000F.



ReferenceArray (variable): An array of **REFERENCE** Records (section 2.3.4.2.2.1).

2.3.4.2.2.1 REFERENCE Record

Specifies a **reference** to an **Automation type library** or **VBA project**.



NameRecord (variable): A **REFERENCENAME** Record (section 2.3.4.2.2.2) that specifies the name of the referenced VBA project or Automation type library. This field is optional.

ReferenceRecord (variable): The type of **ReferenceRecord** is determined by the unsigned 16-bit integer beginning this field. The meanings of the possible values are listed in the following table:

Value	Meaning
0x002F	**ReferenceRecord** is a **REFERENCECONTROL** (section 2.3.4.2.2.3).
0x0033	**ReferenceRecord** is a **REFERENCEORIGINAL** (section 2.3.4.2.2.4).
0x000D	**ReferenceRecord** is a **REFERENCEREGISTERED** (section 2.3.4.2.2.5).
0x000E	**ReferenceRecord** is a **REFERENCEPROJECT** (section 2.3.4.2.2.6).

2.3.4.2.2.2 REFERENCENAME Record

Specifies the name of a referenced **VBA project** or **Automation type library**.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Id																SizeOfName															
...																Name (variable)															
...																															
Reserved																SizeOfNameUnicode															
...																NameUnicode (variable)															
...																															

Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0016.

SizeOfName (4 bytes): An unsigned integer that specifies the size in bytes of **Name**.

Name (variable): An array of **SizeOfName** bytes that specifies the name of the referenced VBA project or Automation type library. MUST contain **MBCS** characters encoded using the **code page** specified in **PROJECTCODEPAGE** Record (section 2.3.4.2.1.4). MUST NOT contain null characters. MUST conform to the following ABNF grammar:

```
ReferenceName = RefProjectName / RefLibraryName

RefProjectName   = VbaIdentifier

RefLibraryName   = Identifier
```

<RefProjectName>: The name of a referenced project. **<ReferenceName>** MUST use the **<RefProjectName>** rule when the **ReferenceRecord** of the parent **REFERENCE** (section 2.3.4.2.2.1) is a **REFERENCEPROJECT** (section 2.3.4.2.2.6).

<RefLibraryName>: The name of a referenced Automation type library. **<ReferenceName>** MUST use the **<RefLibraryName>** rule when the **ReferenceRecord** of the parent **REFERENCE** (section 2.3.4.2.2.1) is a **REFERENCECONTROL** (section 2.3.4.2.2.3) or **REFERENCEREGISTERED** (section 2.3.4.2.2.5). **<Identifier>** is defined in [C706].

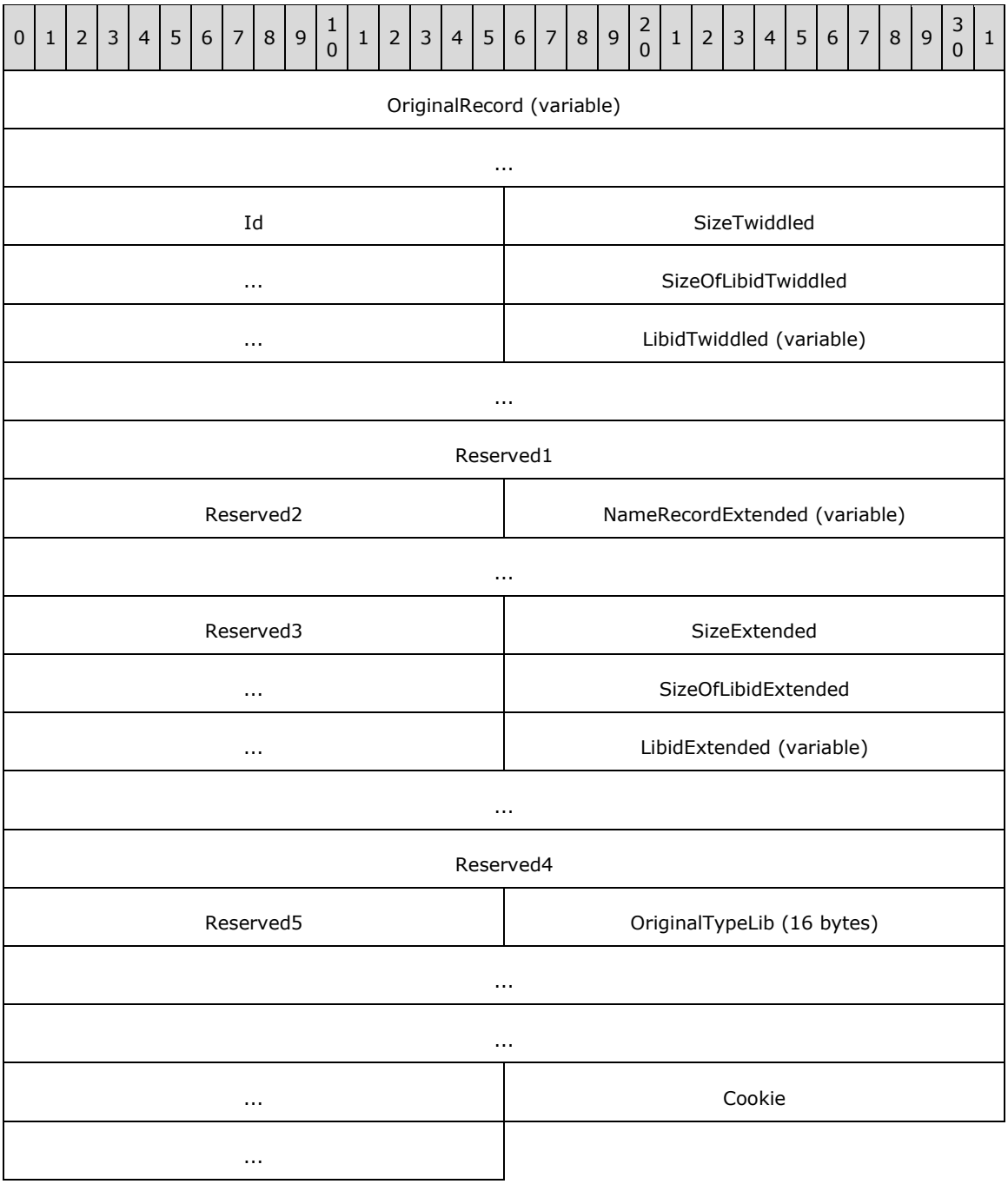
Reserved (2 bytes): MUST be 0x003E. MUST be ignored.

SizeOfNameUnicode (4 bytes): An unsigned integer that specifies the size in bytes of **NameUnicode**.

NameUnicode (variable): An array of **SizeOfNameUnicode** bytes that specifies the name of the referenced VBA project or Automation type library. MUST contain **UTF-16** characters. MUST NOT contain null characters. MUST contain the UTF-16 encoding of **Name**.

2.3.4.2.2.3 REFERENCECONTROL Record

Specifies a **reference** to a **twiddled type library** and its **extended type library**.



OriginalRecord (variable): A **REFERENCEORIGINAL** Record (section 2.3.4.2.2.4) that specifies the **Automation type library** the twiddled type library was generated from. This field is optional.

Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x002F.

SizeTwiddled (4 bytes): An unsigned integer that specifies the sum of the size in bytes of **SizeOfLibidTwiddled**, **LibidTwiddled**, **Reserved1**, and **Reserved2**. MUST be ignored on read.

SizeOfLibidTwiddled (4 bytes): An unsigned integer that specifies the size in bytes of **LibidTwiddled**.

LibidTwiddled (variable): An array of **SizeOfLibidTwiddled** bytes. SHOULD be "*\G{00000000-0000-0000-0000-000000000000}#0.0#0##" (case-sensitive). MAY<9> specify a twiddled type library's identifier. The identifier MUST conform to the ABNF grammar **LibidReference** (section 2.1.1.8). MUST contain **MBCS** characters encoded using the **code page** specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4). MUST NOT contain null characters.

Reserved1 (4 bytes): MUST be 0x00000000. MUST be ignored.

Reserved2 (2 bytes): MUST be 0x0000. MUST be ignored.

NameRecordExtended (variable): A **REFERENCENAME** Record (section 2.3.4.2.2.2) that specifies the name of the extended type library. This field is optional.

Reserved3 (2 bytes): MUST be 0x0030. MUST be ignored.

SizeExtended (4 bytes): An unsigned integer that specifies the sum of the size in bytes of **SizeOfLibidExtended**, **LibidExtended**, **Reserved4**, **Reserved5**, **OriginalTypeLib**, and **Cookie**. MUST be ignored on read.

SizeOfLibidExtended (4 bytes): An unsigned integer that specifies the size in bytes of **LibidExtended**.

LibidExtended (variable): An array of **SizeOfLibidExtended** bytes that specifies the extended type library's identifier. MUST contain MBCS characters encoded using the code page specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4). MUST NOT contain null characters. MUST conform to the ABNF grammar in **LibidReference** (section 2.1.1.8).

Reserved4 (4 bytes): MUST be 0x00000000. MUST be ignored.

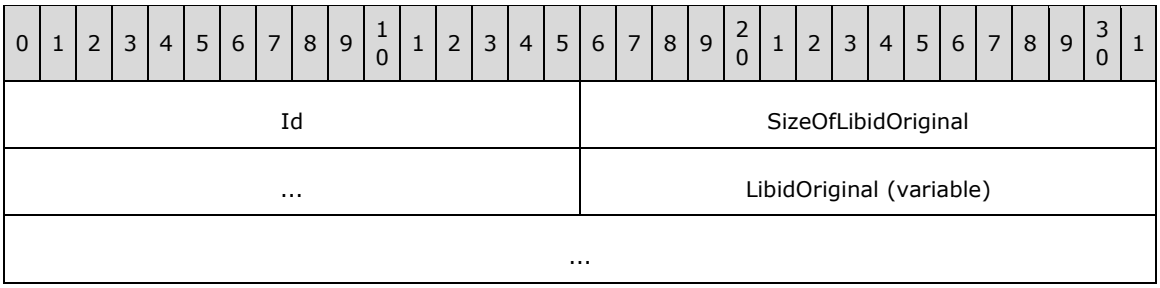
Reserved5 (2 bytes): MUST be 0x0000. MUST be ignored.

OriginalTypeLib (16 bytes): A **GUID** that specifies the Automation type library the extended type library was generated from.

Cookie (4 bytes): An unsigned integer that specifies the extended type library's cookie. MUST be unique for each **REFERENCECONTROL** (section 2.3.4.2.2.3) in the **VBA project** with the same **OriginalTypeLib**.

2.3.4.2.2.4 REFERENCEORIGINAL Record

Specifies the identifier of the **Automation type library** the containing **REFERENCECONTROL**'s (section 2.3.4.2.2.3) **twiddled type library** was generated from.



Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0033.

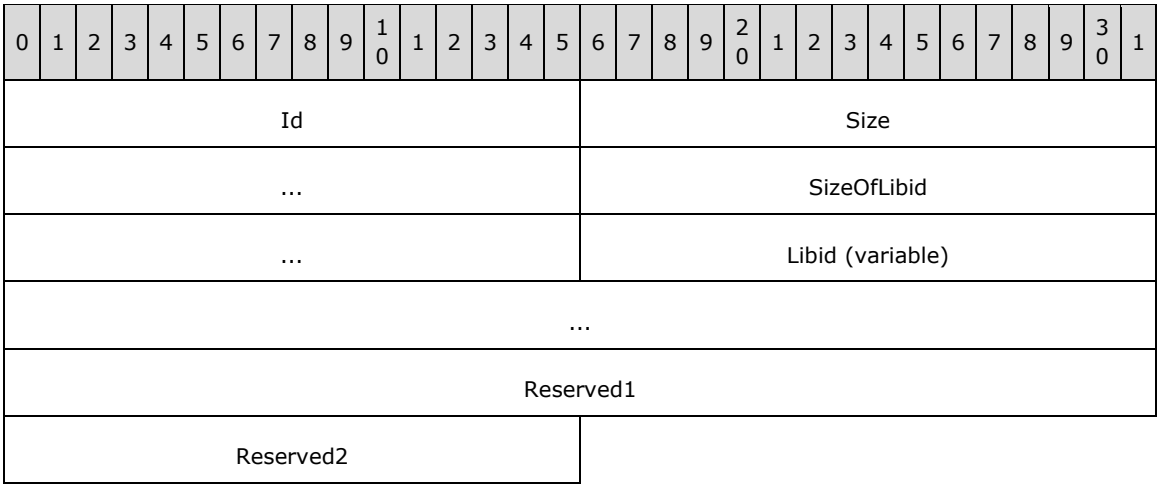
SizeOfLibidOriginal (4 bytes): An unsigned integer that specifies the size in bytes of **LibidOriginal**.

LibidOriginal (variable): An array of **SizeOfLibidOriginal** bytes that specifies the identifier of the Automation type library a **REFERENCECONTROL** (section 2.3.4.2.2.3) was generated from. MUST contain **MBCS** characters encoded using the **code page** specified in **PROJECTCODEPAGE**

(section 2.3.4.2.1.4). MUST NOT contain null characters. MUST conform to the ABNF grammar in **LibidReference** (section 2.1.1.8).

2.3.4.2.2.5 REFERENCEREGISTERED Record

Specifies a **reference** to an **Automation type library**.



Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x000D

Size (4 bytes): An unsigned integer that specifies the total size in bytes of **SizeOfLibid**, **Libid**, **Reserved1**, and **Reserved2**. MUST be ignored on read.

SizeOfLibid (4 bytes): An unsigned integer that specifies the size in bytes of **Libid**.

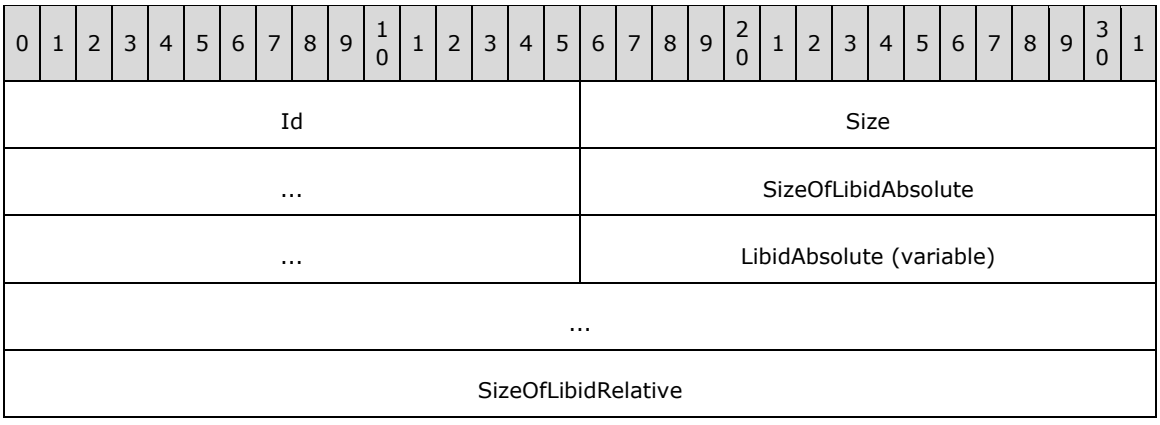
Libid (variable): An array of **SizeOfLibid** bytes that specifies an Automation type library's identifier. MUST contain **MBCS** characters encoded using the **code page** specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4). MUST NOT contain null characters. MUST conform to the ABNF grammar in **LibidReference** (section 2.1.1.8).

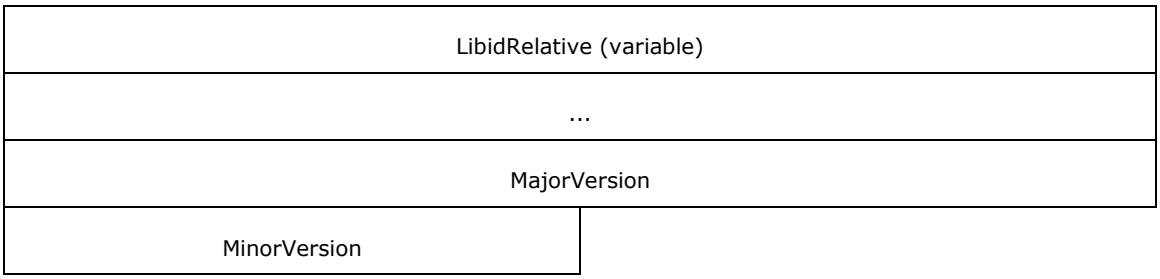
Reserved1 (4 bytes): MUST be 0x00000000. MUST be ignored.

Reserved2 (2 bytes): MUST be 0x0000. MUST be ignored.

2.3.4.2.2.6 REFERENCEPROJECT Record

Specifies a **reference** to an external **VBA project**.





Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x000E.

Size (4 bytes): An unsigned integer that specifies the total size in bytes of **SizeOfLibidAbsolute**, **LibidAbsolute**, **SizeOfLibidRelative**. **LibidRelative**, **MajorVersion**, and **MinorVersion**. MUST be ignored on read.

SizeOfLibidAbsolute (4 bytes): An unsigned integer that specifies the size in bytes of **LibidAbsolute**.

LibidAbsolute (variable): An array of **SizeOfLibidAbsolute** bytes that specifies the referenced VBA project's identifier with an **absolute path**, **<ProjectPath>**. MUST contain **MBCS** characters encoded using the **code page** specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4). MUST NOT contain null characters. MUST conform to the ABNF grammar **ProjectReference** (section 2.1.1.12).

SizeOfLibidRelative (4 bytes): An unsigned integer that specifies the size in bytes of **LibidRelative**.

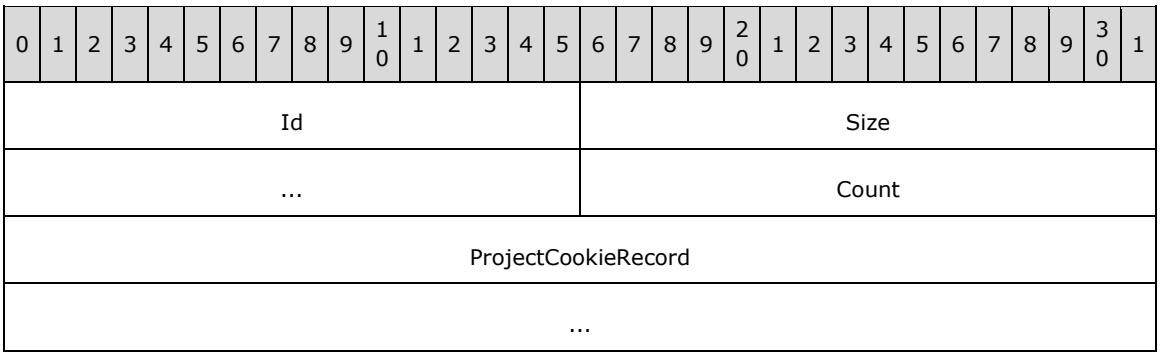
LibidRelative (variable): An array of **SizeOfLibidRelative** bytes that specifies the referenced VBA project's identifier with a **relative path**, **<ProjectPath>,** that is relative to the current VBA project. MUST contain MBCS characters encoded using the code page specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4). MUST NOT contain null characters. MUST conform to the ABNF grammar **ProjectReference** (section 2.1.1.12).

MajorVersion (4 bytes): An unsigned integer that specifies the major version of the referenced VBA project. On write MUST be the **PROJECTVERSION.VersionMajor** (section 2.3.4.2.1.10) of the referenced VBA project.

MinorVersion (2 bytes): An unsigned integer that specifies the minor version of the external VBA project. On write MUST be the **PROJECTVERSION.VersionMinor** (section 2.3.4.2.1.10) of the referenced VBA project.

2.3.4.2.3 PROJECTMODULES Record

Specifies data for the **modules** in the project.



Modules (variable)
...

Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x000F.

Size (4 bytes): An unsigned integer that specifies the size of **Count**. MUST be 0x00000002.

Count (2 bytes): An unsigned integer that specifies the number of elements in **Modules**.

ProjectCookieRecord (8 bytes): A **PROJECTCOOKIE** Record (section 2.3.4.2.3.1).

Modules (variable): An array of **MODULE** Records (section 2.3.4.2.3.2).

2.3.4.2.3.1 PROJECTCOOKIE Record

Specifies data that is ignored.

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Id																Size															
...																Cookie															

Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0013.

Size (4 bytes): An unsigned integer that specifies the size of **Cookie**. MUST be 0x00000002.

Cookie (2 bytes): MUST be ignored on read. MUST be 0xFFFF on write.

2.3.4.2.3.2 MODULE Record

Specifies data for a **module**. Source code for the module can be found in the **ModuleStream** (section 2.3.4.3) named as specified in **StreamNameRecord**. Every **MODULE** (section 2.3.4.2.3.2) MUST have a corresponding **<ProjectModule>** specified in **PROJECT** Stream (section 2.3.1).

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
NameRecord (variable)																															
...																															
NameUnicodeRecord (variable)																															
...																															
StreamNameRecord (variable)																															
...																															
DocStringRecord (variable)																															

...	
OffsetRecord	
...	
...	HelpContextRecord
...	
...	
CookieRecord	
...	
TypeRecord	
...	ReadOnlyRecord (optional)
...	
PrivateRecord (optional)	
...	Terminator
Reserved	

NameRecord (variable): A **MODULENAME** Record (section 2.3.4.2.3.2.1).

NameUnicodeRecord (variable): A **MODULENAMEUNICODE** Record (section 2.3.4.2.3.2.2). This field is optional.

StreamNameRecord (variable): A **MODULESTREAMNAME** Record (section 2.3.4.2.3.2.3).

DocStringRecord (variable): A **MODULEDOCSTRING** Record (section 2.3.4.2.3.2.4).

OffsetRecord (10 bytes): A **MODULEOFFSET** Record (section 2.3.4.2.3.2.5).

