

# ACVP Password-based Key Derivation Function JSON Specification

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## **Abstract**

This document defines the JSON schema for testing Password-based KDF implementations with the ACVP specification.

## **Keywords**

The following are keywords to be used by search engines and document catalogues.

ACVP; cryptography

## **Foreword**

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## **Audience**

This document is intended for the users and developers of ACVP.

## **Conventions**

The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “NOT RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described in BCP 14 of [\[RFC 2119\]](#) and [\[RFC 8174\]](#) when, and only when, they appear in all capitals, as shown here.

## **Acknowledgements**

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## **Executive Summary**

The Automated Crypto Validation Protocol (ACVP) defines a mechanism to automatically verify the cryptographic implementation of a software or hardware crypto module. The ACVP specification defines how a crypto module communicates with an ACVP server, including crypto

capabilities negotiation, session management, authentication, vector processing and more. The ACVP specification does not define algorithm specific JSON constructs for performing the crypto validation. A series of ACVP sub-specifications define the constructs for testing individual crypto algorithms. Each sub-specification addresses a specific class of crypto algorithms. This sub-specification defines the JSON constructs for testing Password-based KDF implementations using ACVP.

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## 1. Introduction

The Automated Crypto Validation Protocol (ACVP) defines a mechanism to automatically verify the cryptographic implementation of a software or hardware crypto module. The ACVP specification defines how a crypto module communicates with an ACVP server, including crypto capabilities negotiation, session management, authentication, vector processing and more. The ACVP specification does not define algorithm specific JSON constructs for performing the crypto validation. A series of ACVP sub-specifications define the constructs for testing individual crypto algorithms. Each sub-specification addresses a specific class of crypto algorithms. This sub-specification defines the JSON constructs for testing Password-based KDF implementations using ACVP.

## 2. Supported KDFs

The following key derivation functions **MAY** be advertised by the ACVP compliant cryptographic module:

- PBKDF / 1.0

### 3. Test Types and Test Coverage

This section describes the design of the tests used to validate Password-based KDF implementations.

#### 3.1. Test Types

There is only one test type: functional tests. Each has a specific value to be used in the testType field. The testType field definitions are:

- “AFT”—Algorithm Functional Test. These tests can be processed by the client using a normal `derive_key` operation. AFTs cause the implementation under test to exercise normal operations on a single block, multiple blocks, or partial blocks. In all cases, random data is used. The functional tests are designed to verify that the logical components of the key derivation process are operating correctly.

#### 3.2. Test Coverage

The tests described in this document have the intention of ensuring an implementation is conformant to XXX.

## 4. Capabilities Registration

ACVP requires crypto modules to register their capabilities. This allows the crypto module to advertise support for specific algorithms, notifying the ACVP server which algorithms need test vectors generated for the validation process. This section describes the constructs for advertising support of PBKDF algorithms to the ACVP server.

The algorithm capabilities **MUST** be advertised as JSON objects within the ‘algorithms’ value of the ACVP registration message. The ‘algorithms’ value is an array, where each array element is an individual JSON object defined in this section. The ‘algorithms’ value is part of the ‘capability\_exchange’ element of the ACVP JSON registration message. See the ACVP specification [\[ACVP\]](#) for more details on the registration message.

### 4.1. Prerequisites

Each algorithm implementation **MAY** rely on other cryptographic primitives. For example, RSA Signature algorithms depend on an underlying hash function. Each of these underlying algorithm primitives must be validated, either separately or as part of the same submission. ACVP provides a mechanism for specifying the required prerequisites:

Prerequisites, if applicable, **MUST** be submitted in the registration as the `prereqVals` JSON property array inside each element of the `algorithms` array. Each element in the `prereqVals` array **MUST** contain the following properties

Table 1 — Prerequisite Properties

JSON Property	Description	JSON Type
<code>algorithm</code>	a prerequisite algorithm	string
<code>valValue</code>	algorithm validation number	string

A “valValue” of “same” **SHALL** be used to indicate that the prerequisite is being met by a different algorithm in the capability exchange in the same registration.

An example description of prerequisites within a single algorithm capability exchange looks like this

```
"prereqVals":
[
  {
    "algorithm": "Alg1",
    "valValue": "Val-1234"
  },
  {
    "algorithm": "Alg2",
    "valValue": "same"
  }
]
```

]

Figure 1

## 4.2. Property Registration

The Password-based KDF mode capabilities are advertised as JSON objects within the ‘capabilities\_exchange’ property.

