

CBOR Object Signing and Encryption  
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ML-DSA for JOSE and COSE  
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## Abstract

This document describes JSON Object Signing and Encryption (JOSE) and CBOR Object Signing and Encryption (COSE) serializations for Module-Lattice-Based Digital Signature Standard (ML-DSA), a Post-Quantum Cryptography (PQC) digital signature scheme defined in FIPS 204.

## About This Document

This note is to be removed before publishing as an RFC.

The latest revision of this draft can be found at <https://cose-wg.github.io/draft-ietf-cose-dilithium/draft-ietf-cose-dilithium.html>. Status information for this document may be found at <https://datatracker.ietf.org/doc/draft-ietf-cose-dilithium/>.

Discussion of this document takes place on the CBOR Object Signing and Encryption Working Group mailing list (<mailto:cose@ietf.org>), which is archived at <https://mailarchive.ietf.org/arch/browse/cose/>. Subscribe at <https://www.ietf.org/mailman/listinfo/cose/>.

Source for this draft and an issue tracker can be found at <https://github.com/cose-wg/draft-ietf-cose-dilithium>.

## Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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## 1. Introduction

This document describes how to use ML-DSA keys and signatures as described in [FIPS-204] with JOSE and COSE.

## 2. Terminology

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 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

Some examples in this specification are truncated using "..." for readability.

## 3. Algorithm Key Pair Type

This section describes a generic cryptographic key structure for use with algorithms not limited to those registered in this document. The Algorithm Key Pair (AKP) Type is used to express Public and Private Keys for use with Algorithms. The concept of public and private information classes for key pairs originates from Section 8.1 of [RFC7517]. The parameters for public and private information classes contain byte strings in a format specified by the "alg" value. The "alg" JSON Web Key Parameter or COSE Key Common Parameter is REQUIRED for all AKP keys. The "pub" parameter contains public information and is REQUIRED. The "priv" parameter contains private information and MUST NOT be present in public keys.

When registering new algorithms, use of multiple key type parameters for private information is NOT RECOMMENDED.

Some algorithms might require or encourage additional structure or length checks for associated key type parameters.

When AKP keys are expressed in JWK, key parameters are base64url encoded.

This document requests the registration of the following key types in [IANA.jose]:

Name	kyt	Description
Algorithm Key Pair	AKP	JSON Web Key Type for the Algorithm Key Pair.

Table 1: Algorithm Key Pair Type for JOSE

An example truncated private key for use with ML-DSA-44 in JWK format is provided below:

```
{
  "kid": "T4xl70S7MT6Zeq6r9V9fPJGVn76wfnXJ21-gyo0Gu6o",
  "kty": "AKP",
  "alg": "ML-DSA-44",
  "pub": "unH59k4Ru...DZgbTP07e7gEWzw4MFRrndjbdQ",
  "priv": "AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA"
}
```

Figure 1: The all zeros ML-DSA-44 JSON Web Key

This document requests the registration of the following key type in [IANA.cose]:

Name	kyt	Description
AKP	TBD (requested assignment 7)	COSE Key Type for the Algorithm Key Pair.

Table 2: Algorithm Key Pair Type for COSE

An example truncated private key for use with ML-DSA-44 in COSE\_Key format is provided below:

```
{
  / kid / 2: h'b8969ab4b37da9f068...6f0583bf5b8d3a8059a',
  / kty / 1: 7, / AKP /
  / alg / 3: -48, / ML-DSA-44 /
  / pub / -1: h'ba71f9f64e11baeb589...3830546b9dd8db0d',
  / priv / -2: h'00000000000000...0000000000000000'
}
```

Figure 2: The all zeros ML-DSA-44 COSE Key

The AKP key type and thumbprint computations are generic, and suitable for use with algorithms other than ML-DSA.

#### 4. ML-DSA Private Keys

Note that FIPS 204 defines 2 expressions for private keys: a seed, and a private key that is expanded from the seed.

Unlike [I-D.draft-ietf-lamps-dilithium-certificates], this document specifies ML-DSA private key information using only the seed.

For the ML-DSA private keys described in this document, the `priv` parameter **MUST** be the seed, and **MUST** have a length of 32 bytes.

