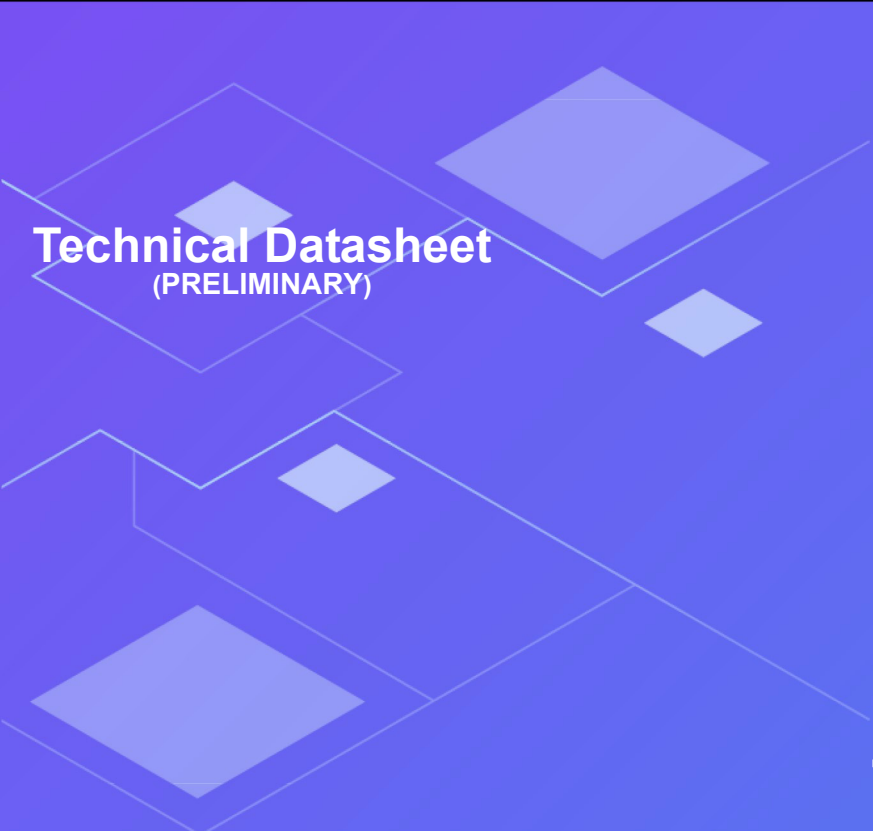




Technical Datasheet
(PRELIMINARY)

TPR1003B

QV_{AULT} TPM 183

TECHNICAL DATASHEET

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1. Product Overview

The QVault TPM 183 is a Trusted Platform Module (TPM) compliant with the Trusted Computing Group (TCG) TPM 2.0 specifications, revision 1.83.

It provides essential cryptographic services for data confidentiality, integrity, and authentication, with interfaces for I²C and SPI communication.

- **Key Applications:**
 - **Trusted Boot:** ensures system integrity during startup
 - **Device attestation:** protects against alterations of identity & device integrity
 - **Secure Authentication:** for devices, users, and platforms
 - **IoT Device Security:** protects connected devices from unauthorized access
 - **Cryptographic Key Management:** secure generation, storage, and management of cryptographic keys
 - **Data Integrity Protection:** ensures data integrity and authenticity
- **Certifications**
 - Common Criteria EAL4+
 - FIPS 140-3
 - TCG TPM 2.0
- **Security Features**
 - Physical and Environmental Protections
 - Side-Channel Attack Resistance
 - Fault Injection Resistance
 - Random Number Generation:
 - FIPS SP800-90A DRBG
 - FIPS SP800-90B Entropy Source for TRNG
 - Endorsement Keys:
 - By default, pre-provisioned with three EK Certificates (RSA 2048, ECC NIST P-256, ECC NIST P-384)
 - Fault-tolerant firmware loader for safe & secure updates
 - Firmware can only be updated with a TCG certified & SEALSQ authenticated new image
- **Memory and Storage**
 - Up to 50KB free NVM for secure data storage
 - Data retention of up to 15 years, with write/erase endurance of 200,000 cycles
- **Interfaces and Communication**
 - I²C Interface up to 1 Mb/s
 - SPI Interface up to 33 MHz
 - Automatic Detection of the Communication Interface
 - 4 GPIOs
- **Electrical Characteristics**
 - Supply Voltage: 1.62 V to 3.6 V
 - Operating Temperature Range: -40°C to 105°C
 - Electrostatic Discharge (ESD) Protection: Up to 2kV (HBM)

