SHE API

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3.1 File List

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4.1 She_api

SHE feature API.

Macros

- #define SHE_KEY_1 (0x04)

  Identifiers for SHE keys.
- #define SHE_KEY_2 (0x05)
- #define SHE_KEY_3 (0x06)
- #define SHE_KEY_4 (0x07)
- #define SHE_KEY_5 (0x08)
- #define SHE_KEY_6 (0x09)
- #define SHE_KEY_7 (0x0a)
- #define SHE_KEY_8 (0x0b)
- #define SHE_KEY_9 (0x0c)
- #define SHE_KEY_10 (0x0d)
- #define SHE_RAM_KEY (0x0e)
- #define SHE_KEY_DEFAULT (0x00)

  Identifiers for SHE keys extensions.
- #define SHE_KEY_N_EXT_1 (0x10)
- #define SHE_KEY_N_EXT_2 (0x20)
- #define SHE_KEY_N_EXT_3 (0x30)
- #define SHE_KEY_N_EXT_4 (0x40)
- #define SHE_MAC_SIZE 16
- #define SHE_MAC_VERIFICATION_SUCCESS 0
- #define SHE_MAC_VERIFICATION_FAILED 1
- #define SHE_AES_BLOCK_SIZE_128 16
- #define SHE_KEY_SIZE 16 /∗∗ SHE keys are 128 bits (16 bytes) long. ∗/
- #define SHE_ENTROPY_SIZE 16
- #define SHE_RND_SIZE 16

Enumerations

- enum she_err_t {
ERC_NO_ERROR = 0x0, ERC_SEQUENCE_ERROR = 0x1, ERC_KEY_NOT_AVAILABLE = 0x2, ERC_KEY_INVALID = 0x3,
ERC_KEY_EMPTY = 0x4, ERC_NO_SECURE_BOOT = 0x5, ERC_KEY_WRITE_PROTECTED = 0x6, ERC_KEY_UPDATE_ERROR = 0x7,
ERC_RNG_SEED = 0x8, ERC_NO_DEBUGGING = 0x9, ERC_BUSY = 0xA, ERC_MEMORY_FAILURE = 0xB,
ERC_GENERAL_ERROR = 0xC }

    Error codes returned by SHE functions.

Functions

- struct she_hdl_s * she_open_session (void)
- void she_close_session (struct she_hdl_s *hdl)
- she_err_t she_cmd_generate_mac (struct she_hdl_s *hdl, uint8_t key_ext, uint8_t key_id, uint32_t message_length, uint8_t *message, uint8_t *mac)
- she_err_t she_cmd_verify_mac (struct she_hdl_s *hdl, uint8_t key_ext, uint8_t key_id, uint32_t message_length, uint8_t *message, uint8_t *mac, uint8_t mac_length, uint8_t *verification_status)
- she_err_t she_cmd_enc_cbc (struct she_hdl_s *hdl, uint8_t key_ext, uint8_t key_id, uint32_t data_length, uint8_t *iv, uint8_t *plaintext, uint8_t *ciphertext)
- she_err_t she_cmd_dec_cbc (struct she_hdl_s *hdl, uint8_t key_ext, uint8_t key_id, uint32_t data_length, uint8_t *iv, uint8_t *ciphertext, uint8_t *plaintext)
- she_err_t she_cmd_enc_ecb (struct she_hdl_s *hdl, uint8_t key_ext, uint8_t key_id, uint8_t *plaintext, uint8_t *ciphertext)
- she_err_t she_cmd_dec_ecb (struct she_hdl_s *hdl, uint8_t key_ext, uint8_t key_id, uint8_t *ciphertext, uint8_t *plaintext)
- she_err_t she_cmd_load_key (struct she_hdl_s *hdl, uint8_t *m1, uint8_t *m2, uint8_t *m3, uint8_t *m4, uint8_t *m5)
- she_err_t she_cmd_load_plain_key (struct she_hdl_s *hdl, uint8_t *key)
- she_err_t she_cmd_export_ram_key (struct she_hdl_s *hdl, uint8_t *m1, uint8_t *m2, uint8_t *m3, uint8_t *m4, uint8_t *m5)
- she_err_t she_cmd_init_rng (struct she_hdl_s *hdl)
- she_err_t she_cmd_extend_seed (struct she_hdl_s *hdl, uint8_t *entropy)
- she_err_t she_cmd_rnd (struct she_hdl_s *hdl, uint8_t *rnd)
- she_err_t she_cmd_get_status (struct she_hdl_s *hdl, uint8_t *sreg)
- she_err_t she_cmd_get_id (struct she_hdl_s *hdl, uint8_t *challenge, uint8_t *id, uint8_t *sreg, uint8_t *mac)
- she_err_t she_cmd_cancel (struct she_hdl_s *hdl)

4.1.1 Detailed Description

SHE feature API.