This specification intentionally does not define a means of utilizing the expanded private key representation defined by NIST so as to increase interoperability by having a single ML-DSA private key representation for COSE and JOSE.

See Security Considerations of this document for details.

#### 5. ML-DSA Algorithms

The ML-DSA Signature Scheme is parameterized to support different security levels.

In this document, the abbreviations ML-DSA-44, ML-DSA-65, and ML-DSA-87 are used to refer to ML-DSA with the parameter choices given in Table 1 of FIPS-204.

This document requests the registration of the following algorithms in [IANA.jose]:

Name	value	Description
ML-DSA-44	ML-DSA-44	JSON Web Signature Algorithm for ML-DSA-44
ML-DSA-65	ML-DSA-65	JSON Web Signature Algorithm for ML-DSA-65
ML-DSA-87	ML-DSA-87	JSON Web Signature Algorithm for ML-DSA-87

Table 3: JOSE algorithms for ML-DSA

This document requests the registration of the following algorithms in [IANA.cose]:

Name	value	Description
ML-DSA-44	TBD (requested assignment -48)	CBOR Object Signing Algorithm for ML-DSA-44
ML-DSA-65	TBD (requested assignment -49)	CBOR Object Signing Algorithm for ML-DSA-65
ML-DSA-87	TBD (requested assignment -50)	CBOR Object Signing Algorithm for ML-DSA-87

Table 4: COSE algorithms for ML-DSA

In accordance with Algorithm Key Pair Type section of this document, ML-DSA key parameters have the following additional constraints:

The "pub" parameter is the ML-DSA public key, as described in Section 5.3 of FIPS-204.

The size of "pub", and the associated signature for each of these algorithms is defined in Table 2 of FIPS-204, and repeated here for convenience:

Algorithm	Private Key	Public Key	Signature Size
ML-DSA-44	2560	1312	2420
ML-DSA-65	4032	1952	3309
ML-DSA-87	4896	2592	4627

Table 5: Sizes (in bytes) of keys and signatures of ML-DSA

Note that priv size is always 32 bytes, and that KeyGen\_internal is called to produce the expanded private keys for "Private Key" in the table above.

See the ML-DSA Private Keys section of this document for more details.

These algorithms are used to produce signatures as described in Algorithm 2 of FIPS-204.

The ctx parameter MUST be the empty string for ML-DSA-44, ML-DSA-65 and ML-DSA-87.

Signatures are encoded as bytestrings using the algorithms defined in Section 7.2 of FIPS-204.

When producing JSON Web Signatures, the signature bytestrings are base64url encoded, and the encoded signature size is larger than described in the table above.

## 6. AKP Thumbprints

When computing the COSE Key Thumbprint as described in [I-D.draft-ietf-cose-key-thumbprint], the required parameters for algorithm key pairs are:

- \* "kty" (label: 1, data type: int, value: 7)
- \* "alg" (label: 3, data type: int, value: int)
- \* "pub" (label: -1, value: bstr)

The COSE Key Thumbprint is produced according to the process described in Section 3 of [I-D.draft-ietf-cose-key-thumbprint].

When computing the JWK Thumbprint as described in [RFC7638], the required parameters for algorithm key pairs are:

- \* "kty"
- \* "alg"
- \* "pub"

Their lexicographic order, per Section 3.3 of [RFC7638], is:

- \* "alg"
- \* "kty"
- \* "pub"

The JWK Key Thumbprint is produced according to the process described in Section 3 of [RFC7638].

See the kid values in the JSON Web Key and COSE Key examples in the appendix for examples of AKP thumbprints.

## 7. Security Considerations

The security considerations of [RFC7515], [RFC7517] and [RFC9053] applies to this specification as well.

A detailed security analysis of ML-DSA is beyond the scope of this specification, see [FIPS-204] for additional details.

### 7.1. Size of keys and signatures

Table 2 of FIPS-204 describes the size of keys and signatures. ML-DSA might not be the best choice for use cases that require small keys or signatures. Use of thumbprints as described in [RFC7638] and [I-D.draft-ietf-cose-key-thumbprint] can reduce the need to repeat public key representations.