HelpContextRecord (10 bytes): A **MODULEHELPCONTEXT** Record (section 2.3.4.2.3.2.6).

CookieRecord (8 bytes): A **MODULECOOKIE** Record (section 2.3.4.2.3.2.7).

TypeRecord (6 bytes): A **MODULETYPE** Record (section 2.3.4.2.3.2.8).

ReadOnlyRecord (6 bytes): A **MODULEREADONLY** Record (section 2.3.4.2.3.2.9). This field is optional.

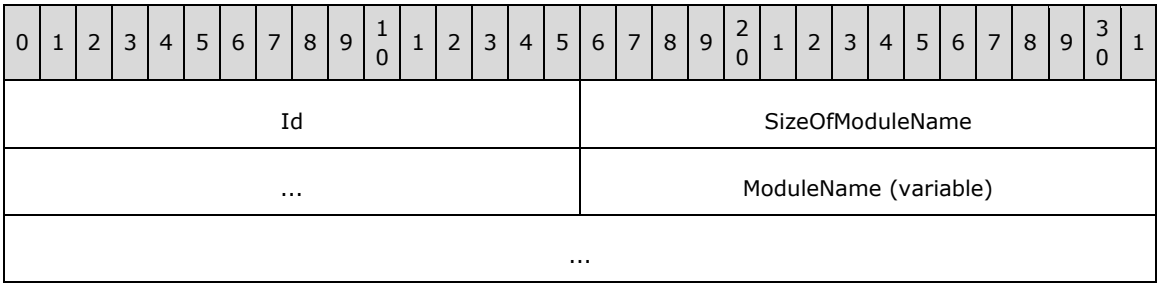
PrivateRecord (6 bytes): A **MODULEPRIVATE** Record (section 2.3.4.2.3.2.10). This field is optional.

Terminator (2 bytes): An unsigned integer that specifies the end of this record. MUST be 0x002B.

Reserved (4 bytes): MUST be 0x00000000. MUST be ignored.

2.3.4.2.3.2.1 MODULENAME Record

Specifies a **VBA identifier** as the name of the containing **MODULE Record** (section 2.3.4.2.3.2).



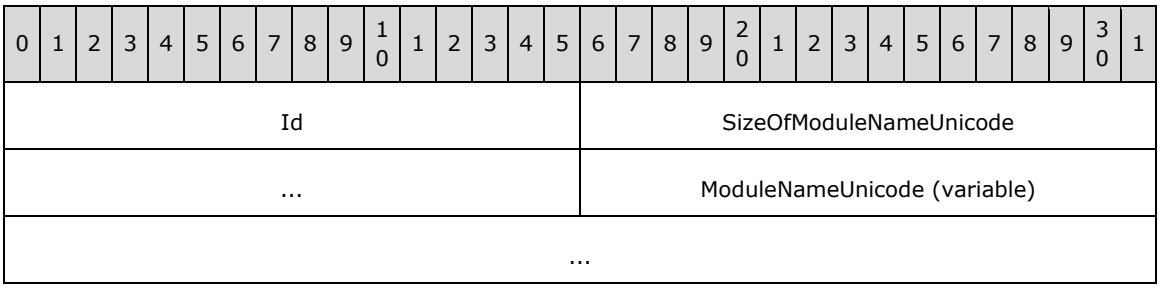
Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0019.

SizeOfModuleName (4 bytes): An unsigned integer that specifies the size in bytes of **ModuleName**.

ModuleName (variable): An array of **SizeOfModuleName** bytes that specifies the VBA identifier for the containing **MODULE Record**. MUST contain **MBCS** characters encoded using the **code page** specified in the **PROJECTCODEPAGE Record** (section 2.3.4.2.1.4). MUST NOT contain null characters.

2.3.4.2.3.2.2 MODULENAMEUNICODE Record

Specifies a **VBA identifier** as the name of the containing **MODULE Record** (section 2.3.4.2.3.2). MUST contain the **UTF-16** encoding of **MODULENAME** Record (section 2.3.4.2.3.2.1).



Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0047.

SizeOfModuleNameUnicode (4 bytes): An unsigned integer that specifies the size in bytes of **ModuleNameUnicode**. MUST be even.

ModuleNameUnicode (variable): An array of **SizeOfModuleNameUnicode** bytes that specifies the VBA identifier for the containing **MODULE Record** (section 2.3.4.2.3.2). MUST contain UTF-16 characters. MUST NOT contain null characters. MUST contain the UTF-16 encoding of **MODULENAME** Record (section 2.3.4.2.3.2.1) **ModuleName**.

2.3.4.2.3.2.3 MODULESTREAMNAME Record

Specifies the **stream** name of the **ModuleStream** (section 2.3.4.3) in the VBA Storage (section 2.3.4) corresponding to the containing **MODULE Record** (section 2.3.4.2.3.2).

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Id																SizeOfStreamName															
...																StreamName (variable)															
...																															
Reserved																SizeOfStreamNameUnicode															
...																StreamNameUnicode (variable)															
...																															

Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x001A.

SizeOfStreamName (4 bytes): An unsigned integer that specifies the size in bytes of **StreamName**.

StreamName (variable): An array of **SizeOfStreamName** bytes that specifies the stream name of the **ModuleStream** (section 2.3.4.3). MUST contain **MBCS** characters encoded using the **code page** specified in PROJECTCODEPAGE (section 2.3.4.2.1.4). MUST NOT contain null characters.

Reserved (2 bytes): MUST be 0x0032. MUST be ignored.

SizeOfStreamNameUnicode (4 bytes): An unsigned integer that specifies the size in bytes of **StreamNameUnicode**. MUST be even.

StreamNameUnicode (variable): An array of **SizeOfStreamNameUnicode** bytes that specifies the stream name of the **ModuleStream** (section 2.3.4.3). MUST contain **UTF-16** characters. MUST NOT contain null characters. MUST contain the UTF-16 encoding of **StreamName**.

2.3.4.2.3.2.4 MODULEDOCSTRING Record

Specifies the description for the containing **MODULE** Record (section 2.3.4.2.3.2).

0	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1
Id																SizeOfDocString															
...																DocString (variable)															
...																															
Reserved																SizeOfDocStringUnicode															
...																DocStringUnicode (variable)															
...																															

Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x001C.

SizeOfDocString (4 bytes): An unsigned integer that specifies the size in bytes of **DocString**.

DocString (variable): An array of **SizeOfDocString** bytes that specifies the description for the containing **MODULE** Record (section 2.3.4.2.3.2). MUST contain **MBCS** characters encoded using the **code page** specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4). MUST NOT contain null characters.

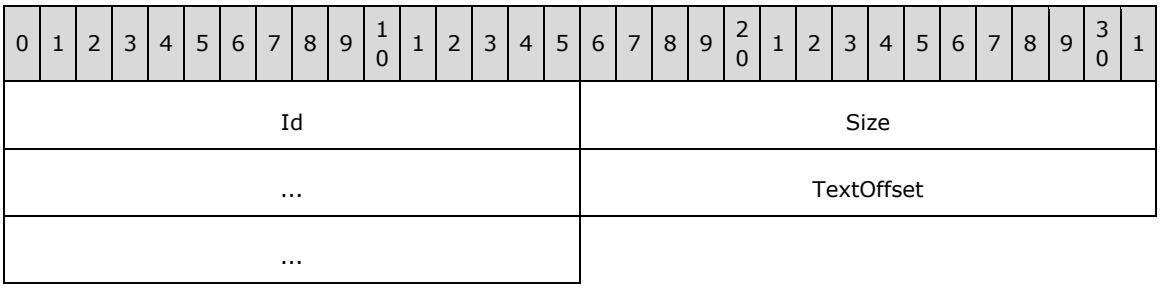
Reserved (2 bytes): MUST be 0x0048. MUST be ignored.

SizeOfDocStringUnicode (4 bytes): An unsigned integer that specifies the size in bytes of **DocStringUnicode**. MUST be even.

DocStringUnicode (variable): An array of **SizeOfDocStringUnicode** bytes that specifies the description for the containing **MODULE** Record (section 2.3.4.2.3.2). MUST contain **UTF-16** characters. MUST NOT contain null characters. MUST contain the UTF-16 encoding of **DocString**.

2.3.4.2.3.2.5 MODULEOFFSET Record

Specifies the location of the source code within the **ModuleStream** (section 2.3.4.3) that corresponds to the containing **MODULE Record** (section 2.3.4.2.3.2).



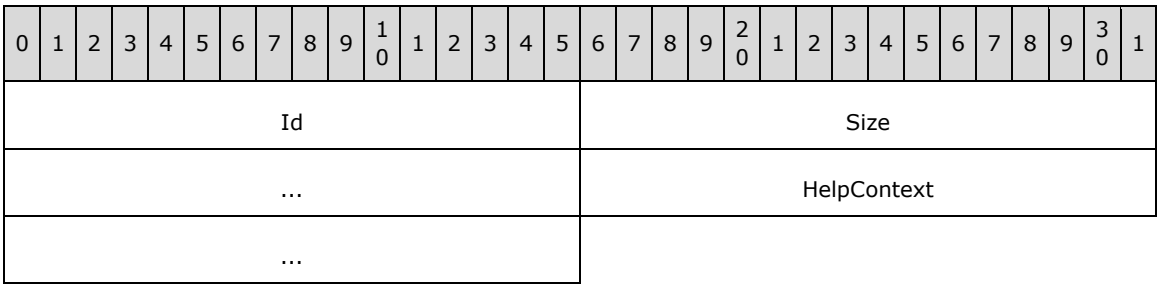
Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0031.

Size (4 bytes): An unsigned integer that specifies the size of **TextOffset**. MUST be 0x00000004.

TextOffset (4 bytes): An unsigned integer that specifies the byte offset of the source code in the **ModuleStream** (section 2.3.4.3) named by **MODULESTREAMNAME** Record (section 2.3.4.2.3.2.3).

2.3.4.2.3.2.6 MODULEHELPCONTEXT Record

Specifies the **Help topic identifier** for the containing **MODULE Record** (section 2.3.4.2.3.2).



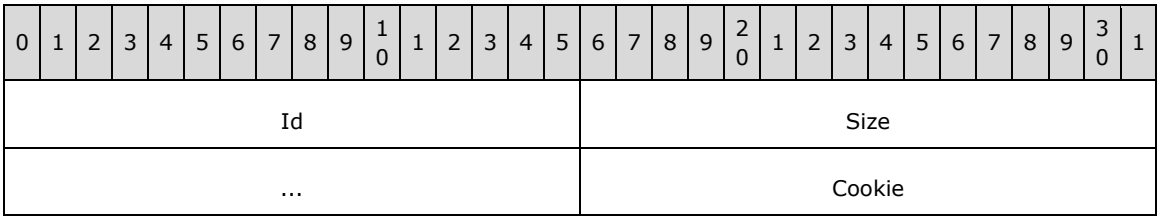
Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x001E.

Size (4 bytes): An unsigned integer that specifies the size of **HelpContext**. MUST be 0x00000004.

HelpContext (4 bytes): An unsigned integer that specifies the Help topic identifier in the **Help file** specified by **PROJECTHELPFILEPATH Record** (section 2.3.4.2.1.7).

2.3.4.2.3.2.7 MODULECOOKIE Record

Specifies ignored data.



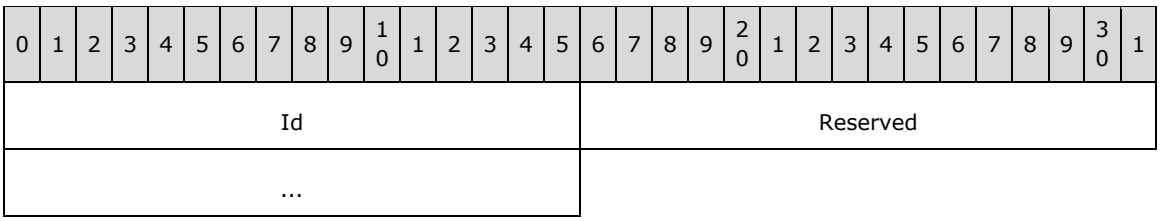
Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x002C.

Size (4 bytes): An unsigned integer that specifies the size of **Cookie**. MUST be 0x00000002.

Cookie (2 bytes): MUST be ignored on read. MUST be 0xFFFF on write.

2.3.4.2.3.2.8 MODULETYPE Record

Specifies whether the containing **MODULE Record** (section 2.3.4.2.3.2) is a **procedural module**, **document module**, **class module**, or **designer module**.

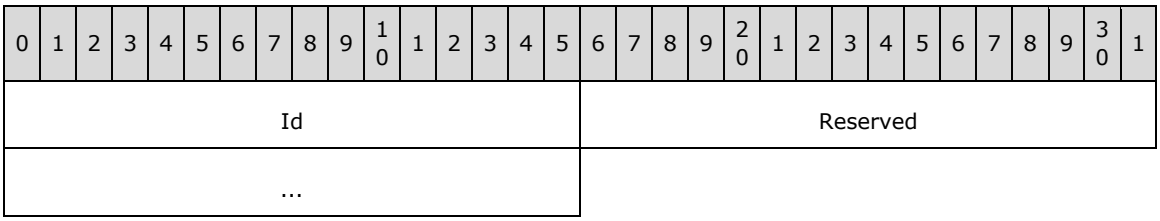


Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0021 when the containing **MODULE Record** (section 2.3.4.2.3.2) is a procedural module. MUST be 0x0022 when the containing **MODULE Record** (section 2.3.4.2.3.2) is a document module, class module, or designer module.

Reserved (4 bytes): MUST be 0x00000000. MUST be ignored.

2.3.4.2.3.2.9 MODULEREADONLY Record

Specifies that the containing **MODULE Record** (section 2.3.4.2.3.2) is read-only.

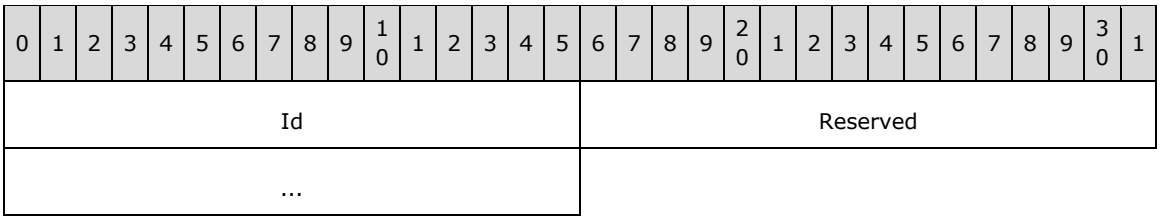


Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0025.

Reserved (4 bytes): MUST be 0x00000000. MUST be ignored.

2.3.4.2.3.2.10 MODULEPRIVATE Record

Specifies that the containing **MODULE Record** (section 2.3.4.2.3.2) is only usable from within the current **VBA project**.

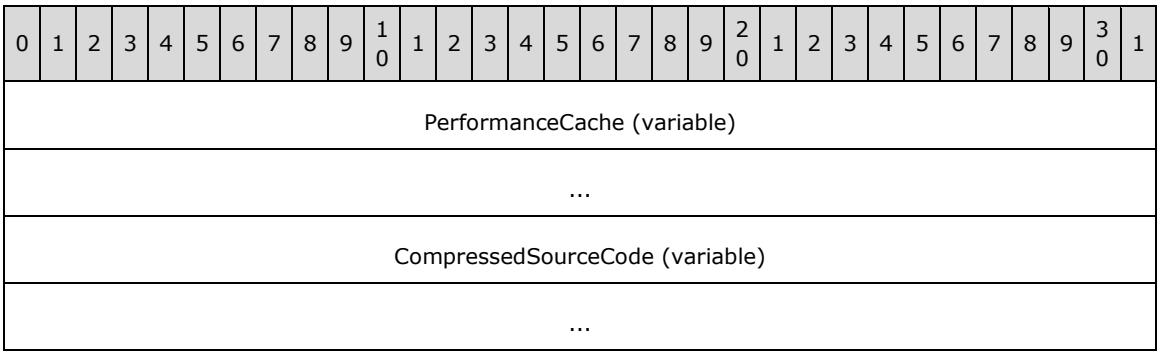


Id (2 bytes): An unsigned integer that specifies the identifier for this record. MUST be 0x0028.

Reserved (4 bytes): MUST be 0x00000000. MUST be ignored.

2.3.4.3 Module Stream: Visual Basic Modules

Specifies the source code for a **module**.



PerformanceCache (variable): An array of bytes that forms an implementation-specific and version-dependent performance cache for the module. MUST be **MODULEOFFSET** (section 2.3.4.2.3.2.5) bytes in size. MUST be ignored on read.

CompressedSourceCode (variable): An array of bytes compressed as specified in Compression (section 2.4.1). When decompressed yields an array of bytes that specifies the textual representation of **VBA** language source code as specified in [MS-VBAL] section 4.2. MUST contain **MBCS** characters encoded using the **code page** specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4).

2.3.5 VBFrame Stream: Designer Information

The VBFrame **stream** specifies the extended property values of a **designer**.

This stream is an array of bytes that specifies the extended property values of a **designer module**. MUST contain **MBCS** characters encoded using the **code page** specified in **PROJECTCODEPAGE** (section 2.3.4.2.1.4).

Property values of the designer are set at design-time. Property values are used at run-time as specified to initialize the designer. For example, a designer can be used at run time to display data to and accept data from a user and the following properties could be used to determine the location of the designer.

ABNF syntax:

```
VBFrameText       = "VERSION 5.00" NWLN
                    "Begin" 1*WSP DesignerCLSID 1*WSP DesignerName *WSP NWLN
                     DesignerProperties "End" NWLN
```

```
DesignerCLSID     = GUID

DesignerName      = ModuleIdentifier
```

<DesignerCLSID>: Specifies the **class identifier (CLSID)** of the designer. The **Automation type library** that contains the designer specified MUST be referenced with a **REFERENCECONTROL** (section 2.3.4.2.2.3). The value "{C62A69F0-16DC-11CE-9E98-00AA00574A4F}" specifies the designer is an Office Form **ActiveX control** specified in [MS-OFORMS].

<DesignerName>: Specifies the name of the designer module associated with the properties.

2.3.5.1 DesignerProperties

Specifies the **VBA**-specific extended properties of a **designer**.

ABNF syntax:

```
DesignerProperties = [ *WSP DesignerCaption *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerHeight *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerLeft *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerTop *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerWidth *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerEnabled *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerHelpContextId *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerRTL *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerShowModal *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerStartupPosition *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerTag *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerTypeInfoVer *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerVisible *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerWhatsThisButton *WSP [ Comment ] NWLN ]
                     [ *WSP DesignerWhatsThisHelp *WSP [ Comment ] NWLN ]

Comment            =  "'" *ANYCHAR
```

<Comment>: Specifies a user-readable comment.

2.3.5.2 DesignerCaption

Specifies the title text of the **designer**.

ABNF syntax:

```
DesignerCaption         = "Caption" EQ DQUOTE DesignerCaptionText DQUOTE

DesignerCaptionText     = *130QUOTEDCHAR
```

2.3.5.3 DesignerHeight

Specifies the height of the **designer** in **twips**.

ABNF syntax:

```
DesignerHeight          = "ClientHeight" EQ FLOAT
```

2.3.5.4 DesignerLeft

Specifies the left edge of the **designer** in **twips** relative to the window specified by **DesignerStartupPosition** (section 2.3.5.11).

ABNF syntax:

```
DesignerLeft            = "ClientLeft" EQ FLOAT
```

2.3.5.5 DesignerTop

Specifies the position of the top edge of the **designer** in **twips** relative to the window specified by **DesignerStartupPosition** (section 2.3.5.11).

ABNF syntax:

```
DesignerTop             = "ClientTop" EQ FLOAT
```

2.3.5.6 DesignerWidth

Specifies the width of the **designer** in **twips**.

ABNF Syntax:

```
DesignerWidth           = "ClientWidth" EQ FLOAT
```

2.3.5.7 DesignerEnabled

Specifies whether the **designer** is enabled. The default is TRUE.

ABNF syntax:

```
DesignerEnabled         = "Enabled" EQ VBABOOL
```

2.3.5.8 DesignerHelpContextId

Specifies the **Help topic identifier** associated with this **designer** in the **Help file** as specified by **ProjectHelpFile** (section 2.3.1.9).

ABNF syntax:

```
DesignerHelpContextId   = "HelpContextID" EQ INT32
```

2.3.5.9 DesignerRTL

Specifies that the **designer** be shown with right and left coordinates reversed for **right-to-left** language use.

ABNF syntax:

```
DesignerRTL             = "RightToLeft" EQ VBABOOL
```

2.3.5.10 DesignerShowModal

Specifies whether the **designer** is a modal window. The default is TRUE.

ABNF syntax:

```
DesignerShowModal       = "ShowModal" EQ VBABOOL
```

2.3.5.11 DesignerStartupPosition

Specifies the startup position of the **designer** as follows.

ABNF syntax:

```
DesignerStartupPosition = "StartUpPosition" EQ RelativeParent

RelativeParent          = "0" / "1" / "2" / "3"
```

<RelativeParent>: Specifies the window used to determine the relative starting coordinates of the control window.

MUST be one of the following values:

Value	Meaning
"0"	"Manual" mode. **DesignerTop** (section 2.3.5.5) and **DesignerLeft** (section 2.3.5.4) coordinates of the designer are relative to the desktop window.
"1"	"CenterOwner" mode. Center the designer relative to its **parent window**.
"2"	"Center" mode. Center the designer relative to the desktop window.
"3"	"WindowsDefault" mode. Place the designer in the upper-left corner of screen.

2.3.5.12 DesignerTag

Specifies user-defined data associated with the **designer**.

ABNF syntax:

```
DesignerTag             = "Tag" EQ DQUOTE DesignerTagText DQUOTE

DesignerTagText         = *130QUOTEDCHAR
```

2.3.5.13 DesignerTypeInfoVer

Specifies the number of times the **designer** has been changed and saved. The default is 0.