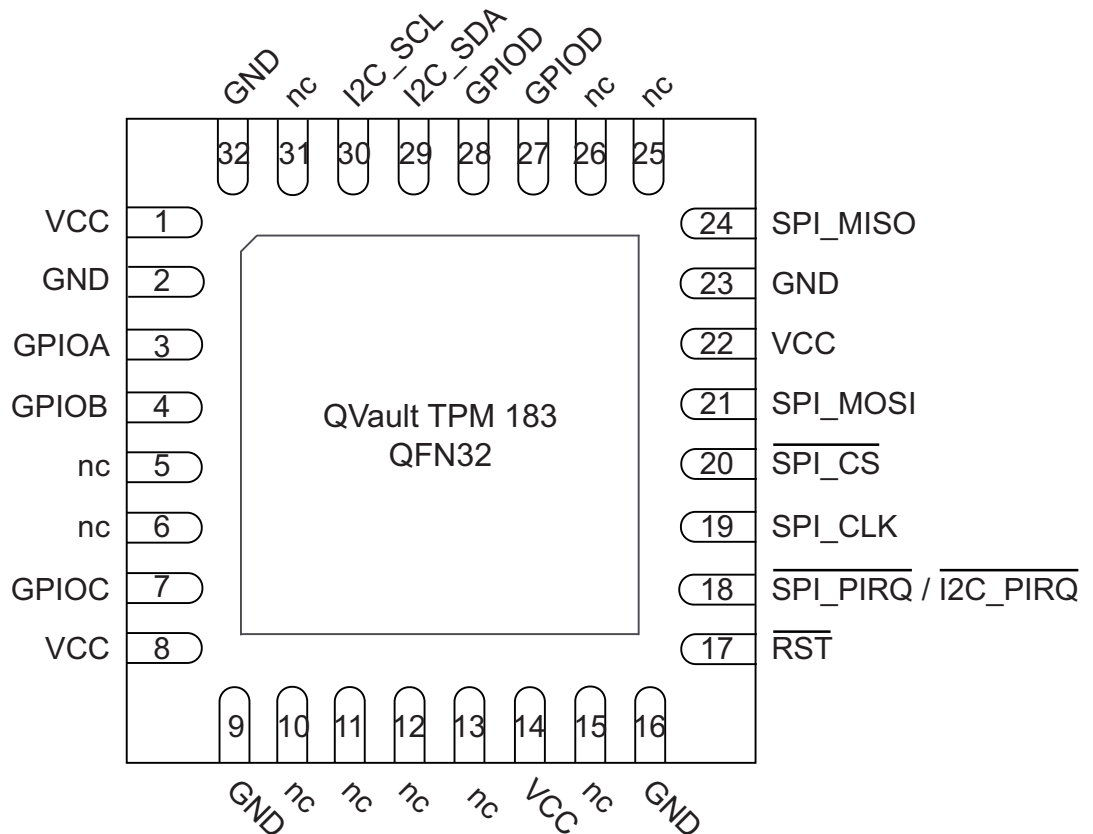
• Ordering information

Table 1-1. Part numbers

Reference	Description
QVault TPM-022-Z	QFN32 production QVault TPM 183
QVAULTTPM_RPI_STK	Development kit for QVault TPM 183 - Raspberry Pi header

2. Pinout and package

The QVault TPM 183 is available in QFN32 package, is pinout compliant with the TCG Specifications and provides both I²C & SPI Interfaces.



nc = not internally connected

The exposed pad is not internally connected (floating).

It is recommended, but not mandatory, to connect it to the board GND

Table 2-1. Pin description

Pin	Type	Description
VCC	Power supply	Power supply
GND	Power supply	Ground
GPIO A, B, C and D	I/O	General purpose input output
$\overline{\text{RST}}$	Input	Device reset, active low
$\overline{\text{SPI_PIRQ}} / \overline{\text{I2C_PIRQ}}$	Output	SPI or I2C interrupt, active low, open drain
SPI_CLK	Input	SPI clock signal

Table 2-1. Pin description

Pin	Type	Description
SPI_CS	Input	SPI chip select
SPI_MOSI	Input	SPI data input
SPI_MISO	Output	SPI data output
I2C_SDA	I/O	I ² C data pin signal - open drain
I2C_SCL	Input	I ² C clock signal

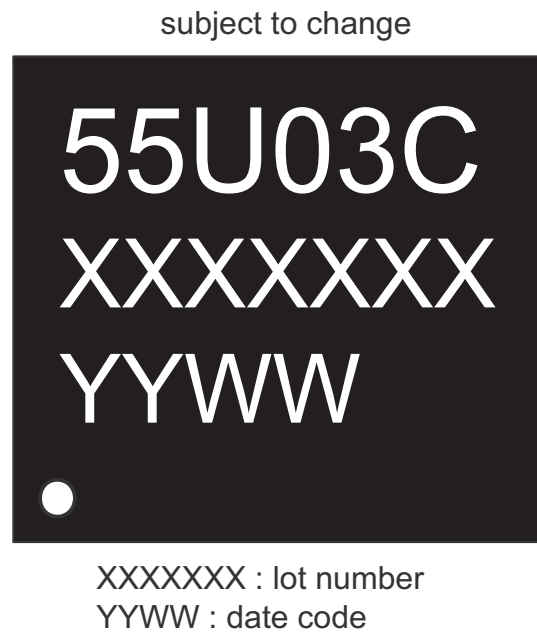
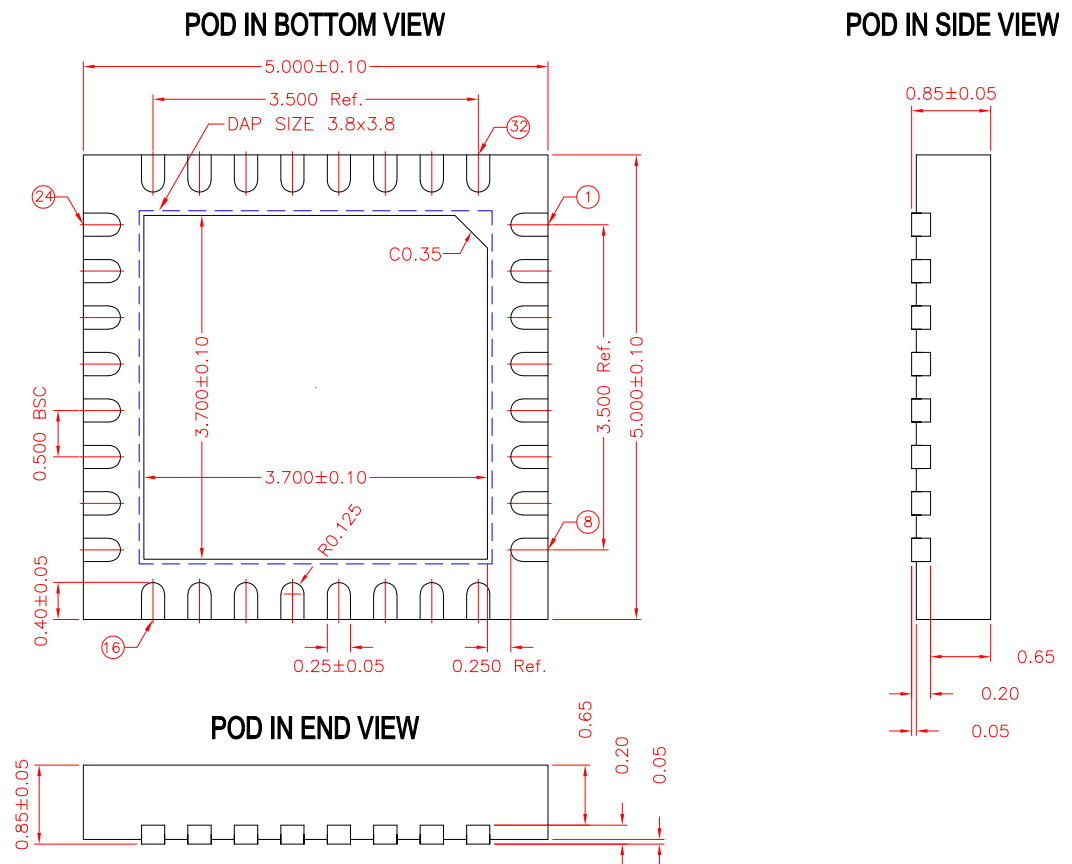
Figure 2-1. Product marking - top view