4.1.2 Macro Definition Documentation

4.1.2.1 #define SHE_AES_BLOCK_SIZE_128 16

size in bytes of a 128bits CBC bloc

4.1.2.2 #define SHE_ENTROPY_SIZE 16

4.1.2.3 #define SHE_KEY_1 (0x04)

Identifiers for SHE keys.

4.1.2.4 #define SHE_KEY_10 (0x0d)

4.1.2.5 #define SHE_KEY_2 (0x05)

4.1.2.6 #define SHE_KEY_3 (0x06)

4.1.2.7 #define SHE_KEY_4 (0x07)

4.1.2.8 #define SHE_KEY_5 (0x08)

4.1.2.9 #define SHE_KEY_6 (0x09)

4.1.2.10 #define SHE_KEY_7 (0x0a)

4.1.2.11 #define SHE_KEY_8 (0x0b)

4.1.2.12 #define SHE_KEY_9 (0x0c)

4.1.2.13 #define SHE_KEY_DEFAULT (0x00)

Identifiers for SHE keys extensions.

no key extension: keys from 0 to 10 as defined in SHE specification.

4.1.2.14 #define SHE_KEY_N_EXT_1 (0x10)

keys 11 to 20.

4.1.2.15 #define SHE_KEY_N_EXT_2 (0x20)

keys 21 to 30.

4.1.2.16 #define SHE_KEY_N_EXT_3 (0x30)

keys 31 to 40.

4.1.2.17 #define SHE_KEY_N_EXT_4 (0x40)

keys 41 to 50.

4.1.2.18 #define SHE_KEY_SIZE 16 /** SHE keys are 128 bits (16 bytes) long. */

4.1.2.19 #define SHE_MAC_SIZE 16

size of the MAC generated is 128bits.

4.1.2.20 #define SHE_MAC_VERIFICATION_FAILED 1

indication of mac verification failure

4.1.2.21 #define SHE_MAC_VERIFICATION_SUCCESS 0

indication of mac verification success

4.1.2.22 #define SHE_RAM_KEY (0x0e)

4.1.2.23 #define SHE_RND_SIZE 16

4.1.3 Enumeration Type Documentation

4.1.3.1 enum she_err_t

Error codes returned by SHE functions.

Enumerator

ERC_NO_ERROR Success.

ERC_SEQUENCE_ERROR Invalid sequence of commands.

ERC_KEY_NOT_AVAILABLE Key is locked.

ERC_KEY_INVALID Key not allowed for the given operation.

ERC_KEY_EMPTY Key has not beed initialized yet.

ERC_NO_SECURE_BOOT Conditions for a secure boot process are not met.

ERC_KEY_WRITE_PROTECTED Memory slot for this key has been write-protected.

ERC_KEY_UPDATE_ERROR Key update did not succeed due to errors in verification of the messages.

ERC_RNG_SEED The seed has not been initialized.

ERC_NO_DEBUGGING Internal debugging is not possible.

ERC_BUSY A function of SHE is called while another function is still processing.

ERC_MEMORY_FAILURE Memory error (e.g. flipped bits)

ERC_GENERAL_ERROR Error not covered by other codes occured.

4.1.4 Function Documentation

4.1.4.1 void she_close_session (struct she_hdl_s * *hdl*)

Terminate a previously opened SHE session

Parameters

hdl	pointer to the session handler to be closed.

4.1.4.2 she_err_t she_cmd_cancel (struct she_hdl_s * *hdl*)

interrupt any given function and discard all calculations and results.

Parameters

hdl	pointer to the SHE session handler

Returns

error code

4.1.4.3 she_err_t she_cmd_dec_cbc (struct she_hdl_s ∗ *hdl,* uint8_t *key_ext,* uint8_t *key_id,* uint32_t *data_length,* uint8_t ∗ *iv,* uint8_t ∗ *ciphertext,* uint8_t ∗ *plaintext*)

CBC decryption of a given ciphertext with the key identified by key_id.

Parameters

hdl	pointer to the SHE session handler
key_ext	identifier of the key extension to be used for the operation
key_id	identifier of the key to be used for the operation
data_length	lenght in bytes of the plaintext and the cyphertext. Must be a multiple of 128bits.
iv	pointer to the 128bits IV to use for the decryption.
ciphertext	pointer to ciphertext to be decrypted.
plaintext	pointer to the plaintext output area.

