

**NAME**

EVP RAND, EVP RAND\_fetch, EVP RAND\_free, EVP RAND\_up\_ref, EVP RAND\_CTX, EVP RAND\_CTX\_new, EVP RAND\_CTX\_free, EVP RAND\_instantiate, EVP RAND\_uninstantiate, EVP RAND\_generate, EVP RAND\_reseed, EVP RAND\_nonce, EVP RAND\_enable\_locking, EVP RAND\_verify\_zeroization, EVP RAND\_get\_strength, EVP RAND\_get\_state, EVP RAND\_get0\_provider, EVP RAND\_CTX\_get0\_rand, EVP RAND\_is\_a, EVP RAND\_get0\_name, EVP RAND\_names\_do\_all, EVP RAND\_get0\_description, EVP RAND\_CTX\_get\_params, EVP RAND\_CTX\_set\_params, EVP RAND\_do\_all\_provided, EVP RAND\_get\_params, EVP RAND\_gettable\_ctx\_params, EVP RAND\_settable\_ctx\_params, EVP RAND\_CTX\_gettable\_params, EVP RAND\_CTX\_settable\_params, EVP RAND\_gettable\_params, EVP RAND\_STATE\_UNINITIALISED, EVP RAND\_STATE\_READY, EVP RAND\_STATE\_ERROR - EVP RAND routines

**SYNOPSIS**

```
#include <openssl/evp.h>
```

```
typedef struct evp_rand_st EVP RAND;
```

```
typedef struct evp_rand_ctx_st EVP RAND_CTX;
```

```
EVP RAND *EVP RAND_fetch(OSSL_LIB_CTX *libctx, const char *algorithm,
                        const char *properties);
int EVP RAND_up_ref(EVP RAND *rand);
void EVP RAND_free(EVP RAND *rand);
EVP RAND_CTX *EVP RAND_CTX_new(EVP RAND *rand, EVP RAND_CTX *parent);
void EVP RAND_CTX_free(EVP RAND_CTX *ctx);
EVP RAND *EVP RAND_CTX_get0_rand(EVP RAND_CTX *ctx);
int EVP RAND_get_params(EVP RAND *rand, OSSL_PARAM params[]);
int EVP RAND_CTX_get_params(EVP RAND_CTX *ctx, OSSL_PARAM params[]);
int EVP RAND_CTX_set_params(EVP RAND_CTX *ctx, const OSSL_PARAM params[]);
const OSSL_PARAM *EVP RAND_gettable_params(const EVP RAND *rand);
const OSSL_PARAM *EVP RAND_gettable_ctx_params(const EVP RAND *rand);
const OSSL_PARAM *EVP RAND_settable_ctx_params(const EVP RAND *rand);
const OSSL_PARAM *EVP RAND_CTX_gettable_params(EVP RAND_CTX *ctx);
const OSSL_PARAM *EVP RAND_CTX_settable_params(EVP RAND_CTX *ctx);
const char *EVP RAND_get0_name(const EVP RAND *rand);
const char *EVP RAND_get0_description(const EVP RAND *rand);
int EVP RAND_is_a(const EVP RAND *rand, const char *name);
const OSSL_PROVIDER *EVP RAND_get0_provider(const EVP RAND *rand);
void EVP RAND_do_all_provided(OSSL_LIB_CTX *libctx,
```

```

        void (*fn)(EVP_RAND *rand, void *arg),
        void *arg);
int EVP_RAND_names_do_all(const EVP_RAND *rand,
        void (*fn)(const char *name, void *data),
        void *data);

int EVP_RAND_instantiate(EVP_RAND_CTX *ctx, unsigned int strength,
        int prediction_resistance,
        const unsigned char *pstr, size_t pstr_len,
        const OSSL_PARAM params[]);
int EVP_RAND_uninstantiate(EVP_RAND_CTX *ctx);
int EVP_RAND_generate(EVP_RAND_CTX *ctx, unsigned char *out, size_t outlen,
        unsigned int strength, int prediction_resistance,
        const unsigned char *addin, size_t addin_len);
int EVP_RAND_reseed(EVP_RAND_CTX *ctx, int prediction_resistance,
        const unsigned char *ent, size_t ent_len,
        const unsigned char *addin, size_t addin_len);
int EVP_RAND_nonce(EVP_RAND_CTX *ctx, unsigned char *out, size_t outlen);
int EVP_RAND_enable_locking(EVP_RAND_CTX *ctx);
int EVP_RAND_verify_zeroization(EVP_RAND_CTX *ctx);
unsigned int EVP_RAND_get_strength(EVP_RAND_CTX *ctx);
int EVP_RAND_get_state(EVP_RAND_CTX *ctx);

#define EVP_RAND_STATE_UNINITIALISED 0
#define EVP_RAND_STATE_READY 1
#define EVP_RAND_STATE_ERROR 2

```

## DESCRIPTION

The EVP RAND routines are a high-level interface to random number generators both deterministic and not. If you just want to generate random bytes then you don't need to use these functions: just call **RAND\_bytes()** or **RAND\_priv\_bytes()**. If you want to do more, these calls should be used instead of the older **RAND** and **RAND\_DRBG** functions.