Figure 2-2. QFN32 (RoHS compliant) 5mm x 5mm x 0.85mm outline



NOTE:

1. ALL DIMENSION ARE IN mm, ANGLES IN DEGREES.
2. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
COPLANARITY SHALL NOT EXCEED 0.08 mm.
3. WARPAGE SHALL NOT EXCEED 0.10 mm.
4. PACKAGE LENGHT / PACKAGE WIDTH ARE CONSIDERED AS SPECIAL CHARACREISTIC. (S)
5. REFER JEDEC MO-220

3. Implementation details

The QVault TPM 183 follows the Trusted Computing Group (TCG) TPM 2.0 specifications, revision 1.83 ([R1] [R2] [R3] [R4]) and the PC Client Platform TPM Profile for TPM 2.0 version 1.06^(*) ([R5]). In these specifications some features are optional and others are vendor-specific. This section details what is actually implemented on the QVault TPM 183.

* Except for t_{CS} and t_{CSS} , see Table 5-6.

3.1 TPM attributes and cryptographic capabilities

3.1.1 QVault TPM properties implementation

The fixed properties of the QVault TPM 183 are defined in the Table 3-1. These properties can be read on the device thanks to the TPM2_Get_Capability query.

Table 3-1. TPM fixed properties

Capability Name	Returned Value	Description
TPM2_PT_HR_TRANSIENT_MIN	3	The number of transient objects that can be held in the QVault TPM RAM. QVault TPM supports 2 RSA 3072-bit keys.
TPM2_PT_HR_PERSISTENT_MIN	7	The number of persistent objects that can be held in QVault TPM NV Memory. QVault TPM supports 2 persistent RSA 3072-bit keys.
TPM2_PT_HR_LOADED_MIN	3	The number of authorization sessions that can be held in QVault TPM RAM.
TPM2_PT_ACTIVE_SESSIONS_MAX	64	The number of authorization sessions that can be active concurrently.
TPM2_PT_MANUFACTURER	0x5345414C	This field is set to 'SEAL'.
TPM2_PT_VENDOR_STRING_1	0x51566175	This field is set to 'QVau'.
TPM2_PT_VENDOR_STRING_2	0x6C742054	This field is set to 'lt T'.
TPM2_PT_VENDOR_STRING_3	0x504D0000	This field is set to 'PM' (+ 2 null bytes).
TPM2_PT_VENDOR_STRING_4	0x00000000	This field is left empty (4 null bytes).
TPM2_PT_FIRMWARE_VERSION_1	0xMMMMmmmm	The TPM firmware version - part 1: Firmware version MMMM.mmmm.PP (PP is in TPM_PT_FIRMWARE_VERSION_2) For example: MMMM = 0x0010 mmmm = 0x000A PP = 0x03 Version is 16.10.3
TPM2_PT_FIRMWARE_VERSION_2	0xPPUUuuRR	PP is a part of the firmware version, as explained above. Upgrader version UU.uu RR is reserved for internal use.
NV_MEMORY_SIZE	51200	50 * 1024.

Table 3-1. TPM fixed properties

TPM2_PT_NV_INDEX_MAX	2048	The maximum size of an NV Index data area.
TPM2_PT_NV_BUFFER_MAX	1024	The maximum data size in one NV write, NV read, NV extend, or NV certify command.
TPM2_PT_NV_COUNTERS_MAX	0	No limitation on the number of NV indexes that are allowed to have the TPMA_NV_COUNTER attribute SET.

3.1.2 Supported algorithms

The QVault TPM supports the algorithms listed in the following table.

Table 3-2. Supported algorithms

Algorithm ID	PC client 1.06 status (M)andatory (R)ecommended (D)eprecated (O)ptional (N)ot allowed	QVault TPM support status
TPM_ALG_RSA	N M M O	RSA 1024-bit keys are not supported RSA 2048-bit keys are supported RSA 3072-bit keys are supported RSA 4096-bit keys are not supported
TPM_ALG_TDES	N	Not supported
TPM_ALG_SHA1	O	Supported
TPM_ALG_HMAC	M	Supported
TPM_ALG_AES	N O O O M	ECB mode is not supported. CTR mode is supported OFB mode is supported CBC mode is supported CFB mode is supported
TPM_ALG_MGF1	M	Supported
TPM_ALG_KEYEDHASH	M	Supported
TPM_ALG_XOR	M	Supported
TPM_ALG_SHA256	M	Supported
TPM_ALG_SHA384	M	Supported
TPM_ALG_SHA512	O	Supported
TPM_ALG_SM3_256	O	Not supported
TPM_ALG_SM4	O	Not supported
TPM_ALG_RSASSA	M	Supported
TPM_ALG_RSAES	M	Supported
TPM_ALG_RSAPSS	M	Supported
TPM_ALG_OAEP	M	Supported
TPM_ALG_ECDSA	M	Supported
TPM_ALG_ECDH	M	Supported
TPM_ALG_ECDSA	O	Supported
TPM_ALG_SM2	O	Not Supported

Table 3-2. Supported algorithms

TPM_ALG_ECSCHNORR	O	Not Supported
TPM_ALG_ECC	M	Supported see Section 3.1.3
TPM_ALG_ECMQV	O	Not Supported
TPM_ALG_SYMCIPHER	M	Supported
TPM_ALG_CAMELLIA	O	Not Supported
TPM_ALG_SHA3_256	O	Not Supported
TPM_ALG_SHA3_384	O	Not Supported
TPM_ALG_SHA3_512	O	Not Supported

3.1.3 Supported curves

The ECC curves supported in QVault TPM are detailed in the following table.