## 4.3. Registration Example

A registration **SHALL** use these properties

Table 2 — PBKDF Algorithm Capabilities JSON Values

JSON Property	Description	JSON Type	Valid Values
algorithm	Name of the algorithm to be validated	string	“PBKDF”
revision	ACVP Test version	string	“1.0”
prereqVals	Prerequisites of the algorithm	object	See <a href="#">Section 4.1</a>
capabilities	Array of capabilities	array	Each object in the array contains the below properties
iterationCount	Number of hash iterations	domain	Min: 1, Max: 10000000
keyLen	The length of the output key in bits	domain	Min: 112, Max: 4096
passwordLen	The length of the password in bytes (characters)	domain	Min: 8, Max: 128
saltLen	The length of the salt in bits	domain	Min: 128, Max: 4096
hmacAlg	The supported hash algorithms used for HMAC	array	See <a href="#">Section 4.3.1</a>

An example registration within an algorithm capability exchange looks like this

```
{
  "algorithm": "PBKDF",
  "revision": "1.0",
  "prereqVals": [
    {
      "algorithm": "SHA",
      "valValue": "same"
    }
  ],
  "capabilities": [
    {
```



```
    "iterationCount": [
      {
        "min": 10,
        "max": 1000,
        "increment": 1
      }
    ],
    "keyLen": [
      {
        "min": 8,
        "max": 4096,
        "increment": 8
      }
    ],
    "passwordLen": [
      {
        "min": 8,
        "max": 128,
        "increment": 1
      }
    ],
    "saltLen": [
      {
        "min": 128,
        "max": 4096,
        "increment": 8
      }
    ],
    "hmacAlg": [
      "SHA-1",
      "SHA2-224",
      "SHA2-256",
      "SHA2-384",
      "SHA2-512",
      "SHA3-224",
      "SHA3-256",
      "SHA3-384",
      "SHA3-512"
    ]
  }
]
```

**Figure 2**

#### 4.3.1. Valid Hash Functions

The following hash functions **MAY** be advertised by an ACVP compliant client under the ‘hmacAlg’ property

- SHA-1
- SHA2-224
- SHA2-256
- SHA2-384
- SHA2-512
- SHA2-512/224
- SHA2-512/256
- SHA3-224
- SHA3-256
- SHA3-384
- SHA3-512

## 5. Test Vectors

The ACVP server provides test vectors to the ACVP client, which are then processed and returned to the ACVP server for validation. A typical ACVP validation test session would require multiple test vector sets to be downloaded and processed by the ACVP client. Each test vector set represents an individual algorithm defined during the capability exchange. This section describes the JSON schema for a test vector set used with Password-based KDF algorithms.

The test vector set JSON schema is a multi-level hierarchy that contains meta data for the entire vector set as well as individual test vectors to be processed by the ACVP client. The following table describes the JSON elements at the top level of the hierarchy.

**Table 3 — Top Level Test Vector JSON Elements**

JSON Values	Description	JSON Type
acvVersion	Protocol version identifier	string
vsId	Unique numeric vector set identifier	integer
algorithm	Algorithm defined in the capability exchange	string
mode	Mode defined in the capability exchange	string
revision	Protocol test revision selected	string
testGroups	Array of test groups containing test data, see <a href="#">Section 5.1</a>	array

An example of this would look like this

```
{
  "acvVersion": "version",
  "vsId": 1,
  "algorithm": "Alg1",
  "mode": "Model",
  "revision": "Revision1.0",
  "testGroups": [ ... ]
}
```

**Figure 3**

### 5.1. Test Groups

The testGroups element at the top level in the test vector JSON object is an array of test groups. Test vectors are grouped into similar test cases to reduce the amount of data transmitted in the vector set. For instance, all test vectors that use the same key size would be grouped together. The Test Group JSON object contains meta data that applies to all test vectors within the group. The following table describes the Password-based KDF JSON elements of the Test Group JSON object

Table 4 — Test Group JSON Object

JSON Values	Description	JSON Type
tgId	Test group identifier	integer
hmacAlg	The hash algorithm used in HMAC	string
testType	Describes the operation the client should perform on the tests data	string
tests	Array of individual test cases	array

The 'tgId', 'testType' and 'tests' objects **MUST** appear in every test group element communicated from the server to the client as a part of a prompt. Other properties are dependent on which 'testType' the group is addressing.