Returns

error code

4.1.4.4 she_err_t she_cmd_dec_ecb (struct she_hdl_s ∗ *hdl,* uint8_t *key_ext,* uint8_t *key_id,* uint8_t ∗ *ciphertext,* uint8_t ∗ *plaintext*)

ECB decryption of a given ciphertext with the key identified by key_id.

Parameters

hdl	pointer to the SHE session handler
key_ext	identifier of the key extension to be used for the operation
key_id	identifier of the key to be used for the operation
ciphertext	pointer to 128bits ciphertext to be decrypted.
plaintext	pointer to the plaintext output area (128bits).

Returns

error code

4.1.4.5 she_err_t she_cmd_enc_cbc (struct she_hdl_s ∗ *hdl,* uint8_t *key_ext,* uint8_t *key_id,* uint32_t *data_length,* uint8_t ∗ *iv,* uint8_t ∗ *plaintext,* uint8_t ∗ *ciphertext*)

CBC encryption of a given plaintext with the key identified by key_id.

Parameters

hdl	pointer to the SHE session handler
key_ext	identifier of the key extension to be used for the operation
key_id	identifier of the key to be used for the operation
data_length	lenght in bytes of the plaintext and the cyphertext. Must be a multiple of 128bits.
iv	pointer to the 128bits IV to use for the encryption.
plaintext	pointer to the message to be encrypted.
ciphertext	pointer to ciphertext output area.

Returns

error code

4.1.4.6 she_err_t she_cmd_enc_ecb (struct she_hdl_s ∗ *hdl,* uint8_t *key_ext,* uint8_t *key_id,* uint8_t ∗ *plaintext,* uint8_t ∗ *ciphertext*)

ECB encryption of a given plaintext with the key identified by key_id.

Parameters

hdl	pointer to the SHE session handler
key_ext	identifier of the key extension to be used for the operation
key_id	identifier of the key to be used for the operation
plaintext	pointer to the 128bits message to be encrypted.
ciphertext	pointer to ciphertext output area (128bits).

Returns

error code

4.1.4.7 she_err_t she_cmd_export_ram_key (struct she_hdl_s ∗ *hdl,* uint8_t ∗ *m1,* uint8_t ∗ *m2,* uint8_t ∗ *m3,* uint8_t ∗ *m4,* uint8_t ∗ *m5*)

exports the RAM_KEY into a format protected by SECRET_KEY.

Parameters

hdl	pointer to the SHE session handler
m1	pointer to the output address for M1 message - 128 bits
m2	pointer to the output address for M2 message - 256 bits
m3	pointer to the output address for M3 message - 128 bits
m4	pointer to the output address for M4 message - 256 bits
m5	pointer to the output address for M5 message - 128 bits

Returns

error code

4.1.4.8 she_err_t she_cmd_extend_seed (struct she_hdl_s ∗ *hdl,* uint8_t ∗ *entropy*)

extends the seed of the PRNG by compressing the former seed value and the supplied entropy into a new seed which will be used to generate the following random numbers. The random number generator has to be initialized by CMD_INIT_RNG before the seed can be extended.

Parameters

hdl	pointer to the SHE session handler
entropy	pointer to the entropy vector (128bits) to use for the operation

Returns

error code

4.1.4.9 she_err_t she_cmd_generate_mac (struct she_hdl_s ∗ *hdl,* uint8_t *key_ext,* uint8_t *key_id,* uint32_t *message_length,* uint8_t ∗ *message,* uint8_t ∗ *mac*)

Generates a MAC of a given message with the help of a key identified by key_id.

Parameters

hdl	pointer to the SHE session handler
key_ext	identifier of the key extension to be used for the operation
key_id	identifier of the key to be used for the operation
message_length	lenght in bytes of the input message
message	pointer to the message to be processed
mac	pointer to where the output MAC should be written (128bits should be allocated there)

Returns

error code

4.1.4.10 she_err_t she_cmd_get_id (struct she_hdl_s ∗ *hdl,* uint8_t ∗ *challenge,* uint8_t ∗ *id,* uint8_t ∗ *sreg,* uint8_t ∗ *mac*)

returns the identity (UID) and the value of the status register protected by a MAC over a challenge and the data.