Table 3-3. Supported curves

Curve Identifier	PC client 1.06 status (M)andatory (O)ptional (U)ndocumented	Support status
TPM_ECC_NIST_P256	M	Supported
TPM_ECC_NIST_P384	M	Supported
TPM_ECC_NIST_P521	U	Supported
TPM_ECC_BN_P256	O	Supported
TPM_ECC_SM2_P256	O	Not Supported

3.2 TPM commands

The table below lists all TPM2 commands described in the PC Client Platform specification and their support status on QVault TPM.

Table 3-4. Command list

Command	PC client 1.06 status (M)andatory (O)ptional (U)ndocumented	QVault TPM support status
Signals / Indications		
_TPM_INIT	M	Supported
_TPM_Hash_Start	M	Supported
_TPM_Hash_Data	M	Supported
_TPM_Hash_End	M	Supported
Startup		
TPM2_Startup	M	Supported
TPM2_Shutdown	M	Supported
Testing		
TPM2_IncrementalSelfTest	M	Supported
TPM2_SelfTest	M	Supported
TPM2_GetTestResult	M	Supported
Session Commands		
TPM2_StartAuthSession	M	Supported
TPM2_PolicyRestart	M	Supported
Object Commands		
TPM2_Create	M	Supported
TPM2_Load	M	Supported
TPM2_LoadExternal	M	Supported
TPM2_ReadPublic	M	Supported
TPM2_ActivateCredential	M	Supported
TPM2_MakeCredential	M	Supported
TPM2_Unseal	M	Supported
TPM2_ObjectChangeAuth	M	Supported
TPM2_CreateLoaded	O	Supported
Duplicate Commands		
TPM2_Duplicate	M	Supported
TPM2_Rewrap	O	Not supported
TPM2_Import	M	Supported
Asymmetric Primitives		
TPM2_RSA_Encrypt	M	Supported
TPM2_RSA_Decrypt	M	Supported
TPM2_ECDH_KeyGen	M	Supported
TPM2_ECDH_ZGen	M	Supported

Table 3-4. Command list

TPM2_ECC_Parameters	M	Supported
TPM2_ZGen_2Phase	O	Not supported
Symmetric Primitives		
TPM2_EncryptDecrypt	O	Not supported
TPM2_EncryptDecrypt2	O	Supported
TPM2_Hash	M	Supported
TPM2_HMAC	M	Supported
TPM2_MAC	O	Not supported
Random Number Generator		
TPM2_GetRandom	M	Supported
TPM2_StirRandom	M	Supported
Hash/HMAC/Event Sequences		
TPM2_HMAC_Start	M	Supported
TPM2_MAC_Start	O	Not supported
TPM2_HashSequenceStart	M	Supported
TPM2_SequenceUpdate	M	Supported
TPM2_SequenceComplete	M	Supported
TPM2_EventSequenceComplete	M	Supported
Attestation Commands		
TPM2_Certify	M	Supported
TPM2_CertifyCreation	M	Supported
TPM2_Quote	M	Supported
TPM2_GetSessionAuditDigest	M	Supported
TPM2_GetCommandAuditDigest	O	Not supported
TPM2_GetTime	M	Supported
TPM2_CertifyX509	O	Not Supported
Anonymous Attestation		
TPM2_Commit	O	Supported
TPM2_EC_Ephemeral	O	Not supported
Signature Verification		
TPM2_VerifySignature	M	Supported
TPM2_Sign	M	Supported
Command Audit		
TPM2_SetCommandCodeAuditStatus	O	Not supported
Integrity Collection (PCR)		
TPM2_PCR_Extend	M	Supported
TPM2_PCR_Event	M	Supported
TPM2_PCR_Read	M	Supported
TPM2_PCR_Allocate	M	Supported
TPM2_PCR_SetAuthPolicy	O	Not supported

Table 3-4. Command list

TPM2_PCR_SetAuthValue	O	Not supported
TPM2_PCR_Reset	M	Supported
Enhanced Authorization (EA)		
TPM2_PolicySigned	M	Supported
TPM2_PolicySecret	M	Supported
TPM2_PolicyTicket	M	Supported
TPM2_PolicyOR	M	Supported
TPM2_PolicyPCR	M	Supported
TPM2_PolicyLocality	M	Supported
TPM2_PolicyNV	M	Supported
TPM2_PolicyCounterTimer	M	Supported
TPM2_PolicyCommandCode	M	Supported
TPM2_PolicyPhysicalPresence	O	Not supported
TPM2_PolicyCpHash	M	Supported
TPM2_PolicyNameHash	M	Supported
TPM2_PolicyDuplicationSelect	M	Supported
TPM2_PolicyAuthorize	M	Supported
TPM2_PolicyAuthValue	M	Supported
TPM2_PolicyPassword	M	Supported
TPM2_PolicyGetDigest	M	Supported
TPM2_PolicyNvWritten	M	Supported
TPM2_PolicyTemplate	M	Supported
TPM2_PolicyAuthorizeNV	M	Supported
TPM2_PolicyCapability	U	Not supported
TPM2_PolicyParameters	U	Not supported
TPM2_Policy_AC_SendSelect	U	Not supported
Hierarchy Commands		
TPM2_CreatePrimary	M	Supported
TPM2_HierarchyControl	M	Supported
TPM2_SetPrimaryPolicy	M	Supported
TPM2_ChangePPS	O	Supported (required for FIPS)
TPM2_ChangeEPS	O	Supported (required for FIPS)
TPM2_Clear	M	Supported
TPM2_ClearControl	M	Supported
TPM2_HierarchyChangeAuth	M	Supported
Dictionary Attack Functions		
TPM2_DictionaryAttackLockReset	M	Supported
TPM2_DictionaryAttackParameters	M	Supported
Miscellaneous Management Functions		
TPM2_PP_Commands	O	Not supported