## 5.2. Test Cases

Each test group contains an array of one or more test cases. Each test case is a JSON object that represents a single test vector to be processed by the ACVP client. The following table describes the JSON elements for each Password-based KDF test vector.

Table 5 — Test Case JSON Object

JSON Values	Description	JSON Type
tcId	Test case identifier	integer
keyLen	Length of the output key	integer
salt	Salt value	hex
password	Password value	string
iterationCount	Number of iterations	integer

Here is an abbreviated yet fully constructed example of the prompt

```
{
  "vsId": 1,
  "algorithm": "PBKDF",
  "revision": "1.0",
  "testGroups": [
    {
      "tgId": 1,
      "testType": "AFT",
      "hmacAlg": "SHA2-224",
      "tests": [
        {
          "tcId": 1,
          "keyLen": 143,
          "salt": "BC902BA1EB3BD8519B68022F0FC15600D5D27A",
          "password": "FSLuCqOV",
          "iterationCount": 955
        }
      ]
    }
  ]
}
```

```
{
  "tcId": 2,
  "keyLen": 188,
  "salt": "8120C1DED77061BC5ED637DD51174F12",
  "password": "HCmKuigggFlqpJv",
  "iterationCount": 269
}
]
}
]
}
```

**Figure 4**

## 6. Responses

After the ACVP client downloads and processes a vector set, it must send the response vectors back to the ACVP server. The following table describes the JSON object that represents a vector set response.

**Table 6 — Vector Set Response JSON Object**

JSON Property	Description	JSON Type
acvVersion	The version of the protocol	string
vsId	The vector set identifier	integer
testGroups	The test group data	array

An example of this is the following

```
{
  "acvVersion": "version",
  "vsId": 1,
  "testGroups": [ ... ]
}
```

**Figure 5**

The testGroups section is used to organize the ACVP client response in a similar manner to how it receives vectors. Several algorithms **SHALL** require the client to send back group level properties in their response. This structure helps accommodate that.

**Table 7 — Vector Set Group Response JSON Object**

JSON Property	Description	JSON Type
tgId	The test group identifier	integer
tests	The test case data	array

An example of this is the following

```
{
  "tgId": 1,
  "tests": [ ... ]
}
```

**Figure 6**

The following table describes the JSON object that represents a test case response for a Password-based KDF.

**Table 8 — Test Case Results JSON Object**

JSON Property	Description	JSON Type
tcId	The test case identifier	integer

JSON Property	Description	JSON Type
derivedKey	The outputted key	hex

Here is an abbreviated example of the response

```
{
  "vsId": 1,
  "algorithm": "PBKDF",
  "revision": "1.0",
  "testGroups": [
    {
      "tgId": 1,
      "tests": [
        {
          "tcId": 1,
          "derivedKey": "986B212420E3B977068244E6BD..."
        },
        {
          "tcId": 2,
          "derivedKey": "B8F3EEC6B5FA270FB05644DE40..."
        }
      ]
    }
  ]
}
```

**Figure 7**

## 7. Security Considerations

There are no additional security considerations outside of those outlined in the ACVP document.



## Appendix A — Terminology

For the purposes of this document, the following terms and definitions apply.

### A.1.

**Prompt**

JSON sent from the server to the client describing the tests the client performs

**Registration**

The initial request from the client to the server describing the capabilities of one or several algorithm, mode and revision combinations

**Response**

JSON sent from the client to the server in response to the prompt

**Test Case**

An individual unit of work within a prompt or response

**Test Group**

A collection of test cases that share similar properties within a prompt or response

**Test Vector Set**

A collection of test groups under a specific algorithm, mode, and revision

**Validation**

JSON sent from the server to the client that specifies the correctness of the response

## Appendix B — Abbreviations and Acronyms

ACVP	Automated Crypto Validation Protocol
JSON	Javascript Object Notation

**Appendix C — Revision History****Table C-1**

<b>Version</b>	<b>Release Date</b>	<b>Updates</b>
1	2019-06-05	Initial Release

## Appendix D — References

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