After creating a **EVP\_RAND\_CTX** for the required algorithm using **EVP\_RAND\_CTX\_new()**, inputs to the algorithm are supplied either by passing them as part of the **EVP\_RAND\_instantiate()** call or using calls to **EVP\_RAND\_CTX\_set\_params()** before calling **EVP\_RAND\_instantiate()**. Finally, call **EVP\_RAND\_generate()** to produce cryptographically secure random bytes.

## Types

**EVP\_RAND** is a type that holds the implementation of a **RAND**.

**EVP RAND\_CTX** is a context type that holds the algorithm inputs. **EVP RAND\_CTX** structures are reference counted.

### Algorithm implementation fetching

**EVP RAND\_fetch()** fetches an implementation of a RAND *algorithm*, given a library context *libctx* and a set of *properties*. See "ALGORITHM FETCHING" in **crypto(7)** for further information.

The returned value must eventually be freed with **EVP RAND\_free(3)**.

**EVP RAND\_up\_ref()** increments the reference count of an already fetched RAND.

**EVP RAND\_free()** frees a fetched algorithm. NULL is a valid parameter, for which this function is a no-op.

### Context manipulation functions

**EVP RAND\_CTX\_new()** creates a new context for the RAND implementation *rand*. If not NULL, *parent* specifies the seed source for this implementation. Not all random number generators need to have a seed source specified. If a parent is required, a NULL *parent* will utilise the operating system entropy sources. It is recommended to minimise the number of random number generators that rely on the operating system for their randomness because this is often scarce.

**EVP RAND\_CTX\_free()** frees up the context *ctx*. If *ctx* is NULL, nothing is done.

**EVP RAND\_CTX\_get0\_rand()** returns the **EVP RAND** associated with the context *ctx*.

### Random Number Generator Functions

**EVP RAND\_instantiate()** processes any parameters in *params* and then instantiates the RAND *ctx* with a minimum security strength of <strength> and personalisation string *pstr* of length <pstr\_len>. If *prediction\_resistance* is specified, fresh entropy from a live source will be sought. This call operates as per NIST SP 800-90A and SP 800-90C.

**EVP RAND\_uninstantiate()** uninstantiates the RAND *ctx* as per NIST SP 800-90A and SP 800-90C. Subsequent to this call, the RAND cannot be used to generate bytes. It can only be freed or instantiated again.

**EVP RAND\_generate()** produces random bytes from the RAND *ctx* with the additional input *addin* of length *addin\_len*. The bytes produced will meet the security *strength*. If *prediction\_resistance* is specified, fresh entropy from a live source will be sought. This call operates as per NIST SP 800-90A and SP 800-90C.

**EVP RAND\_reseed()** reseeds the RAND with new entropy. Entropy *ent* of length *ent\_len* bytes can be supplied as can additional input *addin* of length *addin\_len* bytes. In the FIPS provider, both are treated as additional input as per NIST SP-800-90Ar1, Sections 9.1 and 9.2. Additional seed material is also drawn from the RAND's parent or the operating system. If *prediction\_resistance* is specified, fresh entropy from a live source will be sought. This call operates as per NIST SP 800-90A and SP 800-90C.

**EVP RAND\_nonce()** creates a nonce in *out* of maximum length *outlen* bytes from the RAND *ctx*. The function returns the length of the generated nonce. If *out* is NULL, the length is still returned but no generation takes place. This allows a caller to dynamically allocate a buffer of the appropriate size.

**EVP RAND\_enable\_locking()** enables locking for the RAND *ctx* and all of its parents. After this *ctx* will operate in a thread safe manner, albeit more slowly. This function is not itself thread safe if called with the same *ctx* from multiple threads. Typically locking should be enabled before a *ctx* is shared across multiple threads.

**EVP RAND\_get\_params()** retrieves details about the implementation *rand*. The set of parameters given with *params* determine exactly what parameters should be retrieved. Note that a parameter that is unknown in the underlying context is simply ignored.