Table 3-4. Command list

TPM2_SetAlgorithmSet	O	Not supported
Field Upgrade		
TPM2_FieldUpgradeStart	O	Not supported
TPM2_FieldUpgradeData	O	Not supported
TPM2_FirmwareRead	O	Not supported
Context Management		
TPM2_ContextSave	M	Supported
TPM2_ContextLoad	M	Supported
TPM2_FlushContext	M	Supported
TPM2_EvictControl	M	Supported
Clocks and Timers		
TPM2_ReadClock	M	Supported
TPM2_ClockSet	M	Supported
TPM2_ClockRateAdjust	M	Supported
Capability Commands		
TPM2_GetCapability	M	Supported
TPM2_TestParms	M	Supported
TPM2_SetCapability	U	Not supported
Non-volatile Storage		
TPM2_NV_DefineSpace	M	Supported
TPM2_NV_UndefineSpace	M	Supported
TPM2_NV_UndefineSpaceSpecial	M	Supported
TPM2_NV_ReadPublic	M	Supported
TPM2_NV_Write	M	Supported
TPM2_NV_Increment	M	Supported
TPM2_NV_Extend	M	Supported
TPM2_NV_SetBits	M	Supported
TPM2_NV_WriteLock	M	Supported
TPM2_NV_GlobalWriteLock	O	Not supported
TPM2_NV_Read	M	Supported
TPM2_NV_ReadLock	M	Supported
TPM2_NV_ChangeAuth	M	Supported
TPM2_NV_Certify	M	Supported
Attached Component Commands		
TPM2_AC_GetCapability	O	Not supported
TPM2_AC_Send	O	Not supported
TPM2_Policy_AC_Send	O	Not supported
TPM2_NV_DefineSpace2	U	Not supported
TPM2_NV_ReadPublic2	U	Not supported

Table 3-4. Command list

Authenticated Countdown Timer		
TPM2_ACT_SetTimeout	O	Not supported
Vendor Specific		
TPM2_Vendor_LockEPS	U	Supported
TPM2_Vendor_FieldUpgradeStart	U	Supported
TPM2_Vendor_FieldUpgradeData	U	Supported in field upgrade mode (FUM) See Firmware Upgrade

3.3 Provisioned EK certificates

By default the QVault TPM 183 is provisioned with the following EK certificates (see [\[R8\]](#)):

Table 3-5. EK certificates

NV index	EK certificate	Range
0x01C00002	RSA 2048	Low range
0x01C0000a	ECC P256	Low range
0x01C00016	ECC P384	High Range

3.4 General Purpose I/O (GPIO)

Four GPIO pins can be mapped to ordinary NV indexes with the corresponding handle values listed in the table below.

Table 3-6. Mapping of GPIO NV indexes

GPIO Name	QFN32 Pin	TPM_NV_INDEX
GPIO_A	3	0x01C40000
GPIO_B	4	0x01C40001
GPIO_C	7	0x01C40002
GPIO_D	27/28	0x01C40003

The NV GPIO complies with [\[R5\]](#) section 4.5.5. Operations on GPIO pins as described hereafter.



By default, GPIO pins are not configured and cannot be used by the TPM.

In this case, the pins are electrically configured as input pins with a built-in pull-up resistor and may remain unconnected.

3.4.1 GPIO Configuration

To use a GPIO pin, the related NV index must be first created by using the TPM2_NV_DefineSpace command with the following parameters:

- nvIndex handle must be set to a handle value defined in [Table 3-6](#).
- dataSize must be 2
- index type must be TPM_NT_ORDINARY
- attribute TPMA_NV_WRITEALL must be cleared



For all other NV index attributes, the behavior is the same as for a standard NV index.

Once created, GPIO configuration is done by using the TPM2_NV_Write command. First TPM2_NV_Write command must write 2 bytes at address 0.

The first byte defines the GPIO state in case of an output configuration (see [GPIO usage](#)). The second byte defines the GPIO configuration as described in the following table.

Table 3-7. Configuration of GPIO pins

Byte value	Configuration
1	Output
2	Input
3	Input with pull-down (value in Table 5-4)
4	Input with pull-up (value in Table 5-4)
others	Input with pull-down (value in Table 5-4)



Configuration cannot be changed.

To change a GPIO behavior, undefine and create again the related NV index.

3.4.2 GPIO usage

GPIO pins configured as output can be set by using the TPM2_NV_Write command. In this case (any write after the gpio configuration), only the first byte is accessible. The command must write 1 byte only at address 0:

- data = 1 will set the GPIO output to high level (1)
- data = 0 will set the GPIO output to low level (0)



It is not possible to write a GPIO pin set as input.

In this case, the TPM2_NV_Write command will return the TPM_RC_HANDLE error code.

The current state of any GPIO pins can be read by using the TPM2_NV_Read command. The command must read 1 byte at address 0. The responseCode gives the pin value:

- responseCode == TPMI_YES: GPIO is at high level (1)
- responseCode == TPMI_NO: GPIO is at low level (0)

3.4.3 GPIO Release

TPM2_NV_UndefineSpace will undefine the NV index used to access the GPIO pin.

After TPM2_UndefineSpace, the GPIO pin will be in the same state than after a power on.

3.5 Other TPM features

3.5.1 Identification registers

The registers DID,VID,RID have the values defined in the following table:

Table 3-8. Identification registers

Register	Value	Description and details
TPM_DID_VID	0x00832406	Device ID = 0x83 Vendor ID = 0x2406
TPM_RID	0x02	Revision ID

3.5.2 Locality

The QVault TPM 183 supports 5 localities (0-4).

3.5.3 PCR implementation

The QVault TPM 183 supports four banks of 24 PCRs (0-23) with SHA-1 (deprecated, therefore not recommended for new developments), SHA-256, SHA-384 and SHA-512.

By default SHA-256 and SHA-384 are activated, other configurations can be activated using the TPM2_PCR_Allocate command.

3.5.4 Power Management

The power management is automatically done by the TPM software depending on its state. Typical consumption can be found in [Table 5-7 on page 23](#).

3.5.5 Authenticated Countdown Timer (ACT)

Not supported by the QVault TPM 183.

3.5.6 Physical Presence

Not supported by the QVault TPM 183.

3.6 Firmware Upgrade

The QVault TPM 183 supports firmware upgrade.

The vendor specific command [TPM2_Vendor_FieldUpgradeStart](#) initiates the upgrade process.