Parameters

hdl	pointer to the SHE session handler
challenge	pointer to the challenge vector (128bits)
id	pointer to the output address for the identity (120bits)
sreg	pointer to the output address for status register(8bits)
mac	pointer to the output address for the computed MAC (128bits)

Returns

error code

4.1.4.11 she_err_t she_cmd_get_status (struct she_hdl_s ∗ *hdl*, uint8_t ∗ *sreg*)

returns the content of the status register

Parameters

hdl	pointer to the SHE session handler
sreg	pointer to the output address for status register(8bits)

Returns

error code

4.1.4.12 she_err_t she_cmd_init_rng (struct she_hdl_s ∗ *hdl*)

initializes the seed and derives a key for the PRNG. The function must be called before CMD_RND after every power cycle/reset.

Parameters

hdl	pointer to the SHE session handler

Returns

error code

4.1.4.13 she_err_t she_cmd_load_key (struct she_hdl_s ∗ *hdl*, uint8_t ∗ *m1*, uint8_t ∗ *m2*, uint8_t ∗ *m3*, uint8_t ∗ *m4*, uint8_t ∗ *m5*)

Update an internal key of SHE with the protocol specified by SHE.

Parameters

m1	pointer to M1 message - 128 bits
m2	pointer to M2 message - 256 bits
m3	pointer to M3 message - 128 bits
m4	pointer to the output address for M4 message - 256 bits
m5	pointer to the output address for M5 message - 128 bits

Returns

error code

4.1.4.14 she_err_t she_cmd_load_plain_key (struct she_hdl_s ∗ *hdl*, uint8_t ∗ *key*)

Load a key as plaintext to the RAM_REY slot without encryption and verification.

Parameters

hdl	pointer to the SHE session handler
key	pointer to the plaintext key to be loaded - 128bits

Returns

error code

4.1.4.15 she_err_t she_cmd_rnd (struct she_hdl_s ∗ *hdl,* uint8_t ∗ *rnd*)

returns a vector of 128 random bits. The random number generator has to be initialized by CMD_INIT_RNG before random numbers can be supplied.

Parameters

hdl	pointer to the SHE session handler
rnd	pointer to the output address for the generated 128bits random vector

Returns

error code

4.1.4.16 she_err_t she_cmd_verify_mac (struct she_hdl_s ∗ *hdl,* uint8_t *key_ext,* uint8_t *key_id,* uint32_t *message_length,* uint8_t ∗ *message,* uint8_t ∗ *mac,* uint8_t *mac_length,* uint8_t ∗ *verification_status*)

Verifies the MAC of a given message with the help of a key identified by key_id.

Parameters

hdl	pointer to the SHE session handler
key_ext	identifier of the key extension to be used for the operation
key_id	identifier of the key to be used for the operation
message_length	lenght in bytes of the input message
message	pointer to the message to be processed
mac	pointer to the MAC to be compared (implicitely 128 bits)
mac_length	number of bytes to compare (must be at least 4)
verification_status	pointer to where write the result of the MAC comparison

Returns

error code

4.1.4.17 struct she_hdl_s∗ she_open_session (void)

Initiate a SHE session. The returned session handle pointer is typed with the struct "she_hdl_s". The user doesn't need to know or to access the fields of this struct. It only needs to store this pointer and pass it to every calls to other APIs within the same SHE session.

Returns

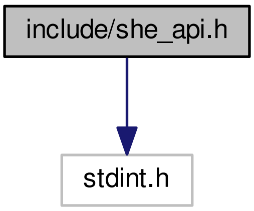
pointer to the session handle.

5 File Documentation

5.1 include/she_api.h File Reference

`#include <stdint.h>`

Include dependency graph for she_api.h:



Macros

- #define SHE_KEY_1 (0x04)

  Identifiers for SHE keys.
- #define SHE_KEY_2 (0x05)
- #define SHE_KEY_3 (0x06)
- #define SHE_KEY_4 (0x07)
- #define SHE_KEY_5 (0x08)
- #define SHE_KEY_6 (0x09)
- #define SHE_KEY_7 (0x0a)
- #define SHE_KEY_8 (0x0b)
- #define SHE_KEY_9 (0x0c)
- #define SHE_KEY_10 (0x0d)
- #define SHE_RAM_KEY (0x0e)
- #define SHE_KEY_DEFAULT (0x00)