ABNF syntax:

```
DesignerTypeInfoVer     = "TypeInfoVer" EQ INT32
```

2.3.5.14 DesignerVisible

Specifies whether the **designer** is visible. The default is TRUE.

ABNF syntax:

```
DesignerVisible         = "Visible" EQ VBABOOL
```

2.3.5.15 DesignerWhatsThisButton

Specifies whether a help button is shown for the **designer**. The default is FALSE.

ABNF syntax:

```
DesignerWhatsThisButton = "WhatsThisButton" EQ VBABOOL
```

2.3.5.16 DesignerWhatsThisHelp

Specifies whether a help topic is associated with this **designer**. The **Help topic identifier** is specified by **DesignerHelpContextId** (section 2.3.5.8).

ABNF syntax:

```
DesignerWhatsThisHelp   = "WhatsThisHelp" EQ VBABOOL
```

2.4 Algorithms

2.4.1 Compression and Decompression

To preserve space, **VBA** uses data compression on a contiguous sequence of records on various **streams**. The data compression technique is **run length encoding**.

The compression algorithm repeatedly reads 4096 bytes from the decompressed buffer into an array. Each group of 4096 bytes is called a chunk. The compression algorithm writes each 4096 byte chunk in an encoded and compressed format. Each output chunk is preceded by a two byte header which denotes the number of bytes in the chunk and the format of the chunk.

The compression algorithm searches for series of bytes that are repeated within the chunk. When series with multiple occurrences are found, the bytes in the first occurrence are encoded as literal tokens and the remaining occurrences are encoded as copy tokens which reference the first occurrence. The encoding for a repeated series of bytes is two bytes in length, thus matches of three bytes or more are required for encoding to be beneficial. Tokens are organized into groups of eight called a Token Sequence, which includes a flag byte. The flag byte is written in advance of the eight tokens. Each bit in the flag byte is used to identify the type of one of the token.

If the compression algorithm fails in producing enough copy tokens to compensate for the space overhead of the copy tokens and the flag bytes, the 4096 byte input chunk is written to the output chunk without any encoding.

The decompression algorithm reads one compressed chunk at a time. Each compressed chunk is decoded into 4096 bytes of uncompressed data which is written to output. For each chunk, the size and format style are extracted from the chunk header. The chunk is then read and decoded according to the format specified in the header.

When the chunk header format specifies that the chunk contains no copy tokens, the 4096 remaining bytes are copied to output. When the chunk header format specifies that copy tokens exist in the chunk, the Token Sequences are decoded. Literal tokens are copied to output. Copy tokens are decoded to find the first occurrence of the byte sequence the copy token represents which is then copied to output.

The pseudocode and record specifications for Compression and Decompression use the following conventions.

- LEFT SHIFT: Bits in the operand are moved from the least significant to the most significant positions. High order bits are truncated. Low order bits become zero.
- RIGHT SHIFT: Bits in the operand are moved from the most significant position to the least significant positions. Low order bits are truncated. High order bits become zero.
- A literal bit sequence is denoted with the initial characters 0b. For example, the literal constant 0xB721 would appear as the binary literal 0b1011011100100001.

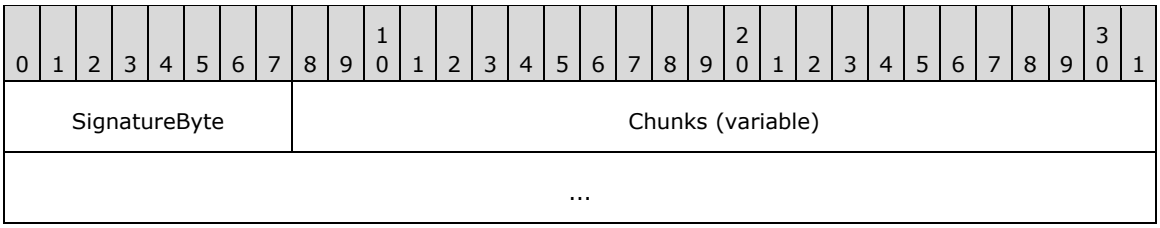
2.4.1.1 Structures

2.4.1.1.1 CompressedContainer

A **CompressedContainer** is an array of bytes holding the compressed data. The **Decompression** algorithm (section 2.4.1.3.1) processes a **CompressedContainer** to populate a **DecompressedBuffer**. The **Compression** algorithm (section 2.4.1.3.6) processes a **DecompressedBuffer** to produce a **CompressedContainer**.

A **CompressedContainer** MUST be the last array of bytes in a **stream**. On read, the end of stream indicator determines when the entire **CompressedContainer** has been read.

The **CompressedContainer** is a **SignatureByte** followed by array of **CompressedChunk** (section 2.4.1.1.4) structures.

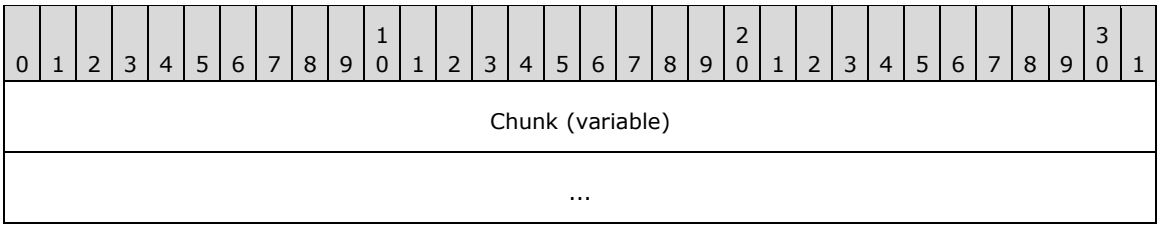


SignatureByte (1 byte): Specifies the beginning of the **CompressedContainer.** MUST be 0x01. The **Decompression** algorithm (section 2.4.1.3.1) reads **SignatureByte**. The **Compression** algorithm (section 2.4.1.3.6) writes **SignatureByte**.

Chunks (variable): An array of **CompressedChunk** (section 2.4.1.1.4) records. Specifies the compressed data. Read by the **Decompression** algorithm. Written by the **Compression** algorithm.

2.4.1.1.2 DecompressedBuffer

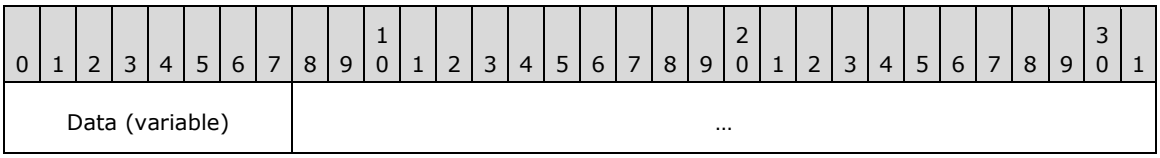
The **DecompressedBuffer** is a resizable array of bytes that contains the same data as the **CompressedContainer** (section 2.4.1.1.1), but the data is in an uncompressed format.



Chunk (variable): An array of **DecompressedChunk** (section 2.4.1.1.3) structures. The number of bytes in the last **DecompressedChunk** in a **DecompressedBuffer** (section 2.4.1.1.2) MUST be greater than zero. The number of bytes in the last **DecompressedChunk** in a **DecompressedBuffer** MUST be less than or equal to 4096. The number of bytes in all other **DecompressedChunks** MUST be 4096. Read by the **Compression** algorithm (section 2.4.1.3.6). Written by the **Decompression** algorithm (section 2.4.1.3.1).

2.4.1.1.3 DecompressedChunk

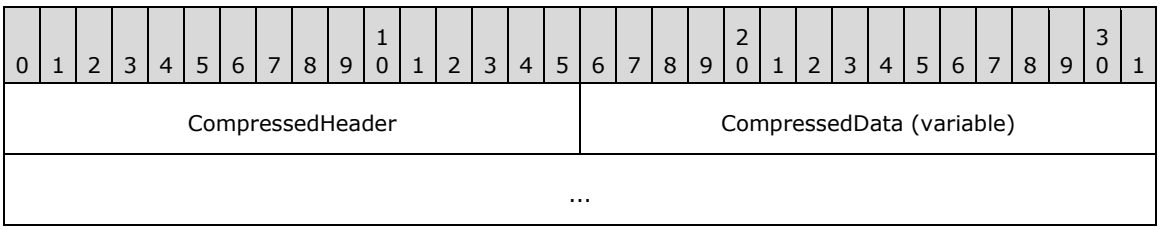
A **DecompressedChunk** is a resizable array of bytes in the **DecompressedBuffer** (section 2.4.1.1.2). The byte array is the data from a **CompressedChunk** (section 2.4.1.1.4) in uncompressed format.



Data (variable): An array of bytes. Each byte specifies a copy of one byte of the **DecompressedBuffer** (section 2.4.1.1.2).

2.4.1.1.4 CompressedChunk

A **CompressedChunk** is a record that encodes all data from a **DecompressedChunk** (section 2.4.1.1.3) in compressed format. A **CompressedChunk** has two parts: a **CompressedChunkHeader** (section 2.4.1.1.5) followed by a **CompressedChunkData** (section 2.4.1.1.6). The number of bytes in a **CompressedChunk** MUST be greater than or equal to 3. The number of bytes in a **CompressedChunk** MUST be less than or equal to 4098.

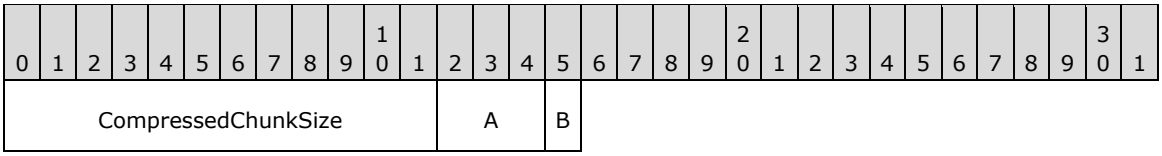


CompressedHeader (2 bytes): A **CompressedChunkHeader**. Read by the **Decompressing a CompressedChunk** algorithm (section 2.4.1.3.2). Written by the **Compressing a DecompressedChunk** algorithm (section 2.4.1.3.7).

CompressedData (variable): A **CompressedChunkData**. The size of **CompressedData** MUST be greater than zero. The size of **CompressedData** MUST be less than or equal to 4096. Read by the **Decompressing a CompressedChunk** algorithm. Written by the **Compressing a DecompressedChunk**.

2.4.1.1.5 CompressedChunkHeader

A **CompressedChunkHeader** is the first record in a **CompressedChunk** (section 2.4.1.1.4). A **CompressedChunkHeader** specifies the size of the entire **CompressedChunk** and the data encoding format in **CompressedChunk**.**CompressedData**. **CompressedChunkHeader** information is used by the **Decompressing a CompressedChunk** (section 2.4.1.3.2) and **Compressing a DecompressedChunk** (section 2.4.1.3.7) algorithms.



CompressedChunkSize (12 bits): An unsigned integer that specifies the number of bytes in the **CompressedChunk** minus 3. MUST be greater than or equal to zero. If **CompressedChunkFlag** is equal to 0b1, this element MUST be less than or equal to 4095. If **CompressedChunkFlag** is equal to 0b0, this element MUST be 4095. Read by the **Extract CompressedChunkSize** (section 2.4.1.3.12) algorithm. Written by the **Pack CompressedChunkSize** (section 2.4.1.3.13) algorithm.

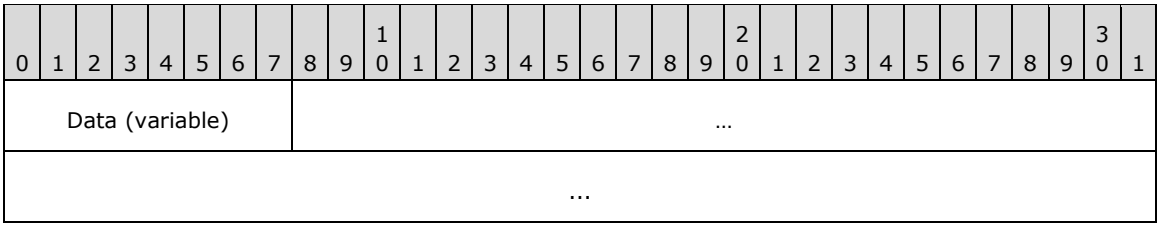
A – CompressedChunkSignature (3 bits): MUST be 0b011. Written by the **Pack CompressedChunkSignature** (section 2.4.1.3.14) algorithm.

B – CompressedChunkFlag (1 bit): A bit specifying how **CompressedChunk.CompressedData** is compressed. If this is 0b1, **CompressedChunk.CompressedData** is in compressed format. If this is 0b0, **CompressedChunk.CompressedData** contains uncompressed data. Read by the **Extract CompressedChunkFlag** (section 2.4.1.3.15) algorithm. Written by the **Pack CompressedChunkFlag** (section 2.4.1.3.16) algorithm.

2.4.1.1.6 CompressedChunkData

If **CompressedChunkHeader.CompressedChunkFlag** (section 2.4.1.1.5) is 0b0, **CompressedChunkData** contains an array of **CompressedChunkHeader.CompressedChunkSize** elements plus 3 bytes of uncompressed data.

If **CompressedChunkHeader CompressedChunkFlag** is 0b1, **CompressedChunkData** contains an array of **TokenSequence** (section 2.4.1.1.7) elements.

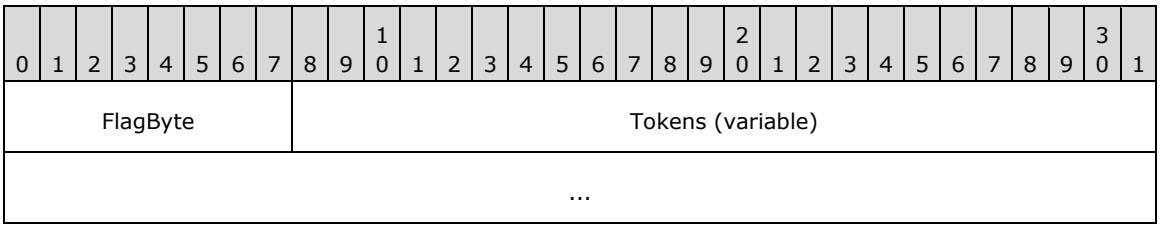


Data (variable): An array of bytes. Specifies an encoding of bytes from the **DecompressedBuffer** (section 2.4.1.1.2). The size of **Data** in bytes MUST be **CompressedChunk.CompressedChunkHeader.CompressedChunkSize** (section 2.4.1.1.4) plus 3. Bytes from the **DecompressedChunk** (section 2.4.1.1.3) are encoded and written to **Data** by the **Compressing a DecompressedChunk** (section 2.4.1.3.7) algorithm. **Data** is read from the **CompressedChunk** to be decoded and written to the **DecompressedChunk** by the **Decompressing a CompressedChunk** (section 2.4.1.3.2) algorithm.

2.4.1.1.7 TokenSequence

A **TokenSequence** is a **FlagByte** followed by an array of **Token**s. The number of **Tokens** in the final **TokenSequence** MUST be greater than or equal to 1. The number of **Token**s in the final

TokenSequence MUST less than or equal to eight. All other **TokenSequences** in the **CompressedChunkData** MUST contain eight **Token**s.



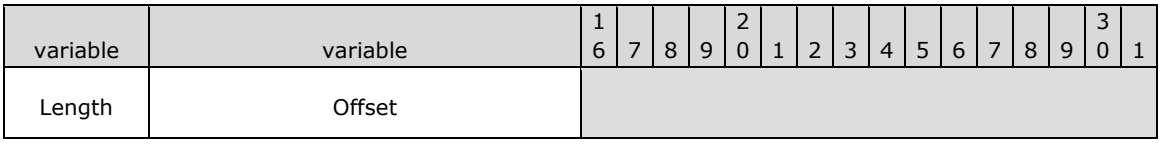
FlagByte (1 byte): An array of bits. Each bit specifies the type of a **Token** in the **TokenSequence**. A value of 0b0 specifies a **LiteralToken**. A value of 0b1 specifies a **CopyToken** (section 2.4.1.1.8). The least significant bit in the **FlagByte** denotes the first **Token** in the **TokenSequence**. The most significant bit in the **FlagByte** denotes the last **Token** in the **TokenSequence**. The correspondence between a **FlagByte** element and a **Token** element is maintained by the **Decompressing a TokenSequence** (section 2.4.1.3.4) and the **Compressing a TokenSequence** (section 2.4.1.3.8) algorithms.

Tokens (variable): An array of **Token**s. Each **Token** can either be a **LiteralToken** or a **CopyToken** as specified by the corresponding bit in **FlagByte**. A **LiteralToken** is a copy of one byte, in uncompressed format, from the **DecompressedBuffer** (section 2.4.1.1.2). A **CopyToken** is a 2-byte encoding of 3 or more bytes from the **DecompressedBuffer**. Read by the **Decompressing a TokenSequence** algorithm. Written by the **Compressing a TokenSequence** algorithm.

2.4.1.1.8 CopyToken

CopyToken is a two-byte record interpreted as an unsigned 16-bit integer in **little-endian** order. A **CopyToken** is a compressed encoding of an array of bytes from a **DecompressedChunk** (section 2.4.1.1.3). The byte array encoded by a **CopyToken** is a byte-for-byte copy of a byte array elsewhere in the same **DecompressedChunk**, called a **CopySequence** (section 2.4.1.3.19).

The starting location, in a **DecompressedChunk**, is determined by the **Compressing a Token** (section 2.4.1.3.9) and the **Decompressing a Token** (section 2.4.1.3.5) algorithms. Packed into the **CopyToken** is the **Offset**, the distance, in byte count, to the beginning of the **CopySequence**. Also packed into the **CopyToken** is the **Length**, the number of bytes encoded in the **CopyToken**. **Length** also specifies the count of bytes in the **CopySequence**. The values encoded in **Offset** and **Length** are computed by the **Matching** (section 2.4.1.3.19.4) algorithm.



Length (variable): A variable bit unsigned integer that specifies the number of bytes contained in a **CopySequence** minus three. MUST be greater than or equal to zero. MUST be less than 4093. The number of bits used to encode **Length** MUST be greater than or equal to four. The number of bits used to encode **Length** MUST be less than or equal to 12. The number of bits used to encode **Length** is computed and used in the **Unpack CopyToken** (section 2.4.1.3.19.2) and the **Pack CopyToken** (section 2.4.1.3.19.3) algorithms.

Offset (variable): A variable bit unsigned integer that specifies the distance, in byte count, from the beginning of a duplicate set of bytes in the DecompressedBuffer to the beginning of a CopySequence. The value stored in **Offset** is the distance minus three. MUST be greater than zero. MUST be less than 4096. The number of bits used to encode **Offset** MUST be greater than or equal to four. The number of bits used to encode **Offset** MUST be less than or equal to 12. The

number of bits used to encode **Offset** is computed and used in the **Unpack CopyToken** and the **Pack CopyToken** algorithms.

2.4.1.2 State Variables

The following state is maintained for the **CompressedContainer** (section 2.4.1.1.1):

CompressedRecordEnd: The location of the byte after the last byte in the **CompressedContainer** (section 2.4.1.1.1).

CompressedCurrent: The location of the next byte in the **CompressedContainer** (section 2.4.1.1.1) to be read by decompression or to be written by compression.

The following state is maintained for the current **CompressedChunk** (section 2.4.1.1.4):

CompressedChunkStart: The location of the first byte of the **CompressedChunk** (section 2.4.1.1.4) within the **CompressedContainer** (section 2.4.1.1.1).

The following state is maintained for a **DecompressedBuffer** (section 2.4.1.1.2):

DecompressedCurrent: The location of the next byte in the **DecompressedBuffer** (section 2.4.1.1.2) to be written by decompression or to be read by compression.

DecompressedBufferEnd: The location of the byte after the last byte in the **DecompressedBuffer** (section 2.4.1.1.2).

The following state is maintained for the current **DecompressedChunk** (section 2.4.1.1.3):

DecompressedChunkStart: The location of the first byte of the **DecompressedChunk** (section 2.4.1.1.3) within the **DecompressedBuffer** (section 2.4.1.1.2).

2.4.1.3 Algorithms

2.4.1.3.1 Decompression Algorithm

The Decompression algorithm pseudocode decodes the data in a **CompressedContainer** (section 2.4.1.1.1) and writes the uncompressed bytes to a **DecompressedBuffer** (section 2.4.1.1.2). The pseudocode first validates **CompressedContainer SignatureByte** (section 2.4.1.1.1). If validation fails, then the **CompressedContainer** (section 2.4.1.1.1) is corrupt and cannot be decoded. The pseudocode then iterates over the **CompressedChunks** (section 2.4.1.1.4). On each iteration, the current **CompressedChunk** is decoded.

The pseudocode to decompress the **CompressedContainer** (section 2.4.1.1.1) into the **DecompressedBuffer** (section 2.4.1.1.2) uses the state variables described in State Variables (section 2.4.1.2): **CompressedCurrent**, **CompressedRecordEnd**, and **DecompressedCurrent**. These state variables MUST be initialized by the caller. **CompressedChunkStart** is also used.

- IF the byte located at CompressedCurrent EQUALS 0x01 THEN
  - INCREMENT CompressedCurrent
  - WHILE CompressedCurrent is LESS THAN CompressedRecordEnd
    - SET CompressedChunkStart TO CompressedCurrent
    - CALL Decompressing a CompressedChunk
  - END WHILE
- ELSE

        - RAISE ERROR
    - ENDIF

2.4.1.3.2 Decompressing a CompressedChunk

The **Decompressing a CompressedChunk** pseudocode decodes the data in a **CompressedChunk** (section 2.4.1.1.4) and writes the uncompressed bytes to the **DecompressedBuffer** (section 2.4.1.1.2).