This command includes a digest protected by a hybrid signature (ECC and MLDSA) to ensure that the upgrade is initiated by the TPM manufacturer.

Once the field upgrade process has been started, the QVault TPM switches to the field upgrade mode (FUM) and only supports the command [TPM2_Vendor_FieldUpgradeData](#).

If the firmware upgrade process is interrupted (power off, reboot, etc.), the QVault TPM will remain in field upgrade mode (FUM); only the command [TPM2_Vendor_FieldUpgradeData](#) is available, until the firmware program flow is started again and completed.

Upgrade does not allow roll-back, it is not possible to revert a firmware to a previous version.

3.7 I²C Interface implementation

3.7.1 Bus speed

The QVault TPM follows the TCG TPM I²C Interface Specification ([R6], [R7]).

The following speeds are supported:

- Standard Mode (up to 100 kbits/s)
- Fast Mode (up to 400 kbits/s)
- Fast Mode plus (up to 1 Mbits/s)

3.7.2 I²C Device address

Address configuration is supported using the TCG defined mechanism (see [R6] section 6.5.15).

The default 7-bit I2C device address of the QVault TPM is 0x2E (following [R5] specification).

3.8 Vendor commands

3.8.1 TPM2_Vendor_LockEPS

This command locks the TPM2_ChangeEPS command

Table 3-9. *TPM2_Vendor_LockEPS command format*

Type	Name	Description
TPMI_ST_COMMAND_TAG	tag	TPM_ST_SESSIONS
UINT32	commandSize	
TPM_CC	commandCode	TPM_CC_Vendor_LockEPS 0x2000D124
TPMI_RH_PLATFORM	@authorization	TPM_RH_PLATFORM Auth Index: 1 Auth Role: ADMIN
TPMI_YES_NO	permanent	YES if the lock should be permanent, NO if temporary (locked until next reset)

Possible response codes are:

Table 3-10. *TPM2_Vendor_LockEPS response code*

Name	Description
TPM_RC_DISABLED	TPM2_ChangeEPS already locked
TPM_RC_SUCCESS	operation successful
Others	session related error codes

3.8.2 TPM2_Vendor_FieldUpgradeStart

This command starts the firmware upgrade.

Table 3-11. *TPM2_Vendor_FieldUpgradeStart command format*

Type	Name	Description
TPMI_ST_COMMAND_TAG	tag	TPM_ST_SESSIONS
UINT32	commandSize	Variable
TPM_CC	commandCode	TPM_CC_Vendor_FieldUpgraderStart 0x2000D12F
TPMI_RH_PLATFORM	@authorization	TPM_RH_PLATFORM Auth Index: 1 Auth Role: ADMIN
TPM2B_DIGEST		
TPMT_SIGNATURE	manifestSignatureECC	signature using the ECC key
TPMT_SIGNATURE	manifestSignaturePQC	signature using the PQC key

3.8.3 TPM2_Vendor_FieldUpgradeData

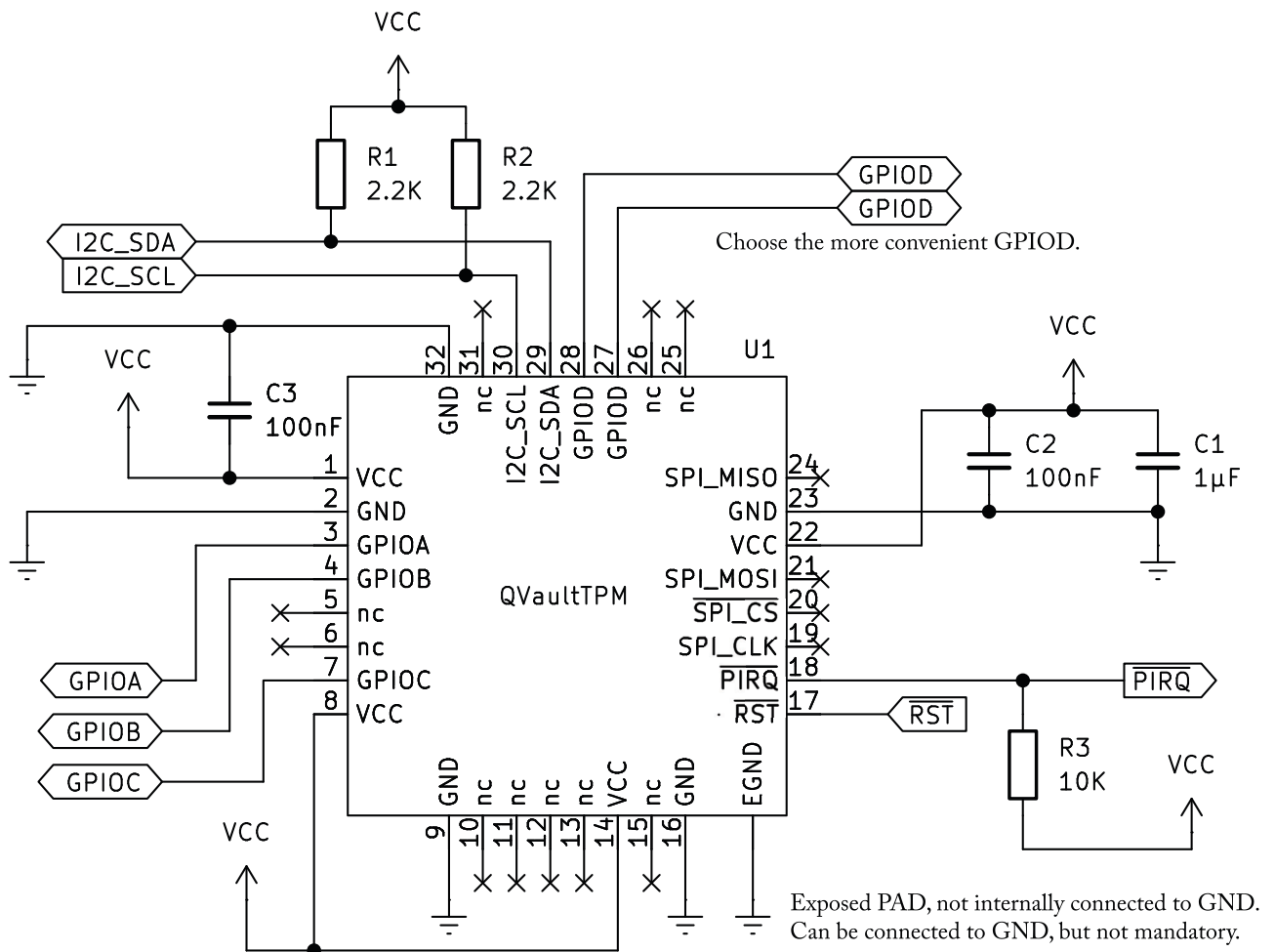
This command loads a new firmware in the QVault TPM.