  Identifiers for SHE keys extensions.
- #define SHE_KEY_N_EXT_1 (0x10)
- #define SHE_KEY_N_EXT_2 (0x20)
- #define SHE_KEY_N_EXT_3 (0x30)
- #define SHE_KEY_N_EXT_4 (0x40)
- #define SHE_MAC_SIZE 16
- #define SHE_MAC_VERIFICATION_SUCCESS 0
- #define SHE_MAC_VERIFICATION_FAILED 1
- #define SHE_AES_BLOCK_SIZE_128 16
- #define SHE_KEY_SIZE 16 /∗∗ SHE keys are 128 bits (16 bytes) long. ∗/
- #define SHE_ENTROPY_SIZE 16
- #define SHE_RND_SIZE 16

Enumerations

- enum she_err_t {
  ERC_NO_ERROR = 0x0, ERC_SEQUENCE_ERROR = 0x1, ERC_KEY_NOT_AVAILABLE = 0x2, ERC_KEY_INVALID = 0x3,
  ERC_KEY_EMPTY = 0x4, ERC_NO_SECURE_BOOT = 0x5, ERC_KEY_WRITE_PROTECTED = 0x6, ERC_KEY_UPDATE_ERROR = 0x7,
  ERC_RNG_SEED = 0x8, ERC_NO_DEBUGGING = 0x9, ERC_BUSY = 0xA, ERC_MEMORY_FAILURE = 0xB,
  ERC_GENERAL_ERROR = 0xC }

  Error codes returned by SHE functions.

Functions

- struct she_hdl_s ∗ she_open_session (void)
- void she_close_session (struct she_hdl_s ∗hdl)
- she_err_t she_cmd_generate_mac (struct she_hdl_s ∗hdl, uint8_t key_ext, uint8_t key_id, uint32_t message_length, uint8_t ∗message, uint8_t ∗mac)
- she_err_t she_cmd_verify_mac (struct she_hdl_s ∗hdl, uint8_t key_ext, uint8_t key_id, uint32_t message_length, uint8_t ∗message, uint8_t ∗mac, uint8_t mac_length, uint8_t ∗verification_status)
- she_err_t she_cmd_enc_cbc (struct she_hdl_s ∗hdl, uint8_t key_ext, uint8_t key_id, uint32_t data_length, uint8_t ∗iv, uint8_t ∗plaintext, uint8_t ∗ciphertext)
- she_err_t she_cmd_dec_cbc (struct she_hdl_s ∗hdl, uint8_t key_ext, uint8_t key_id, uint32_t data_length, uint8_t ∗iv, uint8_t ∗ciphertext, uint8_t ∗plaintext)
- she_err_t she_cmd_enc_ecb (struct she_hdl_s ∗hdl, uint8_t key_ext, uint8_t key_id, uint8_t ∗plaintext, uint8_t ∗ciphertext)
- she_err_t she_cmd_dec_ecb (struct she_hdl_s ∗hdl, uint8_t key_ext, uint8_t key_id, uint8_t ∗ciphertext, uint8_t ∗plaintext)
- she_err_t she_cmd_load_key (struct she_hdl_s ∗hdl, uint8_t ∗m1, uint8_t ∗m2, uint8_t ∗m3, uint8_t ∗m4, uint8_t ∗m5)
- she_err_t she_cmd_load_plain_key (struct she_hdl_s ∗hdl, uint8_t ∗key)
- she_err_t she_cmd_export_ram_key (struct she_hdl_s ∗hdl, uint8_t ∗m1, uint8_t ∗m2, uint8_t ∗m3, uint8_t ∗m4, uint8_t ∗m5)
- she_err_t she_cmd_init_rng (struct she_hdl_s ∗hdl)
- she_err_t she_cmd_extend_seed (struct she_hdl_s ∗hdl, uint8_t ∗entropy)
- she_err_t she_cmd_rnd (struct she_hdl_s ∗hdl, uint8_t ∗rnd)
- she_err_t she_cmd_get_status (struct she_hdl_s ∗hdl, uint8_t ∗sreg)
- she_err_t she_cmd_get_id (struct she_hdl_s ∗hdl, uint8_t ∗challenge, uint8_t ∗id, uint8_t ∗sreg, uint8_t ∗mac)
- she_err_t she_cmd_cancel (struct she_hdl_s ∗hdl)

5.2 include/she_storage.h File Reference

Functions

- struct she_storage_context ∗ she_storage_init (void)
- void she_storage_terminate (struct she_storage_context ∗nvm_ctx)

5.2.1 Function Documentation

5.2.1.1 struct she_storage_context∗ she_storage_init (void)

Initialize SHE storage manager.

Returns

pointer to the storage context

5.2.1.2 void she_storage_terminate (struct she_storage_context ∗ *nvm_ctx*)

terminates the SHE storage manager.

Parameters

ctx	pointer to the context of the storage manager to be closed.

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