The **Decompressing a CompressedChunk** pseudocode inspects **CompressedChunk.CompressedChunkHeader CompressedChunkFlag** (section 2.4.1.1.5) to determine the encoding format of **CompressedChunk CompressedData** (section 2.4.1.1.4), and then decodes the **CompressedChunkData** (section 2.4.1.1.6) using the format.

The pseudocode for **Decompressing a CompressedChunk** uses the state variables described in State Variables (section 2.4.1.2): **DecompressedChunkStart**, **DecompressedCurrent**, **CompressedRecordEnd**, **CompressedCurrent**, and **CompressedChunkStart**.

- SET Header TO the **CompressedChunkHeader** (section 2.4.1.1.5) located at **CompressedChunkStart**
- CALL **Extract CompressedChunkSize** (section 2.4.1.3.12) with Header returning **Size**
- CALL **Extract CompressedChunkFlag** (section 2.4.1.3.15) with Header returning **CompressedFlag**
- SET **DecompressedChunkStart** TO **DecompressedCurrent**
- SET **CompressedEnd** TO the minimum of **CompressedRecordEnd** and (**CompressedChunkStart** PLUS **Size**)
- SET **CompressedCurrent** TO **CompressedChunkStart** PLUS 2
- IF **CompressedFlag** EQUALS 1 THEN
    - WHILE **CompressedCurrent** is LESS THAN **CompressedEnd**
        - CALL **Decompressing a TokenSequence** (section 2.4.1.3.4) with **CompressedEnd**
    - END WHILE
- ELSE
    - CALL **Decompressing a RawChunk** (section 2.4.1.3.3)
- ENDIF

2.4.1.3.3 Decompressing a RawChunk

The **Decompressing a RawChunk** pseudocode is called when the **CompressedChunkFlag** of the current **CompressedChunk** (section 2.4.1.1.4) is 0b0. **CompressedChunk.CompressedChunkData** (section 2.4.1.1.6) MUST contain 4096 bytes of uncompressed data. The **Decompressing a RawChunk** pseudocode copies the uncompressed data to the **DecompressedBuffer** (section 2.4.1.1.2).

The pseudocode for **Decompressing a CompressedChunk** uses the state variables described in State Variables (section 2.4.1.2): **DecompressedCurrent**, **CompressedCurrent**.

- APPEND 4096 bytes from CompressedCurrent TO DecompressedCurrent

- INCREMENT DecompressedCurrent BY 4096
- INCREMENT CompressedCurrent BY 4096

2.4.1.3.4 Decompressing a TokenSequence

The pseudocode for **Decompressing a TokenSequence** decodes the compressed data in a single **TokenSequence** (section 2.4.1.1.7) out of a **CompressedChunk** (section 2.4.1.1.4). The uncompressed data is written to the **DecompressedBuffer** (section 2.4.1.1.2).

The pseudocode for **Decompressing a TokenSequence** take the following input parameter.

CompressedEnd: Specifies the location of the byte after the last byte in the current **CompressedChunk** (section 2.4.1.1.4).

The pseudocode for **Decompressing a TokenSequence** uses the state variable described in State Variables (section 2.4.1.2): **CompressedCurrent**.

- SET Byte TO the **FlagByte** (section 2.4.1.1.7) located at CompressedCurrent
- INCREMENT CompressedCurrent
- IF CompressedCurrent is LESS THAN CompressedEnd THEN
  - FOR index FROM 0 TO 7 INCLUSIVE
    - IF CompressedCurrent is LESS THAN CompressedEnd THEN
      - CALL **Decompressing a Token** (section 2.4.1.3.5) with index and Byte
    - ENDIF
  - ENDFOR
- ENDIF

2.4.1.3.5 Decompressing a Token

The **Decompressing a Token** pseudocode decodes a single token producing uncompressed data. The uncompressed data is written to the **DecompressedBuffer** (section 2.4.1.1.2).

The **Decompressing a Token** pseudocode takes the following input parameters:

Index: An unsigned integer that specifies the element of a **TokenSequence** (section 2.4.1.1.7) to decompress. MUST be greater than or equal to zero. MUST be less than or equal to 7.

Byte (1 byte): The **FlagByte** of the current **TokenSequence** (section 2.4.1.1.7).

The pseudocode for decompressing a token uses the state variables described in State Variables (section 2.4.1.2): **CompressedCurrent**, **DecompressedCurrent**.

- CALL **Extract FlagBit** (section 2.4.1.3.17) with index and Byte returning Flag
- IF Flag EQUALS 0 THEN
  - COPY the byte at CompressedCurrent TO DecompressedCurrent
  - INCREMENT DecompressedCurrent
  - INCREMENT CompressedCurrent
- ELSE

    - SET Token TO the **CopyToken** (section 2.4.1.1.8) at CompressedCurrent
    - CALL **Unpack CopyToken** (section 2.4.1.3.19.2) with Token returning Offset and Length
    - SET CopySource TO DecompressedCurrent MINUS Offset
    - CALL **Byte Copy** (section 2.4.1.3.11) with CopySource, DecompressedCurrent, and Length
    - INCREMENT DecompressedCurrent BY Length
    - INCREMENT CompressedCurrent BY 2
- ENDIF

2.4.1.3.6 Compression algorithm

The pseudocode for the **Compression algorithm** uses the state variables described in State Variables (section 2.4.1.2): **DecompressedCurrent**, **DecompressedBufferEnd**, and **CompressedCurrent**. These state variables MUST be initialized by the caller. **CompressedChunkStart** and **DecompressedChunkStart** are also used.

- SET SignatureByte TO 0x01
- INCREMENT CompressedCurrent
- WHILE DecompressedCurrent is LESS THAN DecompressedBufferEnd
    - SET CompressedChunkStart TO CompressedCurrent
    - SET DecompressedChunkStart TO DecompressedCurrent
    - CALL **Compressing a DecompressedChunk** (section 2.4.1.3.7)
- END WHILE

2.4.1.3.7 Compressing a DecompressedChunk

The pseudocode to compress a **DecompressedChunk** (section 2.4.1.1.3) to a **CompressedChunk** (section 2.4.1.1.4) uses the state variables described in State Variables (section 2.4.1.2): **CompressedChunkStart, CompressedCurrent, DecompressedChunkStart, DecompressedBufferEnd**, and **DecompressedCurrent**.

- SET CompressedEnd TO CompressedChunkStart PLUS 4098
- SET CompressedCurrent TO the CompressedChunkStart PLUS 2
- SET DecompressedEnd TO the minimum of (DecompressedChunkStart PLUS 4096) and DecompressedBufferEnd
- WHILE (DecompressedCurrent is LESS THAN DecompressedEnd) AND (CompressedCurrent is LESS THAN CompressedEnd)
    - CALL Compressing a TokenSequence (section 2.4.1.3.8) with CompressedEnd and DecompressedEnd
- END WHILE
- IF DecompressedCurrent is LESS THAN DecompressedEnd THEN
    - CALL Compressing a RawChunk (section 2.4.1.3.10) with DecompressedEnd MINUS 1
    - SET CompressedFlag TO 0

- ELSE
  - SET CompressedFlag TO 1
- ENDIF
- SET Size TO CompressedCurrent MINUS CompressedChunkStart
- SET Header TO 0x0000
- CALL Pack CompressedChunkSize (section 2.4.1.3.13) with Size and Header
- CALL Pack CompressedChunkFlag (section 2.4.1.3.16) with CompressedFlag and Header
- CALL Pack CompressedChunkSignature (section 2.4.1.3.14) with Header
- SET the CompressedChunkHeader (section 2.4.1.1.5) located at CompressedChunkStart TO Header

2.4.1.3.8 Compressing a TokenSequence

The **Compressing a TokenSequence** pseudocode encodes a sub array of the **DecompressedChunk** (section 2.4.1.1.3) into a **TokenSequence** (section 2.4.1.1.7). The TokenSequence is written to the **CompressedChunk** (section 2.4.1.1.4). The location of the **FlagByte** of the **TokenSequence** (section 2.4.1.1.7) is reserved and then the Compressing a Token algorithm (section 2.4.1.3.9) is called to manufacture the individual **Tokens**. After the encoding of each **Token** has been computed, the **FlagByte** is updated.

The **Compressing a TokenSequence** pseudocode takes the following input parameters.

CompressedEnd: The location of the next byte after the end of the current **CompressedChunk** (section 2.4.1.1.4).

DecompressedEnd: The location of the next byte after the end of the current **DecompressedChunk** (section 2.4.1.1.3).

The pseudocode for **Compressing a TokenSequence** uses the state variables described in State Variables (section 2.4.1.2): **CompressedCurrent** and **DecompressedCurrent**.

- SET FlagByteIndex TO CompressedCurrent
- SET TokenFlags TO 0b00000000
- INCREMENT CompressedCurrent
- FOR index FROM 0 TO 7 INCLUSIVE
  - IF (DecompressedCurrent is LESS THAN DecompressedEnd)
    - AND (CompressedCurrent is LESS THAN CompressedEnd) THEN
      - CALL Compressing a Token with CompressedEnd, DecompressedEnd,
        - index, and TokenFlags,
        - returning TokenFlags
  - ENDIF
- ENDFOR
- SET the byte at location FlagByteIndex TO TokenFlags

2.4.1.3.9 Compressing a Token

The **Compressing a Token** pseudocode uses the Matching algorithm (section 2.4.1.3.19.4) to determine the type of **Token** that can be placed at **CompressedCurrent**, manufactures the **Token**, and places the **Token** in the **CompressedChunk** (section 2.4.1.1.4) at **CompressedCurrent**. If placing the **Token** at **CompressedCurrent** would exceed the boundaries of the current **CompressedChunk** (section 2.4.1.1.4), the **Token** is not inserted and **CompressedCurrent** is set to a value that will signal calling algorithms that the **CompressedChunk** (section 2.4.1.1.4) is full.

The **Compressing a Token** pseudocode takes the following input parameter.

CompressedEnd: The location of the next byte after the end of the current **CompressedChunk** (section 2.4.1.1.4).

DecompressedEnd: The location of the first byte after the end of the **DecompressedChunk** (section 2.4.1.1.3).

Index: An integer that specifies the ordinal of the **Token** within a **TokenSequence** (section 2.4.1.1.7) being encoded. MUST be greater than or equal to 0. MUST be less than or equal to 7.

The **Compressing a Token** pseudocode takes the following input/output parameter.

Flags(1 byte): The **FlagByte** of the current **TokenSequence** (section 2.4.1.1.7).

The pseudocode for **Compressing a Token** uses the state variables described in State Variables (section 2.4.1.2): **CompressedCurrent** and **DecompressedCurrent**.

- SET Offset TO zero
- CALL Matching (section 2.4.1.3.19.4) with DecompressedEnd returning Offset and Length
- IF Offset is not zero THEN
  - IF (CompressedCurrent PLUS 1) is LESS THAN CompressedEnd THEN
    - CALL Pack CopyToken (section 2.4.1.3.19.3) with Offset and Length returning Token
    - APPEND the bytes of the CopyToken (section 2.4.1.1.8) Token TO CompressedCurrent in little-endian order
    - CALL Set FlagBit (section 2.4.1.3.18) with index, 1, and Flags
    - INCREMENT CompressedCurrent BY 2
    - INCREMENT DecompressedCurrent BY Length
  - ELSE
    - SET CompressedCurrent TO CompressedEnd
  - ENDIF
- ELSE
  - IF CompressedCurrent is LESS THAN CompressedEnd THEN
    - APPEND the byte of the LiteralToken at DecompressedCurrent
      - TO CompressedCurrent
    - INCREMENT CompressedCurrent

        - INCREMENT DecompressedCurrent
    - ELSE
        - SET CompressedCurrent TO CompressedEnd
    - ENDIF
- ENDIF

2.4.1.3.10 Compressing a RawChunk

The **Compressing a RawChunk** pseudocode is called when the number of bytes in a **CompressedChunk.CompressedData** (section 2.4.1.1.4) array exceeds 4096. The bytes from the **DecompressedChunk** (section 2.4.1.1.3) are copied, with no compression, into **CompressedChunk.CompressedData** (section 2.4.1.1.4). If fewer than 4096 bytes are copied then the remaining bytes in **CompressedChunk.CompressedData.Data** array are padded with the literal value 0x00.<10>

Compressing a RawChunk takes the following input parameter.

LastByte: Specifies the location of the last byte of the **DecompressedChunk**.

The pseudocode for **Compressing a RawChunk** uses the state variables described in State Variables (section 2.4.1.2): **CompressedCurrent, CompressedChunkStart, DecompressedChunkStart,** and **DecompressedCurrent**.

- SET CompressedCurrent TO CompressedChunkStart PLUS 2
- SET DecompressedCurrent TO DecompressedChunkStart
- SET PadCount TO 4096
- FOR each byte, B, FROM DecompressedChunkStart TO LastByte INCLUSIVE
    - COPY B TO CompressedCurrent
    - INCREMENT CompressedCurrent
    - INCREMENT DecompressedCurrent
    - DECREMENT PadCount
- ENDFOR
- FOR counter FROM 1 TO PadCount INCLUSIVE
    - COPY 0x00 TO CompressedCurrent
    - INCREMENT CompressedCurrent
- ENDFOR

2.4.1.3.11 Byte Copy

The **Byte Copy** pseudocode will copy a source sequence of bytes to a destination sequence of bytes. The source and destination sequences are allowed to overlap; thus it is possible for the **Byte Copy** operation to modify bytes in the source sequence.

Byte copy takes the following input parameters:

CopySource: Specifies the location, in the **DecompressedBuffer**, of the first byte of the source sequence.

DestinationSource: Specifies the location, in the **DecompressedBuffer**, of the first byte of the destination sequence.

ByteCount: Specifies the number of bytes to copy. MUST be greater than 0.

The pseudocode follows:

- SET SrcCurrent TO CopySource
- SET DstCurrent TO DestinationSource
- FOR counter FROM 1 TO ByteCount INCLUSIVE
  - COPY the byte at SrcCurrent TO DstCurrent
  - INCREMENT SrcCurrent
  - INCREMENT DstCurrent
- ENDFOR

2.4.1.3.12 Extract CompressedChunkSize

The Extract CompressedChunkSize pseudocode is used to unpack the size of a **CompressedChunk** (section 2.4.1.1.4) from its **CompressedChunkHeader** (section 2.4.1.1.5). The pseudocode takes the following input parameter:

Header (2 bytes): An instance of a **CompressedChunkHeader** (section 2.4.1.1.5).

The Extract CompressedChunkSize pseudocode takes the following output parameter:

Size (2 bytes): An unsigned 16-bit integer. The number of bytes in the **CompressedChunk** (section 2.4.1.1.4) MUST be less than or equal to 4098. MUST be greater than or equal to three.

- SET temp TO Header BITWISE AND 0x0FFF
- SET Size TO temp PLUS 3

2.4.1.3.13 Pack CompressedChunkSize

Pack CompressedChunkSize pseudocode takes the following input parameters:

Size: An unsigned 16-bit integer. The number of bytes in the **CompressedChunk** (section 2.4.1.1.4). MUST be less than or equal to 4098. MUST be greater than or equal to three.

Pack CompressedChunkSize pseudocode take the following input/output parameter:

Header: An instance of a **CompressedChunkHeader** (section 2.4.1.1.5).

- SET temp1 TO Header BITWISE AND 0xF000
- SET temp2 TO Size MINUS 3
- SET Header TO temp1 BITWISE OR temp2

2.4.1.3.14 Pack CompressedChunkSignature

Pack CompressedChunkSignature sets the **CompressedChunkSignature** of a **CompressedChunkHeader** (section 2.4.1.1.5) to 0b011.

The **Pack CompressedChunkSignature** pseudocode takes the following input/output parameter:

Header (2 bytes): An instance of a **CompressedChunkHeader** (section 2.4.1.1.5).

- SET temp TO Header BITWISE AND 0x8FFF
- SET Header TO temp BITWISE OR 0x3000

2.4.1.3.15 Extract CompressedChunkFlag

The **Extract CompressedChunkFlag** pseudocode takes the following input parameter:

Header (2 bytes): An instance of a **CompressedChunkHeader** (section 2.4.1.1.5).

The **Extract CompressedChunkFlag** pseudocode takes the following output parameter:

CompressedFlag: An unsigned integer. The value returned MUST be zero or one.

- SET temp TO Header BITWISE AND 0x8000
- SET CompressedFlag TO temp RIGHT SHIFT BY 15

2.4.1.3.16 Pack CompressedChunkFlag

The **Pack CompressedChunkFlag** pseudocode takes the following input parameter:

CompressedFlag: An unsigned integer. MUST be zero or one.

The **Pack CompressedChunkFlag** pseudocode takes the following input/output parameter:

Header (2 bytes): An instance of a **CompressedChunkHeader** (section 2.4.1.1.5).

- SET temp1 TO Header BITWISE AND 0x7FFF
- SET temp2 TO CompressedFlag LEFT SHIFT BY 15
- SET Header TO temp1 BITWISE OR temp2

2.4.1.3.17 Extract FlagBit

The **Extract FlagBit** pseudocode takes the following input parameters:

Index: An unsigned integer specifying which FlagBit to extract. MUST be greater than or equal to zero and less than eight.

Byte (1 byte): An instance of a **FlagByte**.

The **Extract FlagBit** pseudocode returns the following output parameters:

Flag: An integer. The value of the bit in **Byte** at location **Index**. The value returned MUST be zero or one.

- SET Flag TO (Byte RIGHT SHIFT BY Index) BITWISE AND 1

2.4.1.3.18 Set FlagBit

The **Set FlagBit** pseudocode sets a specified bit in a FlagByte to 0b0 or 0b1.

The **Set FlagBit** pseudocode takes the following input parameters:

Index: An unsigned integer specifying which FlagBit to set. MUST be greater than or equal to zero. MUST be less than eight.

Flag: An integer. Specifies the bit value to set at location **Index** in **Byte**. MUST be zero or one.

The **Set FlagBit** pseudocode takes the following input/output parameters:

Byte (1 byte): An instance of a **FlagByte**.

- SET temp1 TO Flag LEFT SHIFT BY Index
- SET temp2 TO Byte BITWISE AND (BITWISE NOT temp1)
- SET Byte TO temp2 BITWISE OR temp1

2.4.1.3.19 CopyToken Algorithms

Packed into a **CopyToken** (section 2.4.1.1.8) are an **Offset** value and a **Length** value. The **Offset**, **Length** pair specify the start and length of a sequence of bytes, called a **CopySequence**, in the **DecompressedChunk**. A **CopySequence** is an array of bytes in the **DecompressedChunk** (section 2.4.1.1.3) that are duplicated starting at **DecompressedCurrent**. The **Matching algorithm** (section 2.4.1.3.19.4) will search for a **CopySequence**.

The start of a **CopySequence** MUST be before **DecompressedCurrent**. The start of the **CopySequence** MUST be at or after **DecompressedChunkStart**. The number of bytes in a **CopySequence** MUST be greater than or equal to three. The number of bytes in a **CopySequence** MUST be less than 4096.

Offset specifies the start of the **CopySequence**. **Offset** is the difference between **DecompressedCurrent** and the start of the **CopySequence** minus one. **Length** is the number of bytes minus three in the **CopySequence**.

The number of bits used to pack **Offset** and **Length** is a function of the relationship between **DecompressedCurrent** and **DecompressedChunkStart** as specified as:

DecompressedCurrent minus DecompressedChunkStart	Number of bits used to pack Length	Largest possible value for Length	Number of bits used to pack Offset
1 to 16	12	4098	4
17 to 32	11	2050	5
33 to 64	10	1026	6
65 to 128	9	514	7
129 to 256	8	258	8
257 to 512	7	130	9
513 to 1024	6	66	10
1025 to 2048	5	34	11
2049 to 4096	4	18	12

The **CopyToken Help algorithm** (section 2.4.1.3.19.1) returns values that are used by the **Unpack CopyToken** (section 2.4.1.3.19.2) and **Pack CopyToken** (section 2.4.1.3.19.3) algorithms to manipulate the **Offset** and **Length** fields of a **CopyToken**.

2.4.1.3.19.1 CopyToken Help

CopyToken Help derived bit masks are used by the **Unpack CopyToken** (section 2.4.1.3.19.2) and the **Pack CopyToken** (section 2.4.1.3.19.3) algorithms. **CopyToken Help** also derives the maximum

length for a **CopySequence** (section 2.4.1.3.19) which is used by the **Matching algorithm** (section 2.4.1.3.19.4)**.**

The pseudocode uses the state variables described in State Variables (section 2.4.1.2): **DecompressedCurrent** and **DecompressedChunkStart**.

The pseudocode for **CopyToken Help** returns the following output parameters:

LengthMask (2 bytes): An unsigned 16-bit integer. A bitmask used to access **CopyToken**.**Length**.

OffsetMask (2 bytes): An unsigned 16-bit integer. A bitmask used to access **CopyToken**.**Offset**.

BitCount (2 bytes): An unsigned 16-bit integer. The number of bits set to 0b1 in **OffsetMask**.

MaximumLength (2 bytes): An unsigned 16-bit integer. The largest possible integral value that can fit into **CopyToken**.**Length**.

- SET difference TO DecompressedCurrent MINUS DecompressedChunkStart
- SET BitCount TO the smallest integer that is GREATER THAN OR EQUAL TO LOGARITHM base 2 of difference
- SET BitCount TO the maximum of BitCount and 4
- SET LengthMask TO 0xFFFF RIGHT SHIFT BY BitCount
- SET OffsetMask TO BITWISE NOT LengthMask
- SET MaximumLength TO (0xFFFF RIGHT SHIFT BY BitCount) PLUS 3

2.4.1.3.19.2 Unpack CopyToken

The **Unpack CopyToken** pseudocode will compute the specifications of a **CopySequence** (section 2.4.1.3.19) that are encoded in a CopyToken.