**EVP RAND\_CTX\_get\_params()** retrieves chosen parameters, given the context *ctx* and its underlying context. The set of parameters given with *params* determine exactly what parameters should be retrieved. Note that a parameter that is unknown in the underlying context is simply ignored.

**EVP RAND\_CTX\_set\_params()** passes chosen parameters to the underlying context, given a context *ctx*. The set of parameters given with *params* determine exactly what parameters are passed down. Note that a parameter that is unknown in the underlying context is simply ignored. Also, what happens when a needed parameter isn't passed down is defined by the implementation.

**EVP RAND\_gettable\_params()** returns an **OSSL\_PARAM(3)** array that describes the retrievable and settable parameters. **EVP RAND\_gettable\_params()** returns parameters that can be used with **EVP RAND\_get\_params()**.

**EVP RAND\_gettable\_ctx\_params()** and **EVP RAND\_CTX\_gettable\_params()** return constant **OSSL\_PARAM(3)** arrays that describe the retrievable parameters that can be used with **EVP RAND\_CTX\_get\_params()**. **EVP RAND\_gettable\_ctx\_params()** returns the parameters that can be retrieved from the algorithm, whereas **EVP RAND\_CTX\_gettable\_params()** returns the parameters that can be retrieved in the context's current state.

**EVP RAND\_settable\_ctx\_params()** and **EVP RAND\_CTX\_settable\_params()** return constant

**OSSL\_PARAM(3)** arrays that describe the settable parameters that can be used with **EVP RAND\_CTX\_set\_params()**. **EVP RAND\_settable\_ctx\_params()** returns the parameters that can be retrieved from the algorithm, whereas **EVP RAND\_CTX\_settable\_params()** returns the parameters that can be retrieved in the context's current state.

### Information functions

**EVP RAND\_get\_strength()** returns the security strength of the RAND *ctx*.

**EVP RAND\_get\_state()** returns the current state of the RAND *ctx*. States defined by the OpenSSL RNGs are:

- ⊕ **EVP RAND\_STATE\_UNINITIALISED**: this RNG is currently uninitialised. The instantiate call will change this to the ready state.
- ⊕ **EVP RAND\_STATE\_READY**: this RNG is currently ready to generate output.
- ⊕ **EVP RAND\_STATE\_ERROR**: this RNG is in an error state.

**EVP RAND\_is\_a()** returns 1 if *rand* is an implementation of an algorithm that's identifiable with *name*, otherwise 0.

**EVP RAND\_get0\_provider()** returns the provider that holds the implementation of the given *rand*.

**EVP RAND\_do\_all\_provided()** traverses all RAND implemented by all activated providers in the given library context *libctx*, and for each of the implementations, calls the given function *fn* with the implementation method and the given *arg* as argument.

**EVP RAND\_get0\_name()** returns the canonical name of *rand*.

**EVP RAND\_names\_do\_all()** traverses all names for *rand*, and calls *fn* with each name and *data*.

**EVP RAND\_get0\_description()** returns a description of the rand, meant for display and human consumption. The description is at the discretion of the rand implementation.

**EVP RAND\_verify\_zeroization()** confirms if the internal DRBG state is currently zeroed. This is used by the FIPS provider to support the mandatory self tests.

### PARAMETERS

The standard parameter names are:

"state" (**OSSL\_RAND\_PARAM\_STATE**) <integer>

Returns the state of the random number generator.

"strength" (**OSSL\_RAND\_PARAM\_STRENGTH**) <unsigned integer>

Returns the bit strength of the random number generator.

For rands that are also deterministic random bit generators (DRBGs), these additional parameters are recognised. Not all parameters are relevant to, or are understood by all DRBG rands:

"reseed\_requests" (**OSSL\_DRBG\_PARAM\_RESEED\_REQUESTS**) <unsigned integer>

Reads or set the number of generate requests before reseeding the associated RAND ctx.

"reseed\_time\_interval" (**OSSL\_DRBG\_PARAM\_RESEED\_TIME\_INTERVAL**) <integer>

Reads or set the number of elapsed seconds before reseeding the associated RAND ctx.

"max\_request" (**OSSL\_DRBG\_PARAM\_RESEED\_REQUESTS**) <unsigned integer>

Specifies the maximum number of bytes that can be generated in a single call to `OSSL_FUNC_rand_generate`.

"min\_entropylen" (**OSSL\_DRBG\_PARAM\_MIN\_ENTROPYLEN**) <unsigned integer>

"max\_entropylen" (**OSSL\_DRBG\_PARAM\_MAX\_ENTROPYLEN**) <unsigned integer>

Specify the minimum and maximum number of bytes of random material that can be used to seed the DRBG.