Table 3-12. *TPM2_Vendor_FieldUpgradeData command format*

Type	Name	Description
TPMI_ST_COMMAND_TAG	tag	TPM_ST_NO_SESSIONS
UINT32	commandSize	
TPM_CC	commandCode	TPM_CC_Vendor_FieldUpgraderData 0x2000D141
TPM2B_MAX_UPG_BUFFER	fuData	Field upgrade image data

4. Typical schematics

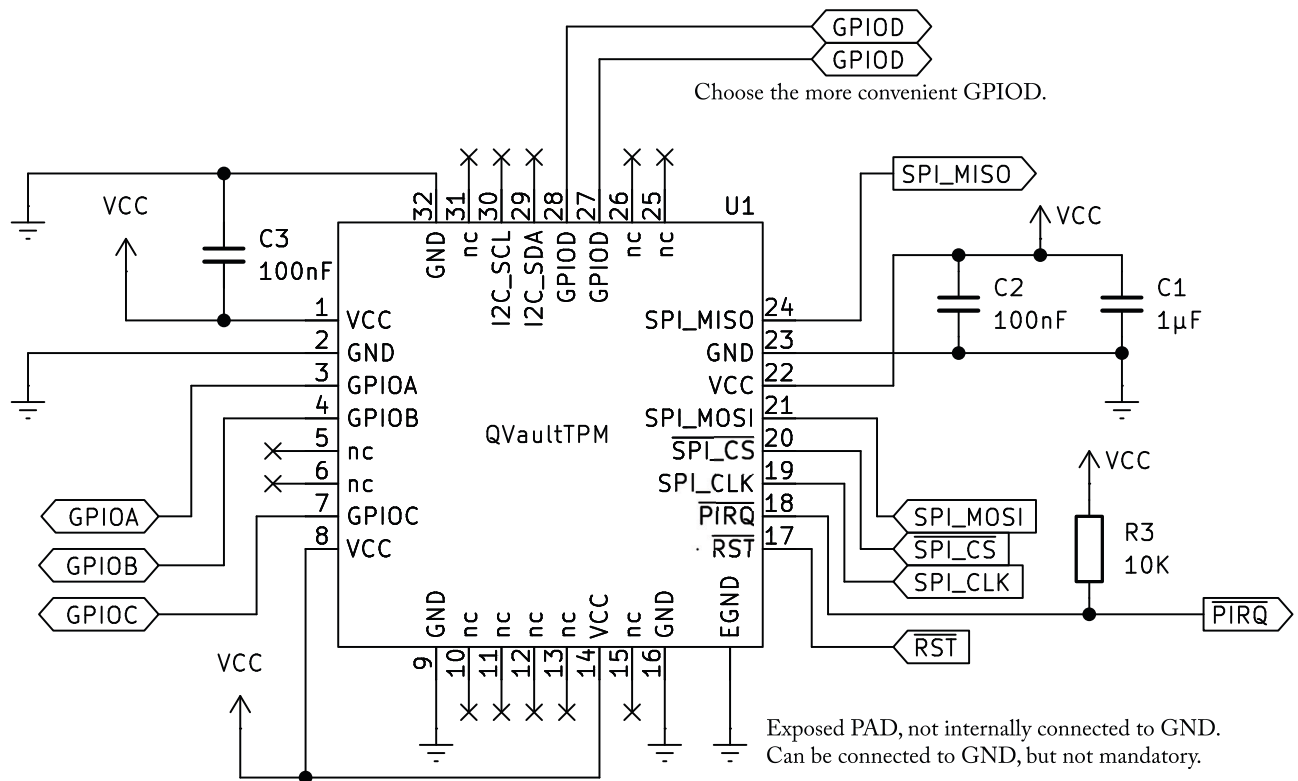
4.1 I²C



Place the 100nF capacitors near their corresponding VCC.

GPIOA, GPIOB, GPIOC, GPIOD and PIRQ are optional, depending on implementation.

4.2 SPI



Place the 100nF capacitors near their corresponding VCC.

GPIOA, GPIOB, GPIOC, GPIOD and PIRQ are optional, depending on implementation.

5. AC/DC characteristics

5.1 Maximum ratings

Table 5-1. Maximum ratings

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_M	Maximum Voltage				TBD	V
T_S	Storage Temperature		TBD		TBD	°C

5.2 AC/DC characteristics (1.62V - 3.60V range; T= -40°C to +105°C)

Table 5-2. AC/DC characteristics - general

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
T_O	Operating Temperature		-40		+105	°C
V_{CC}	Operation Supply Voltage		1.62		3.6	V
V_{MAX}	Voltage Monitor: High Level Detection			3.6		V
V_{MIN}	Voltage Monitor: Low Level Detection			1.62		V
T_{MAX}	Temperature monitor High Level Detection			105		°C
T_{MIN}	Temperature monitor Low Level Detection			-40		°C

Table 5-3. AC/DC characteristics - RST

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
I_{IL}	Leakage Current RST	$V_{IN}=0V$		0		μA
I_{IH}	Leakage Current RST	$V_{IN}=V_{CC}$		0		μA
V_{IH}	Input High Voltage, RST signal		0.7V _{CC}		V _{CC} +0.3	V
V_{IL}	Input Low Voltage, RST signal		-0.3		0.2V _{CC}	V
R_{PULLUP}	RST pin pull-up			105		kΩ
R_{PULLDN}	RST pin pull-down			1000		kΩ