The pseudocode for **Unpack CopyToken** takes the following input parameters:

Token (2 bytes): A **CopyToken** (section 2.4.1.1.8).

The pseudocode takes the following output parameters:

Offset (2 bytes): An unsigned 16-bit integer that specifies the beginning of a **CopySequence** (section 2.4.1.3.19).

Length (2 bytes): An unsigned 16-bit integer that specifies the length of a **CopySequence** (section 2.4.1.3.19) as follows:

1. CALL **CopyToken Help** (section 2.4.1.3.19.1) returning **LengthMask**, **OffsetMask**, and **BitCount**.
2. SET **Length** TO (Token **BITWISE** AND **LengthMask**) PLUS 3.
3. SET **temp1** TO Token **BITWISE** AND **OffsetMask**.
4. SET **temp2** TO 16 MINUS **BitCount**.
5. SET **Offset** TO (**temp1** RIGHT SHIFT BY **temp2**) PLUS 1.

2.4.1.3.19.3 Pack CopyToken

The **Pack CopyToken** pseudocode will take the Offset and Length values that specify a **CopySequence** (section 2.4.1.3.19) and pack them into a **CopyToken** (section 2.4.1.1.8).

The **Pack CopyToken** pseudocode takes the following input parameters:

Offset (2 bytes): An unsigned 16-bit integer that specifies the beginning of a **CopySequence** (section 2.4.1.3.19).

Length (2 bytes): An unsigned 16-bit integer that specifies the length of a **CopySequence** (section 2.4.1.3.19).

The **Pack CopyToken** pseudocode takes the following output parameters:

Token (2 bytes): A **CopyToken** (section 2.4.1.1.8).

- CALL **CopyToken Help** (section 2.4.1.3.19.1) returning LengthMask, OffsetMask, and BitCount
- SET temp1 TO Offset MINUS 1
- SET temp2 TO 16 MINUS BitCount
- SET temp3 TO Length MINUS 3
- SET Token TO (temp1 LEFT SHIFT BY temp2) BITWISE OR temp3

2.4.1.3.19.4 Matching

The **Matching** pseudocode is used to search for a **CopySequence** (section 2.4.1.3.19) in a **DecompressedChunk** (section 2.4.1.1.3), based on an array of bytes in the same DecompressedChunk. The pseudocode uses the state variables described in State Variables (section 2.4.1.2): **DecompressedCurrent**, and **DecompressedChunkStart**.

The Matching pseudocode takes the following input parameters:

DecompressedEnd: Specifies the location of the byte after the last byte in the current **DecompressedChunk**.

The **Matching** pseudocode returns the following output parameters:

Offset: If a match is found, then the number of bytes between the start of the **CopySequence** (section 2.4.1.3.19) and **DecompressedCurrent**. If a match is not found, then zero.

Length: If a match is found, then the number of bytes in the **CopySequence** (section 2.4.1.3.19). If a match is not found, then zero.

- SET Candidate TO DecompressedCurrent MINUS 1
- SET BestLength TO 0
- WHILE Candidate is GREATER THAN OR EQUAL TO DecompressedChunkStart
  - SET C TO Candidate
  - SET D TO DecompressedCurrent
  - SET Len TO 0
  - WHILE (D is LESS THAN DecompressedEnd)
  - and (the byte at D EQUALS the byte at C)
    - INCREMENT Len
    - INCREMENT C

        - INCREMENT D
    - END WHILE
    - IF Len is GREATER THAN BestLength THEN
        - SET BestLength TO Len
        - SET BestCandidate TO Candidate
    - ENDIF
    - DECREMENT Candidate
- END WHILE
- IF BestLength is GREATER THAN OR EQUAL TO 3 THEN
    - CALL **CopyToken Help** (section 2.4.1.3.19.1) returning MaximumLength
    - SET Length TO the MINIMUM of BestLength and MaximumLength
    - SET Offset TO DecompressedCurrent MINUS BestCandidate
- ELSE
    - SET Length TO 0
    - SET Offset TO 0
- ENDIF

2.4.2 Contents Hash

The Contents Hash is a cryptographic **digest** of a subset of the information stored in the VBA Storage (section 2.3.4).

Conventions:

- APPEND specifies appending the bytes of a field to the end of a resizable array of bytes.
- APPEND specifies appending the **MBCS** bytes of a string without null termination to the end of a resizable array of bytes.
- FOR each specifies iteration over a collection of records in their stored order.

This Contents Hash algorithm requires one parameter as input:

VBAStorage(Variable): The VBA Storage (section 2.3.4) to calculate a hash for.

The Contents Hash algorithm produces an array of bytes as output:

CryptographicDigest(16 bytes): The cryptographic digest of **VBAStorage**.

CryptographicDigest is generated by the following pseudocode:

- SET Buffer TO a resizable array of bytes
- APPEND Buffer WITH **PROJECTNAME.ProjectName** (section 2.3.4.2.1.5)
- APPEND Buffer WITH **PROJECTCONSTANTS.ProjectConstants** (section 2.3.4.2.1.11)

- FOR each **REFERENCE** (section 2.3.4.2.2.1) IN **PROJECTREFERENCES.ReferenceArray** (section 2.3.4.2.2)
    - IF Ref.ReferenceRecord.Id = 0x000D THEN
    - APPEND Buffer WITH 0x7B
    - END IF
    - IF Ref.ReferenceRecord.Id = 0x000E THEN
    - SET TempBuffer TO a resizable array of bytes
    - APPEND TempBuffer WITH Ref.ReferenceRecord.SizeOfAbsoluteLibId
    - APPEND TempBuffer WITH Ref.ReferenceRecord.AbsoluteLibId
    - APPEND TempBuffer WITH Ref.ReferenceRecord.SizeOfRelativeLibId
    - APPEND TempBuffer WITH Ref.ReferenceRecord.RelativeLibId
    - APPEND TempBuffer WITH Ref.ReferenceRecord.MajorVersion
    - APPEND TempBuffer WITH Ref.ReferenceRecord.MinorVersion
    - APPEND TempBuffer WITH 0x00
    - SET CopyIndex TO 0
    - SET CopyByte TO TempBuffer[CopyIndex]
    - WHILE NOT CopyByte EQUALS 0x00
        - APPEND Buffer WITH CopyByte
        - INCREMENT CopyIndex
        - SET CopyByte TO TempBuffer[CopyIndex]
    - END WHILE
    - END IF
- END FOR
- FOR each ModuleStream ModStream (section 2.3.4.3) IN VBA Storage (section 2.3.4)
    - SET CompressedContainer TO ModStream.CompressedSourceCode
    - CALL Decompression (section 2.4.1) with CompressedContainer RETURNING DecompressedBuffer
    - SET Text TO the string representation of the bytes in DecompressedBuffer
    - SET Lines TO a resizable array of strings
    - SET TextBuffer TO ""
    - FOR each character Char IN Text
    - IF Char is Carriage Return or Line Feed THEN
        - ADD TextBuffer TO the end of Lines

        - SET TextBuffer TO ""
    - ELSE
        - ADD Char TO the end of TextBuffer
    - END IF
        - END FOR
        - FOR each Line IN Lines
    - IF Line does not start with "Attribute " ignoring case THEN
        - APPEND Buffer WITH Line
    - END IF
        - END FOR
- END FOR
- SET CryptographicDigest TO the cryptographic digest of Buffer as specified by the hashing algorithm.

2.4.3 Data Encryption

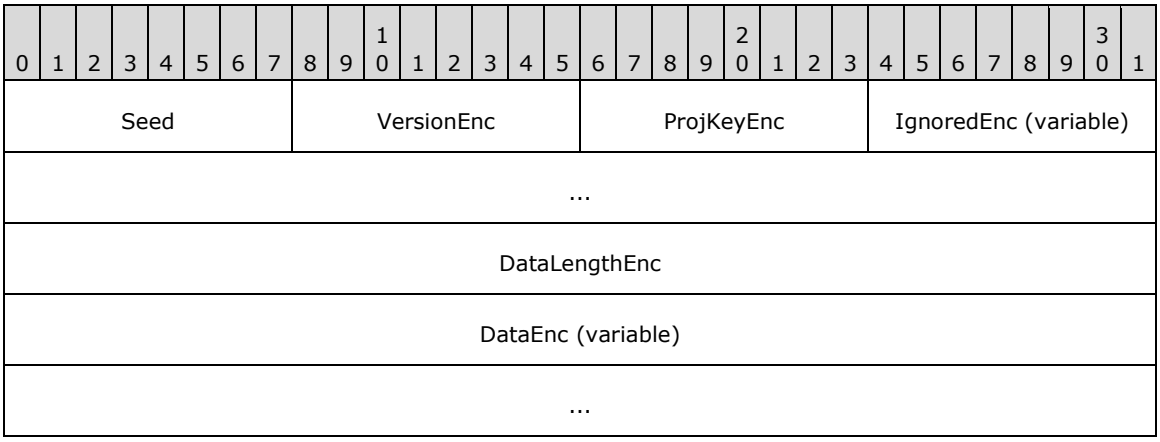
VBA uses a reversible encryption algorithm for selected data.

Conventions:

- XOR specifies a bit-wise exclusive OR operation.
- BAND specifies a bit-wise AND operation.
- All operations resulting in integer overflow MUST only store low-order bits, resulting in high-order bit truncation.

2.4.3.1 Encrypted Data Structure

Specifies encrypted data. This structure has the following format.



Seed (1 byte): Specifies the encryption seed.

VersionEnc (1 byte): Encrypted as specified in section 2.4.3.2. Specifies the encryption version.

ProjKeyEnc (1 byte): Encrypted as specified in section 2.4.3.2. Specifies the project-specific encryption key.

IgnoredEnc (variable): Encrypted as specified in section 2.4.3.2. An array of arbitrary bytes for obfuscation.

DataLengthEnc (4 bytes): Encrypted as specified in section 2.4.3.2. Specifies the length in bytes of **DataEnc**.

DataEnc (variable): Encrypted as specified in section 2.4.3.2. Specifies the data encrypted by the algorithm.

2.4.3.2 Encryption

This encryption accepts two parameters as input:

Data (Variable): An array of bytes to be obfuscated.

Length (4 bytes): An unsigned integer that specifies the length of **Data**.

The algorithm will yield an array of bytes as defined in Encrypted Data Structure (section 2.4.3.1).

To encrypt **Data**, an implementation MUST maintain the following states:

UnencryptedByte1 (1 byte): Specifies the last unencrypted byte read or written.

EncryptedByte1 (1 byte): Specifies the last encrypted byte read or written.

EncryptedByte2 (1 byte): Specifies the next-to-last encrypted byte read or written.

Version (1 byte): Specifies the encryption version.

ProjKey (1 byte): Specifies a project-specific encryption key.

IgnoredLength (1 byte): Specifies the length in bytes of **IgnoredEnc**.

Each field MUST be encrypted in the following order:

VersionEnc is calculated using the following formula:

```
VersionEnc = Seed XOR Version
```

Version MUST be 2.

ProjKey is the checksum of the project identifier as computed by the following pseudocode:

- SET **ProjKey** TO 0.
- FOR each **CharacterByte** IN the string ProjectId.ProjectCLSID (section 2.3.1.2).
  - ADD **CharacterByte** TO **ProjKey**.
- END FOR

ProjKeyEnc is calculated using the following formula:

```
ProjKeyEnc = Seed XOR ProjKey
```

Initialize states for the rest of the encoding:

- SET **UnencryptedByte1** TO **ProjKey**.
- SET **EncryptedByte1** TO **ProjKeyEnc**.
- SET **EncryptedByte2** TO **VersionEnc** .

IgnoredEnc is computed by the following pseudocode:

- SET **IgnoredLength** TO `(Seed BAND 6) / 2`.
- FOR Counter FROM 1 TO **IgnoredLength** INCLUSIVE:
  - SET **TempValue** TO any value.
  - SET **ByteEnc** TO (**TempValue** XOR `(EncryptedByte2 + UnencryptedByte1))`.
  - APPEND **IgnoredEnc** WITH **ByteEnc**.
  - SET **EncryptedByte2** TO **EncryptedByte1**.
  - SET **EncryptedByte1** TO **ByteEnc**.
  - SET **UnencryptedByte1** TO **TempValue**.
- END FOR

DataLengthEnc is computed by the following pseudocode:

- FOR each **Byte** IN **Length** in little endian order:
  - SET **ByteEnc** TO `(Byte XOR (EncryptedByte2 + UnencryptedByte1))`.
  - APPEND **DataLengthEnc** WITH **ByteEnc**.
  - SET **EncryptedByte2** TO **EncryptedByte1**.
  - SET **EncryptedByte1** TO **ByteEnc**.
  - SET **UnencryptedByte1** TO **Byte**.
- END FOR

DataEnc is computed by the following pseudocode:

- FOR each **DataByte** IN **Data**:
  - SET **ByteEnc** TO `(DataByte  XOR (EncryptedByte2 + UnencryptedByte1))`.
  - APPEND **DataEnc** WITH **ByteEnc**.
  - SET **EncryptedByte2** TO **EncryptedByte1**.
  - SET **EncryptedByte1** TO **ByteEnc**.
  - SET **UnencryptedByte1** TO **DataByte**.
- END FOR

2.4.3.3 Decryption

This decryption algorithm accepts an Encrypted Data Structure (section 2.4.3.1) as input and will yield:

Length (4 bytes): An unsigned integer that specifies the length of **Data**.

Data (variable): An array of unencrypted bytes.

To decrypt **Data** from an Encrypted Data Structure (section 2.4.3.1), an implementation MUST maintain the following states:

UnencryptedByte1 (1 byte): Specifies the last unencrypted byte read or written.

EncryptedByte1 (1 byte): Specifies the last encrypted byte read or written.

EncryptedByte2 (1 byte): Specifies the next-to-last encrypted byte read or written.

Version (1 byte): Specifies the encryption version.

ProjKey (1 byte): Specifies a project-specific encryption key.

IgnoredLength (1 byte): Specifies the length in bytes of **IgnoredEnc**.

MUST decrypt in order as follows.

Version is calculated using the following formula.

```
Version = Seed XOR VersionEnc
```

Version MUST be 2.

ProjKey is calculated using the following formula.

```
ProjKey = Seed XOR ProjKeyEnc
```

To initialize states for the rest of the encoding:

- SET **UnencryptedByte1** TO **ProjKey**.
- SET **EncryptedByte1** TO **ProjKeyEnc**.
- SET **EncryptedByte2** TO **VersionEnc**.

The length of **IgnoredEnc** is computed as follows.

```
IgnoredLength = (Seed BAND 6) / 2
```

Decrypting of **IgnoredEnc** MUST be as follows.

- FOR each **ByteEnc** IN **IgnoredEnc**:
  - SET **Byte** TO `(ByteEnc XOR (EncryptedByte2 + UnencryptedByte1))`.
  - SET **EncryptedByte2** TO **EncryptedByte1**.
  - SET **EncryptedByte1** TO **ByteEnc**.

    - SET **UnencryptedByte1 TO** Byte.
- END FOR

Length is computed by the following pseudocode.

- SET **ByteIndex** TO zero.
- FOR each **ByteEnc** IN **DataLengthEnc**:
    - SET **Byte** TO `(ByteEnc XOR (EncryptedByte2 + UnencryptedByte1))`.
    - SET **TempValue** TO 256 raised to the power of **ByteIndex**.
    - MULTIPLY **TempValue** by **Byte**.
    - ADD **TempValue** TO **Length**.
    - SET **EncryptedByte2** TO **EncryptedByte1**.
    - SET **EncryptedByte1** TO **ByteEnc**.
    - SET **UnencryptedByte1** TO **Byte**.
    - INCREMENT **ByteIndex**
- END FOR

Length is equal to the length of **DataEnc**.

Data is computed using the following pseudocode.

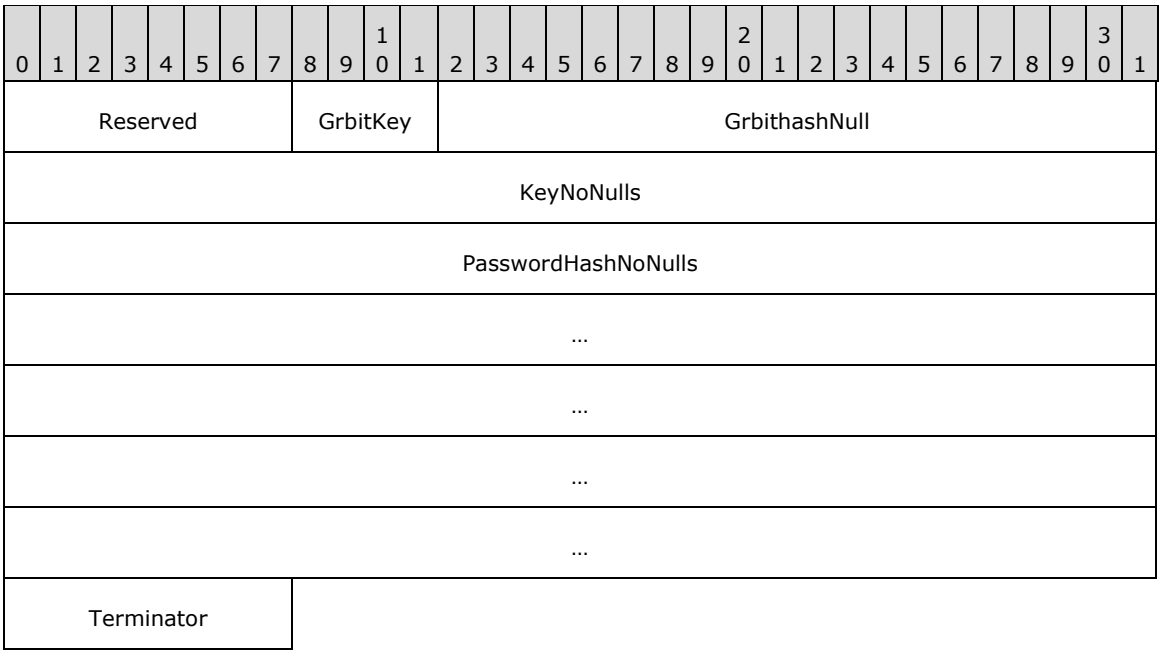
- FOR each **ByteEnc** IN **DataEnc**:
    - SET **Byte** TO `(ByteEnc XOR (EncryptedByte2 + UnencryptedByte1))`.
    - APPEND **Data** WITH **Byte**.
    - SET **EncryptedByte2** TO **EncryptedByte1**.
    - SET **EncryptedByte1** TO **ByteEnc**.
    - SET **UnencryptedByte1** TO **Byte**.
- END FOR

2.4.4 Password Hash

VBA employs a custom format for storing a password hash, obfuscating the password with random data. That random data is stored with the **VBA project** so the hash can be verified without the need to store the original password string.

2.4.4.1 Password Hash Data Structure

The password data structure specifies a password hash and additional random byte data to obfuscate the hash.



Reserved (1 byte): MUST be 0xFF. MUST be ignored.

GrbitKey (4 bits): Each bit specifies a corresponding null byte of **Key** as specified by Encode Nulls (section 2.4.4.2).

GrbitHashNull (20 bits): Each bit specifies a corresponding null byte of **PasswordHash** as specified by Encode Nulls (section 2.4.4.2).

KeyNoNulls (4 bytes): Specifies the **Key** for the Password Hash Algorithm (section 2.4.4.4) with null bytes removed as specified by Encode Nulls (section 2.4.4.2). **Key** is any value.

Key is encoded into **KeyNoNulls** as specified by the following pseudocode:

- CALL Encode Nulls (section 2.4.4.2) with Key RETURNING GrbitKey and KeyNoNulls

Decoding is specified by the following pseudocode:

- CALL Decode Nulls (section 2.4.4.3) with KeyNoNulls and GrbitKey RETURNING Key

PasswordHashNoNulls (20 bytes): Specifies the **PasswordHash** result of the Password Hash Algorithm (section 2.4.4.4) with null bytes removed as specified by Encode Nulls (section 2.4.4.2).

PasswordHash is the 160-bit cryptographic **digest** of a password combined with **Key** as specified by Password Hash Algorithm (section 2.4.4.4).

Encoding is specified by the following pseudocode:

- CALL Encode Nulls (section 2.4.4.2) with PasswordHash RETURNING GrbitHashNull and PasswordHashNoNulls

Decoding is specified by the following pseudocode:

- CALL Decode Nulls (section 2.4.4.3) with PasswordHashNoNulls and GrbitHashNull RETURNING PasswordHash

Terminator (1 byte): MUST be 0x00.

2.4.4.2 Encode Nulls

The Password Hash stores **Key** and **PasswordHash** with null bytes removed. The fields are encoded by replacing 0x00 bytes with 0x01 and setting a bit on the bit-fields **GrbitKey** and **GrbitHashNull**, respectively.

This algorithm accepts the following as parameters:

InputBytes (variable): An input array of bytes to be encoded.

GrbitNull (variable): An output array of bits specifying null bytes in **InputBytes**.

EncodedBytes (variable): An output array of encoded bytes.

Encoding is computed by the following pseudocode:

- FOR each **Byte** IN **InputBytes**:
  - IF **Byte** EQUALS 0x00 THEN:
    - APPEND **EncodedBytes** WITH 0x01.
    - APPEND **GrbitNull** WITH one bit set to FALSE.
  - ELSE:
    - APPEND **EncodedBytes** WITH **Byte**.
    - APPEND **GrbitNull** WITH one bit set to TRUE.
  - END IF
- END FOR

2.4.4.3 Decode Nulls

The Password Hash stores **Key** and **PasswordHash** with null bytes removed as specified by Encode Nulls (section 2.4.4.2). The fields are decoded by reading bit-fields **GrbitKey** and **GrbitHashNull**, and replacing corresponding bytes in **Key** and **PasswordHash** with 0x00.