### 7.2. Regarding HashML-DSA

This document does not specify algorithms for use with HashML-DSA as described in Section 5.4 of FIPS-204.

### 7.3. Validation of keys

When an AKP algorithm requires or encourages that a key be validated before being used, all algorithm related key parameters MUST be validated.

Section 7.2 of FIPS-204 describes the encoding of ML-DSA keys and signatures. The "pub" key parameter MUST be validated according to the pkEncode and pkDecode algorithms before being used. For the ML-DSA algorithms registered in this document, the priv key parameter is the seed, and therefore, only a length check MUST be performed. The length of the seed is 256 bits, which is 32 bytes. However, when the priv parameter is expanded using KeyGen\_internal, the skEncode and skDecode algorithms MUST be used. FIPS-204 notes, "skDecode should only be run on inputs that come from trusted sources" and that "as the seed can be used to compute the private key, it is sensitive data and shall be treated with the same safeguards as a private key".

#### 7.4. Mismatched AKP parameters

When using an AKP key with an algorithm, it is possible that the public and private information class parameters have been tampered with or mismatched. Depending on the algorithm and implementation, the consequences of using mismatched parameters can range from operations failing to key compromise.

### 8. IANA Considerations

#### 8.1. Additions to Existing Registries

##### 8.1.1. New COSE Algorithms

IANA is requested to add the following entries to the COSE Algorithms Registry. The following completed registration templates are provided as described in RFC9053 and RFC9054.

###### 8.1.1.1. ML-DSA-44

- \* Name: ML-DSA-44
- \* Value: TBD (requested assignment -48)
- \* Description: CBOR Object Signing Algorithm for ML-DSA-44
- \* Capabilities: [kty]
- \* Reference: RFC XXXX
- \* Recommended: Yes

###### 8.1.1.2. ML-DSA-65

- \* Name: ML-DSA-65
- \* Value: TBD (requested assignment -49)
- \* Description: CBOR Object Signing Algorithm for ML-DSA-65
- \* Capabilities: [kty]
- \* Reference: RFC XXXX
- \* Recommended: Yes

#### 8.1.1.3. ML-DSA-87

- \* Name: ML-DSA-87
- \* Value: TBD (requested assignment -50)
- \* Description: CBOR Object Signing Algorithm for ML-DSA-87
- \* Capabilities: [kty]
- \* Reference: RFC XXXX
- \* Recommended: Yes

#### 8.1.2. New COSE Key Types

IANA is requested to add the following entries to the COSE Key Types Registry. The following completed registration templates are provided as described in RFC9053.

##### 8.1.2.1. AKP

- \* Name: AKP
- \* Value: TBD (requested assignment 7)
- \* Description: COSE Key Type for Algorithm Key Pairs
- \* Capabilities: [kty(7)]
- \* Reference: RFC XXXX

#### 8.1.3. New COSE Key Type Parameters

IANA is requested to add the following entries to the COSE Key Type Parameters. The following completed registration templates are provided as described in RFC9053.

##### 8.1.3.1. AKP Public Key

- \* Key Type: TBD (requested assignment 7)
- \* Name: pub
- \* Label: -1
- \* CBOR Type: bstr

- \* Description: Public key
- \* Reference: RFC XXXX

#### 8.1.3.2. AKP Private Key

- \* Key Type: TBD (requested assignment 7)
- \* Name: priv
- \* Label: -2
- \* CBOR Type: bstr
- \* Description: Private key
- \* Reference: RFC XXXX

#### 8.1.4. New JOSE Algorithms

IANA is requested to add the following entries to the JSON Web Signature and Encryption Algorithms Registry. The following completed registration templates are provided as described in RFC7518.

##### 8.1.4.1. ML-DSA-44

- \* Algorithm Name: ML-DSA-44
- \* Algorithm Description: ML-DSA-44 as described in FIPS 204.
- \* Algorithm Usage Location(s): alg
- \* JOSE Implementation Requirements: Optional
- \* Change Controller: IETF
- \* Value registry: [IANA.jose] Algorithms
- \* Specification Document(s): RFC XXXX
- \* Algorithm Analysis Documents(s): [FIPS-204]

##### 8.1.4.2. ML-DSA-65

- \* Algorithm Name: ML-DSA-65
- \* Algorithm Description: ML-DSA-65 as described in FIPS 204.