"min\_noncelen" (**OSSL\_DRBG\_PARAM\_MIN\_NONCELEN**) <unsigned integer>

"max\_noncelen" (**OSSL\_DRBG\_PARAM\_MAX\_NONCELEN**) <unsigned integer>

Specify the minimum and maximum number of bytes of nonce that can be used to seed the DRBG.

"max\_perslen" (**OSSL\_DRBG\_PARAM\_MAX\_PERSLEN**) <unsigned integer>

"max\_adinlen" (**OSSL\_DRBG\_PARAM\_MAX\_ADINLEN**) <unsigned integer>

Specify the minimum and maximum number of bytes of personalisation string that can be used with the DRBG.

"reseed\_counter" (**OSSL\_DRBG\_PARAM\_RESEED\_COUNTER**) <unsigned integer>

Specifies the number of times the DRBG has been seeded or reseeded.

"properties" (**OSSL\_RAND\_PARAM\_PROPERTIES**) <UTF8 string>

"mac" (**OSSL\_RAND\_PARAM\_MAC**) <UTF8 string>

"digest" (**OSSL\_RAND\_PARAM\_DIGEST**) <UTF8 string>

"cipher" (**OSSL RAND PARAM CIPHER**) <UTF8 string>

For RAND implementations that use an underlying computation MAC, digest or cipher, these parameters set what the algorithm should be.

The value is always the name of the intended algorithm, or the properties in the case of **OSSL RAND PARAM PROPERTIES**.

## NOTES

The use of a nonzero value for the *prediction\_resistance* argument to **EVP RAND instantiate()**, **EVP RAND generate()** or **EVP RAND reseed()** should be used sparingly. In the default setup, this will cause all public and private DRBGs to be reseeded on next use. Since, by default, public and private DRBGs are allocated on a per thread basis, this can result in significant overhead for highly multi-threaded applications. For normal use-cases, the default "reseed\_requests" and "reseed\_time\_interval" thresholds ensure sufficient prediction resistance over time and you can reduce those values if you think they are too high. Explicitly requesting prediction resistance is intended for more special use-cases like generating long-term secrets.

An **EVP RAND\_CTX** needs to have locking enabled if it acts as the parent of more than one child and the children can be accessed concurrently. This must be done by explicitly calling **EVP RAND enable\_locking()**.

The RAND life-cycle is described in **life\_cycle-rand(7)**. In the future, the transitions described there will be enforced. When this is done, it will not be considered a breaking change to the API.

## RETURN VALUES

**EVP RAND fetch()** returns a pointer to a newly fetched **EVP RAND**, or NULL if allocation failed.

**EVP RAND get0\_provider()** returns a pointer to the provider for the RAND, or NULL on error.

**EVP RAND\_CTX get0\_rand()** returns a pointer to the **EVP RAND** associated with the context.

**EVP RAND get0\_name()** returns the name of the random number generation algorithm.

**EVP RAND up\_ref()** returns 1 on success, 0 on error.

**EVP RAND\_names\_do\_all()** returns 1 if the callback was called for all names. A return value of 0 means that the callback was not called for any names.

**EVP RAND\_CTX\_new()** returns either the newly allocated **EVP RAND\_CTX** structure or NULL if an error occurred.

**EVP RAND\_CTX\_free()** does not return a value.

**EVP RAND\_nonce()** returns the length of the nonce.

**EVP RAND\_get\_strength()** returns the strength of the random number generator in bits.

**EVP RAND\_gettable\_params()**, **EVP RAND\_gettable\_ctx\_params()** and **EVP RAND\_settable\_ctx\_params()** return an array of **OSSL\_PARAMS**.

**EVP RAND\_verify\_zeroization()** returns 1 if the internal DRBG state is currently zeroed, and 0 if not.

The remaining functions return 1 for success and 0 or a negative value for failure.

## SEE ALSO

**RAND\_bytes(3)**, **EVP RAND-CTR-DRBG(7)**, **EVP RAND-HASH-DRBG(7)**,  
**EVP RAND-HMAC-DRBG(7)**, **EVP RAND-TEST-RAND(7)**, **provider-rand(7)**, **life\_cycle-rand(7)**

## HISTORY

This functionality was added to OpenSSL 3.0.

## COPYRIGHT

Copyright 2020-2023 The OpenSSL Project Authors. All Rights Reserved.

Licensed under the Apache License 2.0 (the "License"). You may not use this file except in compliance with the License. You can obtain a copy in the file **LICENSE** in the source distribution or at <https://www.openssl.org/source/license.html>.