This algorithm accepts the following as parameters:

EncodedBytes (variable): An input array of bytes to be encoded.

GrbitNull (variable): An input array of bits specifying null bytes in **DecodedBytes**.

DecodedBytes (variable): An output array of encoded bytes.

Decoding is computed by the following pseudocode:

- SET **Index** TO 0.
- FOR each **Bit** IN **GrbitNull**:
  - IF **Bit** EQUALS FALSE THEN:
    - APPEND **DecodedBytes** WITH 0x00.
  - ELSE:
    - APPEND **DecodedBytes** WITH `EncodedBytes[Index]`.

- END IF
- INCREMENT **Index**.

- END FOR

2.4.4.4 Password Hash Algorithm

This Password Hash Algorithm accepts the following as parameters:

Password (Variable): An array of bytes to be obfuscated. MUST contain **MBCS** characters encoded using the **code page** specified by **PROJECTCODEPAGE** (section 2.3.4.2.1.4).

Key (4 Bytes): An array of 4 bytes of any value.

When comparing a new password to an old cryptographic **digest**, MUST be the same value as stored in the old password's **Password Hash Data Structure.Key** (section 2.4.4).

The algorithm will yield **PasswordHash**, an array of 20 bytes.

The pseudocode for computing the hash is as follows:

- LET **BytesToHash** be a variable array of bytes.
- APPEND **BytesToHash** WITH **Password**.
- APPEND **BytesToHash** WITH **Key**.
- SET **PasswordHash** TO the **SHA-1** cryptographic digest of **BytesToHash**, as specified by [RFC3174].

2.4.4.5 Password Hash Validation

To verify a password against the stored hash, a new password hash MUST be generated using the same **Key** as the existing password. The new hash can then be compared to the hash in the **VBA project**.

Validation accepts the following as parameters:

NewPassword (Variable): An array of bytes specifying a password to validate. MUST contain **MBCS** characters encoded using the **code page** specified by **PROJECTCODEPAGE** (section 2.3.4.2.1.4).

Key (4 bytes): An array of 4 bytes. MUST be the value stored in **Password Hash Data Structure.Key** (section 2.4.4).

OldPasswordHash (20 bytes): A cryptographic **digest**. MUST be the value stored in **Password Hash Data Structure.PasswordHash** (section 2.4.4).

The algorithm yields a Boolean value, **Valid**, specifying that **NewPassword** is valid.

Validation is computed by the following pseudocode:

- LET **NewHash** be an array of 20 bytes.
- CALL Password Hash Algorithm (section 2.4.4.4) with **NewPassword** and Key RETURNING **NewHash**.
- IF **NewHash** EQUALS **OldPasswordHash** THEN:
  - SET **Valid** TO TRUE.

- ELSE:
  - SET **Valid** TO FALSE.
- END IF

3 Structure Examples

The following sections provide structure examples of features of this file format. Note that these examples are illustrative of this file format specification, and do not cover all possible structure usage scenarios.

The examples in section 3.1 illustrate the structures of a single **VBA project storage** as it could be used in a workbook as described in [MS-XLS] section 2.1.7.18.

The examples in section 3.2 illustrate byte arrays that are compressed and decompressed by using the compression and decompression algorithms in section 2.4.1. Note that these examples are illustrative of this file format specification, and do not cover all possible usage scenarios.

3.1 VBA Storage Information Example

3.1.1 _VBA_PROJECT Example

The following table illustrates a **_VBA_PROJECT** (section 2.3.4.1) example that describes the version-dependent information for the **VBA project**.

Offset	Size	Structure	Value
00000000	0007	_VBA_PROJECT Stream: Version Dependent Project Information **- _VBA_PROJECT**	
00000000	0002	unsigned integer **- Reserved1**	0x61CC
00000002	0002	unsigned integer **- Version**	0xFFFF
00000004	0001	BYTE **- Reserved2**	0x00
00000005	0002	unsigned integer **- Reserved3**	0x0001
00000007	0000	Blob **- PerformanceCache**	

Figure 2: _VBA_PROJECT stream

Version: 0xFFFF specifies the version of VBA used to create the VBA project. Write this field as 0xFFFF.

PerformanceCache: This record is empty on write.

3.1.2 dir Stream Example

The following examples illustrate a **dir** (section 2.3.4.2) **stream** for a **VBA project**. The **dir** (section 2.3.4.2) stream examples describe project information, project **references** and modules. The **dir** (section 2.3.4.2) stream ends with an unsigned integer, **Terminator**, and a **Reserved** field.

3.1.2.1 Project Information Example

The following example illustrates a **PROJECTINFORMATION** (section 2.3.4.2.1) record for a **VBA project**.

Offset	Size	Structure	Value
00000000	0122	PROJECTINFORMATION Record **- Information Record**	
00000000	000A	PROJECTSYSKIND Record **- SysKindRecord**	

Offset	Size	Structure	Value
00000000	0002	unsigned integer **- Id**	0x0001
00000002	0004	unsigned integer **- Size**	0x00000004
00000006	0004	unsigned integer **- SysKind**	0x00000001
0000000A	000A	PROJECTLCID Record **- LcidRecord**	
0000000A	0002	unsigned integer **- Id**	0x0002
0000000C	0004	unsigned integer **- Size**	0x00000004
00000010	0004	unsigned integer **- Lcid**	0x00000409
00000014	000A	PROJECTLCIDINVOKE Record **- LcidInvokeRecord**	
00000014	0002	unsigned integer **- Id**	0x0014
00000016	0004	unsigned integer **- Size**	0x00000004
0000001A	0004	unsigned integer **- LcidInvoke**	0x00000409
0000001E	0008	PROJECTCODEPAGE Record **- CodePageRecord**	
0000001E	0002	unsigned integer **- Id**	0x0003
00000020	0004	unsigned integer **- Size**	0x00000002
00000024	0002	unsigned integer **- CodePage**	0x04E4
00000026	0010	PROJECTNAME Record **- NameRecord**	
00000026	0002	unsigned integer **- Id**	0x0004
00000028	0004	unsigned integer **- SizeOfProjectName**	0x0000000A
0000002C	000A	array of bytes **- ProjectName**	VBAProject
00000036	0069	PROJECTDOCSTRING Record **- DocStringRecord**	
00000036	0002	unsigned integer **- Id**	0x0005
00000038	0004	unsigned integer **- SizeOfDocString**	0x0000001F
0000003C	001F	array of bytes **- DocString**	Example VBA Project Description
0000005B	0002	unsigned integer **- Reserved**	0x0040
0000005D	0004	unsigned integer **- SizeOfDocStringUnicode**	0x0000003E
00000061	003E	array of bytes **- DocStringUnicode**	Example VBA Project Description
0000009F	0042	PROJECTHELPFILEPATH Record **- HelpFilePathRecord**	
0000009F	0002	unsigned integer **- Id**	0x0006
000000A1	0004	unsigned integer **- SizeOfHelpFile1**	0x0000001B
000000A5	001B	array of bytes **- HelpFile1**	c:\example path\example.hlp
000000C0	0002	unsigned integer **- Reserved**	0x003D

Offset	Size	Structure	Value
000000C2	0004	unsigned integer **- SizeOfHelpFile2**	0x0000001B
000000C6	001B	array of bytes **- HelpFile2**	c:\example path\example.hlp
000000E1	000A	PROJECTHELPCONTEXT Record **- HelpContextRecord**	
000000E1	0002	unsigned integer **- Id**	0x0007
000000E3	0004	unsigned integer **- Reserved**	0x00000004
000000E7	0004	unsigned integer **- HelpContext**	0x00000001
000000EB	000A	PROJECTLIBFLAGS Record **- LibFlagsRecord**	
000000EB	0002	unsigned integer **- Id**	0x0008
000000ED	0004	unsigned integer **- Size**	0x00000004
000000F1	0004	unsigned integer **- ProjectLibFlags**	0x00000000
000000F5	000C	PROJECTVERSION Record **- VersionRecord**	
000000F5	0002	unsigned integer **- Id**	0x0009
000000F7	0004	unsigned integer **- Reserved**	0x00000004
000000FB	0004	unsigned integer **- VersionMajor**	0x49B5196B
000000FF	0002	unsigned integer **- VersionMinor**	0x0006
00000101	0021	PROJECTCONSTANTS Record **- ConstantsRecord**	
00000101	0002	unsigned integer **- Id**	0x000C
00000103	0004	unsigned integer **- SizeOfConstants**	0x00000007
00000107	0007	array of bytes **- Constants**	abc = 1
0000010E	0002	unsigned integer **- Reserved**	0x003C
00000110	0004	unsigned integer **- SizeOfConstantsUnicode**	0x0000000E
00000114	000E	array of bytes **- ConstantsUnicode**	abc = 1

Figure 3: ProjectInformation record

The preceding table illustrates a **PROJECTINFORMATION** (section 2.3.4.2.1) record. The **PROJECTINFORMATION** (section 2.3.4.2.1) record stores the VBA project's properties.

SysKindRecord.SysKind: 0x00000001 specifies this project is intended for the 32-bit Windows Platform.

CodePageRecord.CodePage: 0x04E4 specifies 1252 - Western Latin code page. For more information, see specified in [MC-CPB].

NameRecord.ProjectName: "VBAProject" specifies the name of the VBA project in **MBCS** characters.

DocStringRecord: Specifies the description, "Example VBA Project Description" for the VBA project. The description of the project can be used to provide additional information about the project beyond the **ProjectName**.

DocStringRecord.DocString: "Example VBA Project Description" specifies the description for the project in MBCS characters.

DocStringRecord.DocStringUnicode: "Example VBA Project Description" specifies the description for the project in **Unicode** characters. This value is equivalent to the **DocString** field value.

HelpFilePathRecord.HelpFile1: "c:\example path\example.hlp" specifies the path to a **Help file** for this VBA project in MBCS characters.

HelpFilePathRecord.HelpFile2: "c:\example path\example.hlp" specifies the path to a Help file for this VBA project in MBCS characters.

HelpContextRecord.HelpContext: 0x00000001 specifies the **Help topic identifier** for the VBA project, which is the help topic the user will see when the **HelpFilePathRecord.HelpFile1** is requested. For example, if the user requested help for this context, the **HelpFilePathRecord.HelpFile1,** "c:\example path\example.hlp", would be opened and the user would see the help topic corresponding to the **HelpContext**, 1, in this example.

VersionRecord.VersionMajor: 0x49B5196B specifies the major version of the VBA project.

VersionRecord.VersionMinor: 0x0006 specifies the minor version of the VBA project.

ConstantsRecord: Specifies **compilation constants** for the VBA project. **Constants** are used to conditionally compile code within the VBA project. The Constant, "abc = 1" from this example is illustrated in the Sheet3.1.4 Decompressed Module Stream Example (section 3.1.4).

ConstantsRecord.Constants: "abc = 1" specifies the compilation constants for the VBA project in MBCS characters.

ConstantsRecord.ConstantsUnicode: "abc = 1" specifies the compilation constants for the VBA project in Unicode characters. This value is equivalent to the **Constants** field value.

3.1.2.2 Project Reference Information Example

The following example illustrates the **PROJECTREFERENCES** (section 2.3.4.2.2) record for the **VBA project**. This project includes four **references**.

Offset	Size	Structure	Value
00000122	0380	VBA_Canonical_ReferenceArray **- ReferenceArray**	
00000122	008C	REFERENCE Record **- Reference[0]**	
00000122	001E	REFERENCENAME Record **- NameRecord**	
00000122	0002	unsigned integer **- Id**	0x0016
00000124	0004	unsigned integer **- SizeOfName**	0x00000006
00000128	0006	array of bytes **- Name**	stdole
0000012E	0002	unsigned integer **- Reserved**	0x003E
00000130	0004	unsigned integer **- SizeOfNameUnicode**	0x0000000C
000001	000	array of bytes	stdole

Offset	Size	Structure	Value
34	C	**- NameUnicode**	
00000140	006E	REFERENCEREGISTERED Record **- ReferenceRecord[0]**	
00000140	0002	unsigned integer **- Id**	0x000D
00000142	0004	unsigned integer **- Size**	0x00000068
00000146	0004	unsigned integer **- SizeOfLibid**	0x0000005E
0000014A	005E	array of bytes **- Libid**	*\G{00020430-0000-0000-C000-000000000046}#2.0#0#C:\Windows\system32\stdole2.tlb#OLE Automation
000001A8	0004	unsigned integer **- Reserved1**	0x00000000
000001AC	0002	unsigned integer **- Reserved2**	0x0000
000001AE	00C2	REFERENCE Record **- Reference[1]**	
000001AE	001E	REFERENCENAME Record **- NameRecord**	
000001AE	0002	unsigned integer **- Id**	0x0016
000001B0	0004	unsigned integer **- SizeOfName**	0x00000006
000001B4	0006	array of bytes **- Name**	Office
000001BA	0002	unsigned integer **- Reserved**	0x003E
000001BC	0004	unsigned integer **- SizeOfNameUnicode**	0x0000000C
000001C0	000C	array of bytes **- NameUnicode**	Office
000001CC	00A4	REFERENCEREGISTERED Record **- ReferenceRecord[1]**	
000001CC	0002	unsigned integer **- Id**	0x000D
000001CE	0004	unsigned integer **- Size**	0x0000009E
000001D2	0004	unsigned integer **- SizeOfLibid**	0x00000094
000001D6	0094	array of bytes **- Libid**	*\G{2DF8D04C-5BFA-101B-BDE5-00AA0044DE52}#2.0#0#C:\Program Files\Common Files\Microsoft Shared\OFFICE12\MSO.DLL#Microsoft Office 12.0 Object Library
0000026A	0004	unsigned integer **- Reserved1**	0x00000000
0000026E	0002	unsigned integer **- Reserved2**	0x0000
00000270	0091	REFERENCE Record **- Reference[2]**	

Offset	Size	Structure	Value
00000270	002D	REFERENCENAME Record **- NameRecord**	
00000270	0002	unsigned integer **- Id**	0x0016
00000272	0004	unsigned integer **- SizeOfName**	0x0000000B
00000276	000B	array of bytes **- Name**	VBAProject1
00000281	0002	unsigned integer **- Reserved**	0x003E
00000283	0004	unsigned integer **- SizeOfNameUnicode**	0x00000016
00000287	0016	array of bytes **- NameUnicode**	VBAProject1
0000029D	0064	REFERENCEPROJECT Record **- ReferenceRecord[2]**	
0000029D	0002	unsigned integer **- Id**	0x000E
0000029F	0004	unsigned integer **- Size**	0x0000005E
000002A3	0004	unsigned integer **- SizeOfLibidAbsolute**	0x00000030
000002A7	0030	array of bytes **- LibidAbsolute**	*\CC:\Example Path\Example-ReferencedProject.xls
000002D7	0004	unsigned integer **- SizeOfLibidRelative**	0x00000020
000002DB	0020	array of bytes **- LibidRelative**	*\CExample-ReferencedProject.xls
000002FB	0004	unsigned integer **- MajorVersion**	0x49A95F46
000002FF	0002	unsigned integer **- MinorVersion**	0x000D
00000301	01A1	REFERENCE Record **- Reference[3]**	
00000301	0021	REFERENCENAME Record **- NameRecord**	
00000301	0002	unsigned integer **- Id**	0x0016
00000303	0004	unsigned integer **- SizeOfName**	0x00000007
00000307	0007	array of bytes **- Name**	MSForms
0000030E	0002	unsigned integer **- Reserved**	0x003E
00000310	0004	unsigned integer **- SizeOfNameUnicode**	0x0000000E

Offset	Size	Structure	Value
00000314	000E	array of bytes **- NameUnicode**	MSForms
00000322	0180	REFERENCECONTROL Record **- ReferenceRecord[3]**	
00000322	0075	REFERENCEORIGINAL Record **- OriginalRecord**	
00000322	0002	unsigned integer **- Id**	0x0033
00000324	0004	unsigned integer **- SizeOfLibidOriginal**	0x0000006F
00000328	006F	array of bytes **- LibidOriginal**	*\G{0D452EE1-E08F-101A-852E-02608C4D0BB4}#2.0#0#C:\Windows\system32\FM20.DLL#Microsoft Forms 2.0 Object Library
00000397	0002	unsigned integer **- Id**	0x002F
00000399	0004	unsigned integer **- SizeTwiddled**	0x0000003B
0000039D	0004	unsigned integer **- SizeOfLibidTwiddled**	0x00000031
000003A1	0031	array of bytes **- LibidTwiddled**	*\G{00000000-0000-0000-0000-000000000000}#0.0#0##
000003D2	0004	unsigned integer **- Reserved1**	0x00000000
000003D6	0002	unsigned integer **- Reserved2**	0x0000
000003D8	0021	REFERENCENAME Record **- NameRecordExtended**	
000003D8	0002	unsigned integer **- Id**	0x0016
000003DA	0004	unsigned integer **- SizeOfName**	0x00000007
000003DE	0007	array of bytes **- Name**	MSForms
000003E5	0002	unsigned integer **- Reserved**	0x003E
000003E7	0004	unsigned integer **- SizeOfNameUnicode**	0x0000000E
000003EB	000E	array of bytes **- NameUnicode**	MSForms
000003F9	0002	unsigned integer **- Reserved3**	0x0030
000003FB	0004	unsigned integer **- SizeExtended**	0x000000A3

Offset	Size	Structure	Value
000003FF	0004	unsigned integer **- SizeOfLibidExtended**	0x00000085
00000403	0085	array of bytes **- LibidExtended**	*\G{896C2D83-5466-46ED-8FAE-4C3E4F85E710}#2.0#0#C:\Users\jsmith\AppData\Local\Temp\VBE\MSForms.exd#Microsoft Forms 2.0 Object Library
00000488	0004	unsigned integer **- Reserved4**	0x00000000
0000048C	0002	unsigned integer **- Reserved5**	0x0000
0000048E	0010	GUID **- OriginalTypeLib**	E1 2E 45 0D 8F E0 1A 10 85 2E 02 60 8C 4D 0B B4
0000049E	0004	unsigned integer **- Cookie**	0x00000001

Figure 4: Project reference record

The example described in preceding table illustrates a set of four external references for the example VBA project. Description for **Reference[1]** is omitted as it duplicates the example of a **REFERENCEREGISTERED** (section 2.3.4.2.2.5) type, illustrated in **Reference[0]**. **Reference[2]** illustrates an example of a **REFERENCEPROJECT** (section 2.3.4.2.2.6) type. **Reference[3]** illustrates an example of a **REFERENCECONTROL** (section 2.3.4.2.2.3) type.

ReferenceArray: Specifies an array of four **REFERENCE** (section 2.3.4.2.2.1) records. In this array, **Reference[0]** and **Reference[1]** are **REFERENCEREGISTERED** (section 2.3.4.2.2.5) type records. **Reference[2]** is a **REFERENCEPROJECT** (section 2.3.4.2.2.6) record. **Reference[3]** is a **REFERENCECONTROL** (section 2.3.4.2.2.3) record.

Reference[0]: Specifies a record of type **REFERENCEREGISTERED** (section 2.3.4.2.2.5).

Reference[0].NameRecord.Name: "stdole" specifies a reference to the stdole2.tlb **Automation type library** in **MBCS** characters.

Reference[0].NameRecord.NameUnicode: "stdole" specifies a reference to the stdole2.tlb Automation type library in **Unicode** characters. This value is equivalent to the **Name** field value.

Reference[0].ReferenceRecord[0].Libid: "*\G{00020430-0000-0000-C000-000000000046}#2.0#0#C:\Windows\system32\stdole2.tlb#OLE Automation" specifies a **LibidReference** (section 2.1.1.8) and conforms to the ABNF Syntax for Libid references.

The **LibidReferenceKind,** "*\G", specifies the **LibidPath** is a Windows Path.

The **LibidGuid, "**{00020430-0000-0000-C000-000000000046}", specifies the **CLSID** of the "OLE Automation" Automation type library.

The **LibidMajorVersion** is 2.

The **LibidMinorVersion** is 0.

The **LibidLCID** is 0.

The **LibidPath** is "C:\Windows\system32\stdole2.tlb".

The **LibidRegName** is "OLE Automation".

Reference[2]: Specifies a reference of type **REFERENCEPROJECT** (section 2.3.4.2.2.6). This reference illustrates the information required to reference another VBA project that exists in another Excel workbook file. The **ProjectName** of the referenced workbook cannot match the **ProjectName** of the referencing workbook.

Reference[2].NameRecord.Name: "VBAProject1" specifies the **ProjectName** of the referenced VBA project in MBCS characters.

Reference[2].NameRecord.NameUnicode: "VBAProject1" specifies the **ProjectName** of the referenced VBA project in Unicode characters. This value is equivalent to the **Name** field value.

Reference[2].ReferenceRecord[2].LibidAbsolute: "*\CC:\Example Path\Example-ReferencedProject.xls" specifies the absolute path to the file containing the referenced VBA project.

The **Projectkind,** "*\C" specifies a Windows file path.

The **ProjectPath** is "C:\Example Path\ReferencedProject.xls".

Reference[2].ReferenceRecord[2].LibidRelative: "*\CExample-ReferencedProject.xls" specifies the relative path to the file containing the referenced VBA project. In this example, both files exist in the same directory ("C:\Example Path").

The **Projectkind,** "*\C" specifies a Windows file path.

The **ProjectPath** is "Example-ReferencedProject.xls", as it is relative, there is no additional file path. If the referenced file existed in the subdirectory "Test" the Project Path would be "\Test\Example-ReferencedProject.xls".

Reference[2].ReferenceRecord[2].MajorVersion: "0x49A95F46" specifies the **MajorVersion** of the referenced VBA project. The **MajorVersion** is equivalent to the **VersionMajor** of the referenced VBA project's **PROJECTVERSION** record (section 2.3.4.2.1.10).