- \* Algorithm Usage Location(s): alg
- \* JOSE Implementation Requirements: Optional
- \* Change Controller: IETF
- \* Value registry: [IANA.jose] Algorithms
- \* Specification Document(s): RFC XXXX
- \* Algorithm Analysis Documents(s): [FIPS-204]

#### 8.1.4.3. ML-DSA-87

- \* Algorithm Name: ML-DSA-87
- \* Algorithm Description: ML-DSA-87 as described in FIPS 204.
- \* Algorithm Usage Location(s): alg
- \* JOSE Implementation Requirements: Optional
- \* Change Controller: IETF
- \* Value registry: [IANA.jose] Algorithms
- \* Specification Document(s): RFC XXXX
- \* Algorithm Analysis Documents(s): [FIPS-204]

#### 8.1.5. New JOSE Key Types

IANA is requested to add the following entries to the JSON Web Key Types Registry. The following completed registration templates are provided as described in RFC7518 RFC7638.

##### 8.1.5.1. AKP

- \* "kty" Parameter Value: AKP
- \* Key Type Description: Algorithm Key Pair
- \* JOSE Implementation Requirements: Optional
- \* Change Controller: IETF
- \* Specification Document(s): RFC XXXX

#### 8.1.6. New JSON Web Key Parameters

IANA is requested to add the following entries to the JSON Web Key Parameters Registry. The following completed registration templates are provided as described in RFC7517, and RFC7638.

##### 8.1.6.1. AKP Public Key

- \* Parameter Name: pub
- \* Parameter Description: Public key
- \* Used with "kty" Value(s): AKP
- \* Parameter Information Class: Public
- \* Change Controller: IETF
- \* Specification Document(s): RFC XXXX

##### 8.1.6.2. AKP Private Key

- \* Parameter Name: priv
- \* Parameter Description: Private key
- \* Used with "kty" Value(s): AKP
- \* Parameter Information Class: Private
- \* Change Controller: IETF
- \* Specification Document(s): RFC XXXX

## 9. References

### 9.1. Normative References

- [FIPS-204] "Module-Lattice-Based Digital Signature Standard", n.d., <<https://doi.org/10.6028/NIST.FIPS.204>>.
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## 9.2. Informative References

- [I-D.draft-ietf-lamps-dilithium-certificates]  
Massimo, J., Kampanakis, P., Turner, S., and B. Westerbaan, "Internet X.509 Public Key Infrastructure - Algorithm Identifiers for the Module-Lattice-Based Digital Signature Algorithm (ML-DSA)", Work in Progress, Internet-Draft, draft-ietf-lamps-dilithium-certificates-12, 26 June 2025, <<https://datatracker.ietf.org/doc/html/draft-ietf-lamps-dilithium-certificates-12>>.
- [NIST-PQC-2022]  
"Selected Algorithms 2022", n.d., <<https://csrc.nist.gov/Projects/post-quantum-cryptography/selected-algorithms-2022>>.

A.1. JOSE

```
{
  "priv": "0000000000000000000000000000000000000000000000000000000000000000",
  "jwk": {
    "kid": "T4xl70S7MT6Zeq6r9V9fPJGVn76wfnXJ21-gyo0Gu6o",
    "kty": "AKP",
    "alg": "ML-DSA-44",
    "pub": "unH59k4RuutY-pxvu24U5h8YZD2rSVtHU5qRZsoBmBMcRPgmu9VuNOVdteXilzNIXjnqJg_GAAxep
LqA00Vc3l00bzRIKu39VFD8Lhuk8l0V-cFEJC-zm7Ui hxiQMMUEmOFxe3x1lixkKZ0jqmqP3rKryx8tSbtCxyfea64
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    "priv": "AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA"
  },
  "jws": "eyJhbGciOiJNTClEU0EtNDQiLCJraWQiOiJUNHhsNzBTN0lUNlplcTZYOVY5ZlBKR1ZuNzZ3Zm5YSjI
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Figure 4: ML\_DSA\_65



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Figure 7: ML\_DSA\_65

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Figure 8: ML\_DSA\_87

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