Reference[2].ReferenceRecord[2].MinorVersion: "0x000D" specifies the **MinorVersion** of the referenced VBA project. The **MinorVersion** is equivalent to the **VersionMinor** of the referenced VBA project's **PROJECTVERSION** record (section 2.3.4.2.1.10).

Reference[3]: Specifies a reference of type **REFERENCECONTROL** (section 2.3.4.2.2.3) to an **ActiveX control library**.

Reference[3].NameRecord.Name: "MSForms" specifies the name of an Office Form **ActiveX control** in MBCS characters as described in [MS-OFORMS].

Reference[3].NameRecord.NameUnicode: "MSForms" specifies the name of an Office Form ActiveX control in Unicode characters as described in [MS-OFORMS]. This value is equivalent to the **Name** field value.

Reference[3].ReferenceRecord[3].OriginalRecord.LibidOriginal: "*\G{0D452EE1-E08F-101A-852E-02608C4D0BB4}#2.0#0#C:\Windows\system32\FM20.DLL#Microsoft Forms 2.0 Object Library" specifies the Office Form ActiveX control library identifier.

The **LibidReferenceKind,** "*\G", specifies the **LibidPath** is a Windows Path.

The **LibidGuid**, "{0D452EE1-E08F-101A-852E-02608C4D0BB4}", specifies the **ClassId** of the Office Form ActiveX control as described in [MS-OFORMS].

The **LibidMajorVersion** is 2.

The **LibidMinorVersion** is 0.

The **LibidLCID** is 0.

The **LibidPath** is "C:\Windows\system32\FM20.DLL".

The **LibidRegName** is "Microsoft Forms 2.0 Object Library".

Reference[3].ReferenceRecord[3].LibidTwiddled: *\G{00000000-0000-0000-0000-000000000000}#0.0#0## specifies the **ReferenceRecord** does not reference a **twiddled type library**.

The **LibidReferenceKind**, "*\G" specifies a Windows file path.

The **LibidGuid** is {00000000-0000-0000-0000-000000000000}.

The **LibidMajorVersion** is 0.

The **LibidMinorVersion** is 0.

The **LibidLCID** is 0.

The **LibidPath** and **LibidRegName** are empty, signifying the **ReferenceRecord** is not a twiddled type library.

Reference[3].ReferenceRecord[3].NameRecordExtended.Name: "MSForms" specifies the name of the **extended type library** in MBCS characters

Reference[3].ReferenceRecord[3].NameRecordExtended.NameUnicode: "MSForms" specifies the name of the extended type library in Unicode characters. This value is equivalent to the **Name** field value.

Reference[3].ReferenceRecord[3].LibidExtended: *\G{896C2D83-5466-46ED-8FAE-4C3E4F85E710}#2.0#0#C:\Users\jsmith\AppData\Local\Temp\VBE\MSForms.exd#Microsoft Forms 2.0 Object Library specifies the Office Form ActiveX control library as the extended control library as described in [MS-OFORMS].

The **LibidReferenceKind,** "*\G" specifies the **LibidPath** is a Windows path.

The **LibidGuid,** {896C2D83-5466-46ED-8FAE-4C3E4F85E710} specifies the **ClassID** of the Office Form extended control library described in [MS-OFORMS].

The **LibidMajorVersion** is 2.

The **LibidMinorVersion** is 0.

The **LibidLCID** is 0.

The **LibidPath** is "C:\Users\jsmith\AppData\Local\Temp\VBE\MSForms.exd".

The **LibidRegName** is "Microsoft Forms 2.0 Object Library".

Reference[3].ReferenceRecord[3].OriginalTypeLib: E1 2E 45 0D 8F E0 1A 10 85 2E 02 60 8C 4D 0B B4 specifies the CLSID of the Automation type library the extended type library was generated from. This value is equivalent to the **LibidGuid** value of this record's **LibidOriginal** field, "{0D452EE1-E08F-101A-852E-02608C4D0BB4}".

3.1.2.3 Module Information Example

3.1.2.3.1 PROJECT MODULES Example

The following illustrates a **PROJECTMODULES** (section 2.3.4.2.3) example that includes three modules for the **VBA project**.

Offset	Size	Structure	Value
000004A2	01EA	PROJECTMODULES Record **- ModulesRecord**	

Offset	Size	Structure	Value
000004A2	0002	unsigned integer **- Id**	0x000F
000004A4	0004	unsigned integer **- Size**	0x00000002
000004A8	0002	unsigned integer **- Count**	0x0003
000004AA	0008	PROJECTCOOKIE Record **- ProjectCookieRecord**	
000004AA	0002	unsigned integer **- Id**	0x0013
000004AC	0004	unsigned integer **- Size**	0x00000002
000004B0	0002	unsigned integer **- Cookie**	0xFFFF

Figure 5: Project modules stream

Count: 0x0003 specifies 3 modules for the project.

ProjectCookieRecord.Cookie: 0xFFFF specifies ignored data. Write this field as 0xFFFF.

3.1.2.3.2 Module Record Examples

3.1.2.3.2.1 ThisWorkbook Document Module Record Example

This module record example describes a typical **document module** record.

Offset	Size	Structure	Value
000004B2	0094	MODULE Record **- ModuleRecord**	
000004B2	0012	MODULENAME Record **- NameRecord**	
000004B2	0002	unsigned integer **- Id**	0x0019
000004B4	0004	unsigned integer **- SizeOfModuleName**	0x0000000C
000004B8	000C	array of bytes **- ModuleName**	ThisWorkbook
000004C4	001E	MODULENAMEUNICODE Record **- NameUnicodeRecord**	
000004C4	0002	unsigned integer **- Id**	0x0047
000004C6	0004	unsigned integer **- SizeOfModuleNameUnicode**	0x00000018
000004CA	0018	array of bytes **- ModuleNameUnicode**	ThisWorkbook
000004E2	0030	MODULESTREAMNAME Record **- StreamNameRecord**	
000004E2	0002	unsigned integer **- Id**	0x001A
000004E4	0004	unsigned integer **- SizeOfStreamName**	0x0000000C
000004E8	000C	array of bytes **- StreamName**	ThisWorkbook
000004F4	0002	unsigned integer **- Reserved**	0x0032
000004F6	0004	unsigned integer **- SizeOfStreamNameUnicode**	0x00000018
000004FA	0018	array of bytes **- StreamNameUnicode**	ThisWorkbook
00000512	000C	MODULEDOCSTRING Record **- DocStringRecord**	

Offset	Size	Structure	Value
00000512	0002	unsigned integer **- Id**	0x001C
00000514	0004	unsigned integer **- SizeOfDocString**	0x00000000
00000518	0000	array of bytes **- DocString**	
00000518	0002	unsigned integer **- Reserved**	0x0048
0000051A	0004	unsigned integer **- SizeOfDocStringUnicode**	0x00000000
0000051E	0000	array of bytes **- DocStringUnicode**	
0000051E	000A	MODULEOFFSET Record **- OffsetRecord**	
0000051E	0002	unsigned integer **- Id**	0x0031
00000520	0004	unsigned integer **- Size**	0x00000004
00000524	0004	unsigned integer **- TextOffset**	0x00000000
00000528	000A	MODULEHELPCONTEXT Record **- HelpContextRecord**	
00000528	0002	unsigned integer **- Id**	0x001E
0000052A	0004	unsigned integer **- Size**	0x00000004
0000052E	0004	unsigned integer **- HelpContext**	0x00000000
00000532	0008	MODULECOOKIE Record **- CookieRecord**	
00000532	0002	unsigned integer **- Id**	0x002C
00000534	0004	unsigned integer **- Size**	0x00000002
00000538	0002	unsigned integer **- Cookie**	0xFFFF
0000053A	0006	MODULETYPE Record **- TypeRecord**	
0000053A	0002	unsigned integer **- Id**	0x0022
0000053C	0004	unsigned integer **- Reserved**	0x00000000
00000540	0002	unsigned integer **- Terminator**	0x002B
00000542	0004	unsigned integer **- Reserved**	0x00000000

Figure 6: "ThisWorkbook" module record

The preceding table illustrates the module record for the record named "ThisWorkbook". The **DocStringRecord** and **HelpContextRecord** descriptions for this module example are omitted as they are empty for this example and illustrated in the next example. The decompressed code can be found in the corresponding **ThisWorkbook Decompressed Module Stream Example** (section 3.1.3).

NameRecord.ModuleName: "ThisWorkbook" specifies the name of the module in **MBCS** characters as specified by the **PROJECTCODEPAGE** (section 2.3.4.2.1.4).

NameUnicodeRecord.ModuleNameUnicode: "ThisWorkbook" specifies the name of the module in **Unicode** characters. This value is equivalent to the **NameRecord.ModuleName** field value.

StreamNameRecord.StreamName: "ThisWorkbook" specifies the **stream** name in MBCS characters of the **ModuleStream** (section 2.3.4.3) in the VBA Storage (section 2.3.4) corresponding to the containing **MODULE Record** (section 2.3.4.2.3.2).

StreamNameRecord.StreamNameUnicode: "ThisWorkbook" specifies the stream name in Unicode characters of the **ModuleStream** (section 2.3.4.3) in the VBA Storage (section 2.3.4) corresponding to the containing **MODULE Record** (section 2.3.4.2.3.2). This value is equivalent to the **StreamName** field value.

OffsetRecord: Specifies the location of the source code in the module stream that corresponds to this module record. The corresponding module stream can be found in **ThisWorkbook Decompressed Module Stream Example** (section 3.1.3).

OffsetRecord.TextOffset: 0x00000000 specifies the code in the corresponding Module stream as described by the **ModuleName** record begins at 0x00000000.

CookieRecord.Cookie: 0xFFFF specifies ignored data. Write this field as 0xFFFF.

TypeRecord.Id: 0x0022 specifies this module is a document module, class module, or designer module.

3.1.2.3.2.2 Sheet1 Document Module Record Example

This example illustrates a **document module** record, it differs from the previous module record example in record values. This example is included to illustrate the **MODULEDOCSTRING** (section 2.3.4.2.3.2.4) and **MODULEHELPCONTEXT** (section 2.3.4.2.3.2.6) records.

Offset	Size	Structure	Value
00000546	00BE	MODULE Record **- ModuleRecord**	
00000546	000C	MODULENAME Record **- NameRecord**	
00000546	0002	unsigned integer **- Id**	0x0019
00000548	0004	unsigned integer **- SizeOfModuleName**	0x00000006
0000054C	0006	array of bytes **- ModuleName**	Sheet1
00000552	0012	MODULENAMEUNICODE Record **- NameUnicodeRecord**	
00000552	0002	unsigned integer **- Id**	0x0047
00000554	0004	unsigned integer **- SizeOfModuleNameUnicode**	0x0000000C
00000558	000C	array of bytes **- ModuleNameUnicode**	Sheet1
00000564	001E	MODULESTREAMNAME Record **- StreamNameRecord**	
00000564	0002	unsigned integer **- Id**	0x001A
00000566	0004	unsigned integer **- SizeOfStreamName**	0x00000006
0000056A	0006	array of bytes **- StreamName**	Sheet1
00000570	0002	unsigned integer **- Reserved**	0x0032
00000572	0004	unsigned integer **- SizeOfStreamNameUnicode**	0x0000000C
00000576	000C	array of bytes **- StreamNameUnicode**	Sheet1
00000582	005A	MODULEDOCSTRING Record **- DocStringRecord**	
00000582	0002	unsigned integer **- Id**	0x001C

Offset	Size	Structure	Value
00000584	0004	unsigned integer **- SizeOfDocString**	0x0000001A
00000588	001A	array of bytes **- DocString**	Example Module Description
000005A2	0002	unsigned integer **- Reserved**	0x0048
000005A4	0004	unsigned integer **- SizeOfDocStringUnicode**	0x00000034
000005A8	0034	array of bytes **- DocStringUnicode**	Example Module Description
000005DC	000A	MODULEOFFSET Record **- OffsetRecord**	
000005DC	0002	unsigned integer **- Id**	0x0031
000005DE	0004	unsigned integer **- Size**	0x00000004
000005E2	0004	unsigned integer **- TextOffset**	0x00000000
000005E6	000A	MODULEHELPCONTEXT Record **- HelpContextRecord**	
000005E6	0002	unsigned integer **- Id**	0x001E
000005E8	0004	unsigned integer **- Size**	0x00000004
000005EC	0004	unsigned integer **- HelpContext**	0x00000002
000005F0	0008	MODULECOOKIE Record **- CookieRecord**	
000005F0	0002	unsigned integer **- Id**	0x002C
000005F2	0004	unsigned integer **- Size**	0x00000002
000005F6	0002	unsigned integer **- Cookie**	0xFFFF
000005F8	0006	MODULETYPE Record **- TypeRecord**	
000005F8	0002	unsigned integer **- Id**	0x0022
000005FA	0004	unsigned integer **- Reserved**	0x00000000
000005FE	0002	unsigned integer **- Terminator**	0x002B
00000600	0004	unsigned integer **- Reserved**	0x00000000

Figure 7: Sheet1 module record

The preceding table illustrates a module record for a document module with a description and link to a Windows **Help file** (.hlp). The description is described in the **DocStringRecord**. The link to the Help file is illustrated in the **HelpFilePathRecord** of the **PROJECTINFORMATION** (section 2.3.4.2.1). The link to the Help topic for this example is illustrated in the **HelpContextRecord**. The decompressed code can be found in the corresponding Sheet3.1.2.3.2.2 Decompressed Module Stream Example (section 3.1.4).

DocStringRecord.DocString: "Example Module Description" specifies the description of the module in **MBCS** characters.

DocStringRecord.DocStringUnicode: "Example Module Description" specifies the description of the module in **Unicode** characters. This value is equivalent to the **DocString** field value.

HelpContextRecord.HelpContext: 0x00000002 specifies the **Help topic identifier** in the Help file specified by **PROJECTHELPFILEPATH Record** (section 2.3.4.2.1.7).

3.1.2.3.2.3 UserForm1 Designer Module Record Example

The following example illustrates a **designer module** record.

Offset	Size	Structure	Value
00000604	0088	MODULE Record **- ModuleRecord**	
00000604	000F	MODULENAME Record **- NameRecord**	
00000604	0002	unsigned integer **- Id**	0x0019
00000606	0004	unsigned integer **- SizeOfModuleName**	0x00000009
0000060A	0009	array of bytes **- ModuleName**	UserForm1
00000613	0018	MODULENAMEUNICODE Record **- NameUnicodeRecord**	
00000613	0002	unsigned integer **- Id**	0x0047
00000615	0004	unsigned integer **- SizeOfModuleNameUnicode**	0x00000012
00000619	0012	array of bytes **- ModuleNameUnicode**	UserForm1
0000062B	0027	MODULESTREAMNAME Record **- StreamNameRecord**	
0000062B	0002	unsigned integer **- Id**	0x001A
0000062D	0004	unsigned integer **- SizeOfStreamName**	0x00000009
00000631	0009	array of bytes **- StreamName**	UserForm1
0000063A	0002	unsigned integer **- Reserved**	0x0032
0000063C	0004	unsigned integer **- SizeOfStreamNameUnicode**	0x00000012
00000640	0012	array of bytes **- StreamNameUnicode**	UserForm1
00000652	000C	MODULEDOCSTRING Record **- DocStringRecord**	
00000652	0002	unsigned integer **- Id**	0x001C
00000654	0004	unsigned integer **- SizeOfDocString**	0x00000000
00000658	0000	array of bytes **- DocString**	
00000658	0002	unsigned integer **- Reserved**	0x0048
0000065A	0004	unsigned integer **- SizeOfDocStringUnicode**	0x00000000
0000065E	0000	array of bytes **- DocStringUnicode**	
0000065E	000A	MODULEOFFSET Record **- OffsetRecord**	
0000065E	0002	unsigned integer **- Id**	0x0031
00000660	0004	unsigned integer **- Size**	0x00000004
00000664	0004	unsigned integer **- TextOffset**	0x00000000
00000668	000A	MODULEHELPCONTEXT Record **- HelpContextRecord**	
00000668	0002	unsigned integer **- Id**	0x001E

Offset	Size	Structure	Value
0000066A	0004	unsigned integer **- Size**	0x00000004
0000066E	0004	unsigned integer **- HelpContext**	0x00000000
00000672	0008	MODULECOOKIE Record **- CookieRecord**	
00000672	0002	unsigned integer **- Id**	0x002C
00000674	0004	unsigned integer **- Size**	0x00000002
00000678	0002	unsigned integer **- Cookie**	0xFFFF
0000067A	0006	MODULETYPE Record **- TypeRecord**	
0000067A	0002	unsigned integer **- Id**	0x0022
0000067C	0004	unsigned integer **- Reserved**	0x00000000
00000680	0006	MODULEPRIVATE Record **- PrivateRecord**	
00000680	0002	unsigned integer **- Id**	0x0028
00000682	0004	unsigned integer **- Reserved**	0x00000000
00000686	0002	unsigned integer **- Terminator**	0x002B
00000688	0004	unsigned integer **- Reserved**	0x00000000

Figure 8: UserForm1 module record

The preceding table illustrates a Module record for a designer module. The fields for this example are omitted, with the exception of **PrivateRecord**. The decompressed data can be found in the corresponding UserForm3.1.2.3.2.3 Decompressed Module Stream Example (section 3.1.5).

PrivateRecord: The presence of this record with a value of 0x0028 for the identifier specifies that the module is only usable from within this **VBA project**. Referencing VBA projects might not call this module.

3.1.3 ThisWorkbook Decompressed Module Stream Example

The following example illustrates the decompressed module **stream** for the "ThisWorkbook" module record.

Offset	Size	Structure	Value
00000000	0163	array of bytes **- TextDecompressedData**	Attribute VB_Name = "ThisWorkbook"\r\nAttribute VB_Base = "0{00020819-0000-0000-C000-000000000046}"\r\nAttribute VB_GlobalNameSpace = False\r\nAttribute VB_Creatable = False\r\nAttribute VB_PredeclaredId = True\r\nAttribute VB_Exposed = True\r\nAttribute VB_TemplateDerived = False\r\nAttribute VB_Customizable = True\r\nSub helloworld()\r\nMsgBox "Hello, World"\r\nEnd Sub\r\n

Figure 9: Decompressed module data

The preceding table illustrates the decompressed module data for the "ThisWorkbook" module.

TextDecompressedData: Specifies the attributes of the "ThisWorkbook" module and the code for the module, as described in [MS-VBAL]. The following text is formatted for readability.

```
Attribute VB_Name = "ThisWorkbook"
```

```
Attribute VB_Base = "0{00020819-0000-0000-C000-000000000046}"
Attribute VB_GlobalNameSpace = False
Attribute VB_Creatable = False
Attribute VB_PredeclaredId = True
Attribute VB_Exposed = True
Attribute VB_TemplateDerived = False
Attribute VB_Customizable = True
Sub helloworld()
    MsgBox "Hello, World"
End Sub
```

3.1.4 Sheet1 Decompressed Module Stream Example

The following example illustrates the decompressed module **stream** example for the "Sheet1" module record.

Offset	Size	Structure	Value
00000000	01D5	array of bytes - **TextDecompressedData**	Attribute VB_Name = "Sheet1"\r\nAttribute VB_Base = "0{00020820-0000-0000-C000-000000000046}"\r\nAttribute VB_GlobalNameSpace = False\r\nAttribute VB_Creatable = False\r\nAttribute VB_PredeclaredId = True\r\nAttribute VB_Exposed = True\r\nAttribute VB_TemplateDerived = False\r\nAttribute VB_Customizable = True\r\nAttribute VB_HelpID = 2\r\nAttribute VB_Description = "Example Module Description"\r\nSub CompiliationExample()\r\n\r\n#If abc Then\r\n MsgBox "abc=1"\r\n#End If\r\n \r\nEnd Sub\r\n\r\n

Figure 10: Decompressed module data

TextDecompressedData: Specifies the attributes of the "Sheet1" module and the code for the module as described in [MS-VBAL]. The following text is formatted for readability.

```
Attribute VB_Name = "Sheet1"
Attribute VB_Base = "0{00020820-0000-0000-C000-000000000046}"
Attribute VB_GlobalNameSpace = False
Attribute VB_Creatable = False
Attribute VB_PredeclaredId = True
Attribute VB_Exposed = True
Attribute VB_TemplateDerived = False
Attribute VB_Customizable = True
Attribute VB_HelpID = 2
Attribute VB_Description = "Example Module Description"
Sub CompiliationExample()

#If abc Then
    MsgBox "abc=1"
#End If

End Sub
```

3.1.5 UserForm1 Decompressed Module Stream Example

The following example illustrates the decompressed module **stream** example for the "UserForm1" module record.

Offset	Size	Structure	Value
00000000	0156	array of bytes - **TextDecompressedData**	Attribute VB_Name = "UserForm1"\r\nAttribute VB_Base = "0{842E9C5E-88B5-439A-912E-4C2D9AA0EC27}{2DC3C962-DA1C-47BA-AB63-

Offset	Size	Structure	Value
			E9D578FC2637}"\r\nAttribute VB_GlobalNameSpace = False\r\nAttribute VB_Creatable = False\r\nAttribute VB_PredeclaredId = True\r\nAttribute VB_Exposed = False\r\nAttribute VB_TemplateDerived = False\r\nAttribute VB_Customizable = False\r\n

Figure 11: Decompressed module data

TextDecompressedData: Specifies the attributes of the "UserForm1" module. The following text is formatted for readability.

```
Attribute VB_Name = "UserForm1"
Attribute VB_Base = "0{842E9C5E-88B5-439A-912E-4C2D9AA0EC27}{2DC3C962-DA1C-47BA-AB63-
E9D578FC2637}"
Attribute VB_GlobalNameSpace = False
Attribute VB_Creatable = False
Attribute VB_PredeclaredId = True
Attribute VB_Exposed = False
Attribute VB_TemplateDerived = False
Attribute VB_Customizable = False
```

3.1.6 PROJECT Stream Example

This example illustrates the properties of the **VBA project** in the Project Stream.

Offset	Size	Structure	Value
00000000	027F	array of bytes - **text**	ID="{917DED54-440B-4FD1-A5C1-74ACF261E600}"\r\nDocument=ThisWorkbook/&H00000000\r\nDocument=Sheet1/&H00000000\r\nPackage={AC9F2F90-E877-11CE-9F68-00AA00574A4F}\r\nBaseClass=UserForm1\r\nHelpFile="c:\example path\example.hlp"\r\nName="VBAProject"\r\nHelpContextID="1"\r\nDescription="Example VBA Project Description"\r\nVersionCompatible32="393222000"\r\nCMG="0705D8E3D8EDDBF1DBF1DBF1DBF1"\r\nDPB="0E0CD1ECDFF4E7F5E7F5E7"\r\nGC="1517CAF1D6F9D7F9D706"\r\n\r\n[Host Extender Info]\r\n&H00000001={3832D640-CF90-11CF-8E43-00A0C911005A};VBE;&H00000000\r\n\r\n[Workspace]\r\nThisWorkbook=23, 23, 911, 280, \r\nSheet1=69, 69, 724, 317, C\r\nUserForm1=0, 0, 0, 0, C, 46, 46, 701, 294, Z

Figure 12: Project stream

The preceding table illustrates an array of bytes that contains the example **VBAPROJECTText** (section 2.3.1). The **VBAPROJECTText** (section 2.3.1) conforms to the ABNF syntax.

text: The example **VBAPROJECTText** (section 2.3.1) follows. The following text is formatted for readability:

```
ID="{917DED54-440B-4FD1-A5C1-74ACF261E600}"
Document=ThisWorkbook/&H00000000
Document=Sheet1/&H00000000
Package={AC9F2F90-E877-11CE-9F68-00AA00574A4F}
BaseClass=UserForm1
HelpFile="c:\example path\example.hlp"
Name="VBAProject"
HelpContextID="1"
Description="Example VBA Project Description"
VersionCompatible32="393222000"
CMG="0705D8E3D8EDDBF1DBF1DBF1DBF1"

DPB="0E0CD1ECDFF4E7F5E7F5E7"
GC="1517CAF1D6F9D7F9D706"
```

```
[Host Extender Info]
&H00000001={3832D640-CF90-11CF-8E43-00A0C911005A};VBE;&H00000000

[Workspace]
ThisWorkbook=23, 23, 911, 280,
Sheet1=69, 69, 724, 317, C
UserForm1=0, 0, 0, 0, C, 46, 46, 701, 294, Z
```

ProjectID (section 2.3.1.2): "ID="{917DED54-440B-4FD1-A5C1-74ACF261E600}"" specifies the **CLSID** of the VBA project's **Automation type library**.

ProjectDocModule (section 2.3.1.4): specifies the module names, "ThisWorkbook" and "Sheet1", of the **document module**s in the VBA project. "&H00000000" specifies the modules are document modules. This example contains no **ProjectStdModule** (section 2.3.1.5) or **ProjectClassModule** (section 2.3.1.6) properties as there are no **procedural modules** or **class modules**.

ProjectPackage (section 2.3.1.8): "Package={AC9F2F90-E877-11CE-9F68-00AA00574A4F}" specifies the CLSID for the **designer module**, "UserForm1", as specified in the **ProjectDesignerModule** (section 2.3.1.7) property.

ProjectHelpFile (section 2.3.1.9): "HelpFile="c:\example path\example.hlp"" is equivalent to the value specified in **PROJECTHELPFILEPATH** (section 2.3.4.2.1.7) field in the **PROJECTINFORMATION** record (section 2.3.4.2.1).

ProjectName (section 2.3.1.11): "Name="VBAProject"" is equivalent to the value specified in **PROJECTNAME** (section 2.3.4.2.1.5).

ProjectHelpId (section 2.3.1.12): "HelpContextID="1"" is equivalent to the value specified in **PROJECTHELPCONTEXT** (section 2.3.4.2.1.8).

ProjectDescription (section 2.3.1.13): "Description="Example VBA Project Description"" is equivalent to the **DocStringRecord** (section 2.3.4.2.1.6) field in the **PROJECTINFORMATION** record (section 2.3.4.2.1).

ProjectVersionCompat2.3.1.14 (section 2.3.1.14): "VersionCompatible32="393222000"" specifies the **VBA** version of the VBA project.

ProjectProtectionState (section 2.3.1.15): "CMG="0705D8E3D8EDDBF1DBF1DBF1DBF1"" specifies no sources are restricted access to the VBA project. The value is obfuscated by Data Encryption (section 2.4.3). The following is the decrypted value of the **ProjectProtectionState** (section 2.3.1.15) as specified by an **Encrypted Data Structure** (section 2.4.3.1). The text is formatted for readability:

```
Seed:           0x07
Version:        0x02
ProjKey:        0xDF
Ignored:        0x070707
DataLength:     0x00000004
Data:           0x00000000
```

ProjectPassword (section 2.3.1.16): "DPB="0E0CD1ECDFF4E7F5E7F5E7"" specifies the VBA project has no password. The value is obfuscated by Data Encryption (section 2.4.3). The following is the decrypted value of the **ProjectProtectionState** (section 2.3.1.15) as specified by an **Encrypted Data Structure** (section 2.4.3.1). The text is formatted for readability:

```
Seed:           0x0E
Version:        0x02
ProjKey:        0xDF
```

```
Ignored:        0x070707
DataLength:     0x00000001
Data:           0x00
```

ProjectVisibilityState (section 2.3.1.17): "GC="1517CAF1D6F9D7F9D706"" specifies the VBA project is visible. The value is obfuscated by Data Encryption (section 2.4.3). The following text is the decrypted value of **ProjectVisibilityState** (section 2.3.1.17) as specified by an **Encrypted Data Structure** (section 2.4.3.1). The text is formatted for readability:

```
Seed:           0x15
Version:        0x02
ProjKey:        0xDF
Ignored:        0x0707
DataLength:     0x00000001
Data:           0xFF
```

HostExtenderRef (section 2.3.1.18): "&H00000001={3832D640-CF90-11CF-8E43-00A0C911005A};VBE;&H00000000", specifies the list of **host extenders**. There is only one host extender for the VBA project.

ExtenderIndex: "&H00000001" specifies the host extender entry is "1".

ExtenderGuid: "{3832D640-CF90-11CF-8E43-00A0C911005A}" specifies the **GUID** of the Automation type library to extend.

LibName: "VBE" specifies a built in name for the VBA Automation type library.

CreationFlags: "&H00000000" specifies that a new **extended type library** for the **aggregatable server** cannot be created if there is one available.

ProjectWorkspace record (section 2.3.1.19) specifies **module** window states for the three modules in the VBA project.

The first **ProjectWorkspace** record (section 2.3.1.19) specifies the module window state for the "ThisWorkbook" module. The **ModuleIdentifier** value, "ThisWorkbook" specifies the name of the module. The first **CodeWindow** value, "23, 23, 911, 280", specifies the coordinates of the window as follows:

WindowLeft 23

WindowTop 23

WindowRight 911

WindowBottom 280

There is no value for **WindowState** for this module.

The second **ProjectWorkspace** record (section 2.3.1.19) specifies the module window state for the "Sheet1" module. **ModuleIdentifier** "Sheet1" specifies the name of the module. The **CodeWindow** Value, "69, 69, 724, 317" specifies the coordinates of the window as follows:

WindowLeft = 69

WindowTop = 69

WindowRight = 724

WindowBottom = 317

The **WindowState**, "C" specifies the code window for this module is closed.

The third **ProjectWorkspace** record (section 2.3.1.19) specifies the module windows state for the "UserForm1" designer module. **ModuleIdentifier** "UserForm1" specifies the name of the module. The **CodeWindow** value, "0, 0, 0, 0", specifies no code window coordinates for this **ProjectWorkspace** record (section 2.3.1.19). The WindowState, "C", specifies the code window for this module is closed. The **DesignerWindow** value, "46, 46, 701, 294", specifies the coordinates of the window as follows:

WindowLeft = 46

WindowTop = 46

WindowRight = 701

WindowBottom = 294

WindowState: "Z" specifies the **DesignerWindow** is zoomed to fill the available viewing area.

3.1.7 VBFrame Stream Example

The following example illustrates the extended properties for a designer module.

Offset	Size	Structure	Value
00000000	0123	array of bytes **- text**	VERSION 5.00\r\nBegin {C62A69F0-16DC-11CE-9E98-00AA00574A4F} UserForm1 \r\n Caption = "UserForm1"\r\n ClientHeight = 3210\r\n ClientLeft = 45\r\n ClientTop = 345\r\n ClientWidth = 4710\r\n StartUpPosition = 1 'CenterOwner\r\n TypeInfoVer = 1\r\nEnd\r\n

Figure 13: VBFrame stream

The preceding table illustrates the **VBFrame Stream** (section 2.2.11). This **stream** contains an Office Form **ActiveX control library** as described in [MS-OFORMS].

text: This **VBFrame Stream** (section 2.2.11) describes the extended properties for the "UserForm1" **designer module**. The following text is formatted for readability:

```
VERSION 5.00
Begin {C62A69F0-16DC-11CE-9E98-00AA00574A4F} UserForm1
   Caption         =   "UserForm1"
   ClientHeight    =   3210
   ClientLeft      =   45
   ClientTop       =   345
   ClientWidth     =   4710
   StartUpPosition =   1  'CenterOwner
   TypeInfoVer     =   2
End
```

DesignerCLSID: "{C62A69F0-16DC-11CE-9E98-00AA00574A4F}" specifies the **class identifier (CLSID)** of the Office Form **ActiveX control** as described in [MS-OFORMS].

DesignerName: "UserForm1" specifies the name of the designer module.

DesignerCaption (section 2.3.5.2): "UserForm1" specifies the title text of the **designer**.

DesignerHeight (section 2.3.5.3): "ClientHeight = 3210" specifies the height of the designer is 3210 **twips**.

DesignerLeft (section 2.3.5.4): "ClientLeft = 45" specifies the left edge of the designer is 45 twips from the **DesignerStartupPosition** (section 2.3.5.11).

DesignerTop (section 2.3.5.5): "ClientTop = 345" specifies the top edge of the designer is 345 twips from the **DesignerStartupPosition** (section 2.3.5.11).

DesignerWidth (section 2.3.5.6): "ClientWidth = 4710" specifies the width of the designer is 4710 twips.

DesignerStartupPosition (section 2.3.5.11): "StartUpPosition = 1" specifies the **RelativeParent** value of "1". This specifies the designer is centered relative to its **parent window**. The text "'CenterOwner" is a comment as described in [MS-VBAL].

DesignerTypeInfoVer (section 2.3.5.13): "TypeInfoVer = 2" specifies the designer has been changed and saved 2 times.

3.2 Compression/Decompression Examples

3.2.1 No Compression Example

The following string illustrates an ASCII text string with a set of characters that cannot be compressed by the compression algorithm specified in section 2.4.1.

```
abcdefghijklmnopqrstuv.
```

This example is provided to demonstrate the results of compressing and decompressing the string using an interoperable implementation of the algorithm specified in section 2.4.1.

The following hex array represents the compressed byte array of the example string as compressed by the compression algorithm.

```
01 19 B0 00 61 62 63 64 65 66 67 68 00 69 6A 6B 6C
6D 6E 6F 70 00 71 72 73 74 75 76 2E
```

The following hex array represents the decompressed byte array of the example string as decompressed by the decompression algorithm.

```
61 62 63 64 65 66 67 68 69 6A 6B 6C 6D 6E 6F 70 71
72 73 74 75 76 2E
```

3.2.2 Normal Compression Example

The following string illustrates an ASCII text string with a typical set of characters that can be compressed by the compression algorithm.

```
#aaabcdefaaaaghijaaaaaklaaamnopqaaaaaaaaaaaarstuvwxyzaaa
```

This example is provided to demonstrate the results of compressing and decompressing the example string using an interoperable implementation of the algorithm specified in section 2.4.1.

The following hex array represents the compressed byte array of the example string as compressed by the compression algorithm:

```
01 2F B0 00 23 61 61 61 62 63 64 65 82 66 00 70
61 67 68 69 6A 01 38 08 61 6B 6C 00 30 6D 6E 6F
70 06 71 02 70 04 10 72 73 74 75 76 10 77 78 79
```

```
7A 00 3C
```

The following hex array represents the decompressed byte array of the example string as decompressed by the decompression algorithm:

```
23 61 61 61 62 63 64 65  66 61 61 61 61 67 68 69
6a 61 61 61 61 61 6B 6C  61 61 61 6D 6E 6F 70 71
61 61 61 61 61 61 61 61  61 61 61 61 72 73 74 75
76 77 78 79 7A 61 61 61
```

3.2.3 Maximum Compression Example

The following illustrates a set of repeating characters that represent a string that can be maximally compressed using the compression algorithm.

```
aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa
```

This example is provided to demonstrate the results of compressing and decompressing the example string using an interoperable implementation of the algorithm specified in section 2.4.1.

The following hex array represents the compressed byte array of the example string as compressed by the compression algorithm:

```
01 03 B0 02 61 45 00
```

The following hex array represents the decompressed byte array of the example string as decompressed by the decompression algorithm:

```
61 61 61 61 61 61 61 61 61 61 61 61 61 61 61 61
61 61 61 61 61 61 61 61 61 61 61 61 61 61 61 61
61 61 61 61 61 61 61 61 61 61 61 61 61 61 61 61
61 61 61 61 61 61 61 61 61 61 61 61 61 61 61 61
61 61 61 61 61 61 61 61 61
```

4 Security Considerations

4.1 Project Integrity Verification

The Visual Basic for Applications (**VBA**) cryptographic **digest** for a **VBA project** – see **Contents Hash** (section 2.4.2) – can be stored externally and used to verify the integrity of the VBA project.

4.2 Encryption Method

When data in a **VBA project**, such as a password, is encrypted, the information necessary to decrypt the data is stored with the encrypted data. The design of this encryption is to obfuscate sensitive information, not to secure it. For more information, see Data Encryption (section 2.4.3). Following is a list of encrypted items:

- Project password – see **ProjectPassword** (section 2.3.1.16)
- Project protection state – see **ProjectProtectionState** (section 2.3.1.15)
- Project visibility state – see **ProjectVisibilityState** (section 2.3.1.17)

5 Appendix A: Product Behavior

The information in this specification is applicable to the following Microsoft products or supplemental software. References to product versions include updates to those products.

- Microsoft Office 97
- Microsoft Office 2000
- Microsoft Office XP
- Microsoft Office 2003
- the 2007 Microsoft Office system
- Microsoft Office 2010 suites
- Microsoft Office 2013
- Microsoft Office 2016

Exceptions, if any, are noted in this section. If an update version, service pack or Knowledge Base (KB) number appears with a product name, the behavior changed in that update. The new behavior also applies to subsequent updates unless otherwise specified. If a product edition appears with the product version, behavior is different in that product edition.

Unless otherwise specified, any statement of optional behavior in this specification that is prescribed using the terms "SHOULD" or "SHOULD NOT" implies product behavior in accordance with the SHOULD or SHOULD NOT prescription. Unless otherwise specified, the term "MAY" implies that the product does not follow the prescription.

<1> Section 1.5: This persistence format provides interoperability with applications that create or read documents conforming to this structure, including Microsoft Word 97, Microsoft Word 2000, Microsoft Word 2002, Microsoft Office Word 2003, Microsoft Office Word 2007, Microsoft Word 2010, Microsoft Excel 97, Microsoft Excel 2000, Microsoft Excel 2002, Microsoft Office Excel 2003, Microsoft Office Excel 2007, Microsoft Excel 2010, Microsoft PowerPoint 97, Microsoft PowerPoint 2000, Microsoft PowerPoint 2002, Microsoft Office PowerPoint 2003, Microsoft Office PowerPoint 2007, and Microsoft PowerPoint 2010.

<2> Section 2.1.1.9: Microsoft Visual Basic for Applications 5.0 (VBA 5.0) does not require the name to be an identifier.

<3> Section 2.3.1.11: VBA 5.0 uses the file name of the containing document.

<4> Section 2.3.1.14: VBA 5.0 does not write this record.

<5> Section 2.3.1.15: VBA 5.0 will save 0x00000000 regardless of protection state.

<6> Section 2.3.1.16: VBA 5.0 will save the encrypted plain text password.

<7> Section 2.3.2.1: Can be 0x00000000 even though **SizeOfLicenseKey** is not zero. This happens when a document is originally created with an **ActiveX control** that requires license-aware object creation, and then resaved after the ActiveX control removes that requirement.

<8> Section 2.3.4.2.1.11: Microsoft Visual Basic for Applications (VBA) will write user-specified values between −32768 and 32767. However, VBA will only read values between -9999 and 32767.

<9> Section 2.3.4.2.2.3: VBA 5.0 uses **LibidTwiddled** to specify a **twiddled type library**

<10> Section 2.4.1.3.10: The 0x00 byte padding is indistinguishable from bytes in the original **DecompressedChunk**. Thus, it is possible for an application of the **Compression algorithm**

followed by an application of the **Decompression algorithm** to result in a **DecompressedBuffer** that contains more bytes than the original.

6 Change Tracking

This section identifies changes that were made to this document since the last release. Changes are classified as Major, Minor, or None.

The revision class **Major** means that the technical content in the document was significantly revised. Major changes affect protocol interoperability or implementation. Examples of major changes are:

- A document revision that incorporates changes to interoperability requirements.
- A document revision that captures changes to protocol functionality.

The revision class **Minor** means that the meaning of the technical content was clarified. Minor changes do not affect protocol interoperability or implementation. Examples of minor changes are updates to clarify ambiguity at the sentence, paragraph, or table level.

The revision class **None** means that no new technical changes were introduced. Minor editorial and formatting changes may have been made, but the relevant technical content is identical to the last released version.

The changes made to this document are listed in the following table. For more information, please contact dochelp@microsoft.com.

Section	Description	Revision class
3.1.2.3.2.3 UserForm1 Designer Module Record Example	Updated the description for PrivateRecord.	Minor
3.1.6 PROJECT Stream Example	Updated the description for CreationFlags.	Minor

7 Index

_

_VBA_PROJECT example 82
_VBA_PROJECT stream 20

A

ABNF rules 15
Algorithms
  compression 54
  contents hash 71
  data encryption 73
  decompression 54
  encryption 73
  password hash 77
Applicability 14

B

Byte ordering - overview 13

C

Change tracking 108
Compression algorithms 54
Contents hash algorithm 71
Conventions 15

D

Data encryption algorithm 73
Decompressed module stream example – Sheet1 98
Decompressed module stream example - ThisWorkbook 97
Decompressed module stream example – UserForm1 98
Decompression algorithms 54
Designer storage 20
Details
  _VBA_PROJECT stream 20
  ABNF rules 15
  compression algorithms 54
  contents hash algorithm 71
  conventions 15
  data encryption algorithm 73
  decompression algorithms 54
  designer storage 20
  dir stream 20
  file structure 19
  module stream 20
  password hash algorithm 77
  project root storage 19
  PROJECT stream 20
  PROJECT stream project information 21
  PROJECTlk stream 20
  PROJECTlk stream ActiveX control information 28
  PROJECTwm stream 20
  PROJECTwm stream module name information 29
  pseudocode 18
  SRP stream 20
  VBA storage 19
  VBA storage project information 29
  VBFrame stream 21
  VBFrame stream designer information 50
dir stream 20
dir stream example 82

E

Encryption algorithm 73
Examples 82
  _VBA_PROJECT 82
  decompressed module stream – Sheet1 98
  decompressed module stream - ThisWorkbook 97
  decompressed module stream – UserForm1 98
  dir stream 82
  maximum compression 104
  no compression 103
  normal compression 103
  PROJECT stream 99
  Sheet1 decompressed module stream 98
  ThisWorkbook decompressed module stream 97
  UserForm1 decompressed module stream 98
  VBFrame stream 102

F

Fields - vendor-extensible 14
File structure 19

G

Glossary 8

I

Informative references 11
Introduction 8

L

Localization 14

M

Maximum compression example 104
Module stream 20

N

No compression example 103
Normal compression example 103
Normative references 11

O

Overview (synopsis) 12

P

Password hash algorithm 77

Product behavior 106
Project information - overview 12
Project items - overview 12
Project references - overview 12
Project root storage 19
PROJECT stream 20
PROJECT stream example 99
PROJECT stream project information 21
PROJECTlk stream 20
PROJECTlk stream ActiveX control information 28
PROJECTwm stream 20
PROJECTwm stream module name information 29
Pseudocode 18

R

References 11
  informative 11
  normative 11
Relationship to protocols and other structures 13

S

Security
  encryption method 105
  project integrity verification 105
Security – encryption method 105
Security - project integrity verification 105
Sheet1 decompressed module stream example 98
SRP stream 20
Structures
  _VBA_PROJECT stream 20
  ABNF rules 15
  compression algorithms 54
  contents hash algorithm 71
  conventions 15
  data encryption algorithm 73
  decompression algorithms 54
  designer storage 20
  dir stream 20
  module stream 20
  password hash algorithm 77
  project root storage 19
  PROJECT stream 20
  PROJECT stream project information 21
  PROJECTlk stream 20
  PROJECTlk stream ActiveX control information 28
  PROJECTwm stream 20
  PROJECTwm stream module name information 29
  pseudocode 18
  SRP stream 20
  VBA storage 19
  VBA storage project information 29
  VBFrame stream 21
  VBFrame stream designer information 50

T

ThisWorkbook decompressed module stream example 97
Tracking changes 108

U

UserForm1 decompressed module stream example 98

V

VBA storage 19
VBA storage project information 29
VBFrame stream 21
VBFrame stream designer information 50
VBFrame stream example 102
Vendor-extensible fields 14
Versioning 14