Table 5-4. AC/DC characteristics - GPIO

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
I_{IL}	Leakage Current I/O	$V_{IN}=0$		0		μA
I_{IH}	Leakage Current I/O	$V_{IN}=V_{CC}$		0		μA
V_{IH}	Input High Voltage, I/O signal		$0.7V_{CC}$		$V_{CC}+0.3$	V
V_{IL}	Input Low Voltage, I/O signal		-0.3		$0.2V_{CC}$	V
V_{OH}	Output High Voltage, I/O signal	$I_{OH}=20\mu A$ $R_{PULLUP}=20K$	$0.7V_{CC}$			V
V_{OL}	Output Low Voltage, I/O signal	$I_{OL}<0.5mA$			$0.15V_{CC}$	V
R_{PULLUP}	GPIO pin pull-up	$V_{CC}=1.8V$		100		$k\Omega$
		$V_{CC}=3.3V$		47		
R_{PULLDN}	GPIO pin pull-down	$V_{CC}=1.8V$		90		$k\Omega$
		$V_{CC}=3.3V$		40		

Table 5-5. AC/DC characteristics - I²C

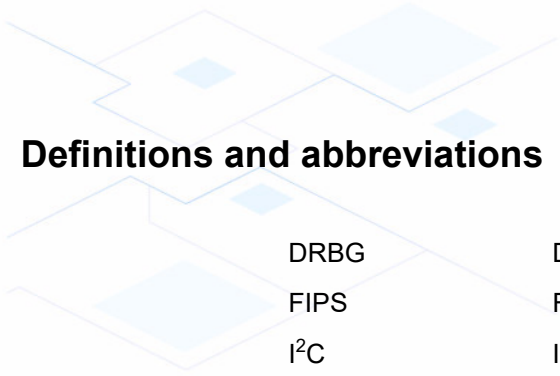
Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{DD}	Voltage applied on SDA and SCL pull-up resistors		1.62		5.5	V
V_{IH}	SDA SCL Input High Voltage		$0.7V_{DD}$			V
V_{IL}	SDA SCL Input Low Voltage		-0.5		$0.3V_{DD}$	V
V_{OL}	Output Low Voltage, SDA/SCL	3 mA sink current; $V_{DD} > 2 V$	0		0.4	V
		2 mA sink current; $V_{DD} \leq 2 V$	0		$0.2V_{DD}$	
t_{of}	Output fall time from V_{IHmin} to V_{ILmax}				TBD	ns

Table 5-6. AC/DC characteristics - SPI

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
SPI input pins - SPI_CLK - $\overline{\text{SPI_CS}}$ - SPI_MOSI						
V_{IH}	Input High Voltage		0.7Vcc		Vcc+0.3	V
V_{IL}	Input Low Voltage		-0.3		0.2Vcc	V
SPI output pin - SPI_MISO						
V_{OH}	Output High Voltage		0.7Vcc			V
V_{OL}	Output Low Voltage				0.15Vcc	V
T_r	Output Rise Time	$C_{out} = 30 \text{ pF}$			TBD	ns
T_f	Output Fall Time	$C_{out} = 30 \text{ pF}$			TBD	ns
SPI timing						
F_{SPI_CLK}	SPI_CLK frequency		1		36	MHz
D_{SPI_CLK}	SPI_CLK duty cycle		40		60	%
t_{CS}	$\overline{\text{SPI_CS}}$ rising edge to falling edge		TBD			ns
t_{CSS}	$\overline{\text{SPI_CS}}$ low to SPI_CLK starts		TBD			ns
t_{CSH}	SPI_CLK stops to $\overline{\text{SPI_CS}}$ high		5			ns
t_{SU}	SPI_MOSI setup to SPI_CLK		2			ns
t_H	SPI_MOSI hold to SPI_CLK		3			ns
t_{HO}	SPI_MISO hold time		0			ns
t_V	SPI_MISO valid from SPI_CLK falling edge				TBD	ns

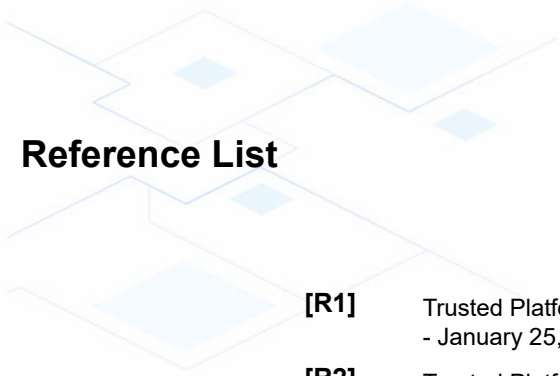
Table 5-7. AC/DC characteristics - consumption

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
I_{SBY}	Current consumption in standby mode	No communication, no operation in progress		TBD		mA
I_{MAX}	Maximum current consumption				TBD	mA



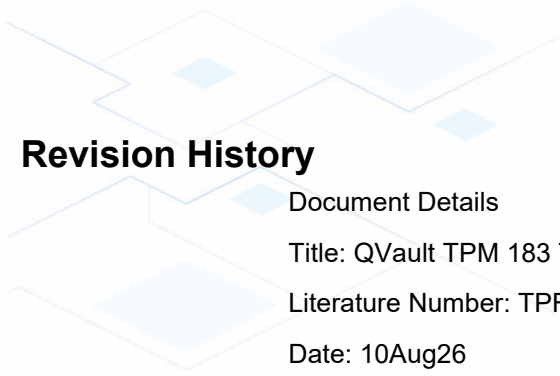
Definitions and abbreviations

DRBG	Deterministic Random Bit Generator
FIPS	Federal Information Processing Standards
I ² C	Inter-Integrated Circuit bus
LSB / MSB	Least Significant Bit and Most Significant Bit respectively
NIST	National Institute of Standards and Technology
NVM	Non Volatile Memory
PCR	Platform Configuration Register
TRNG	True Random Number Generator
SHA	Secure Hash Algorithm as defined in FIPS PUB 180-4 [R9]
SPI	Serial Peripheral Interface bus
TCG	Trusted Computing Group
TPM	Trusted Platform Module



Reference List

- [R1]** Trusted Platform Module Library Part 1: Architecture - Level 00 Revision 01.83 - January 25, 2024
- [R2]** Trusted Platform Module Library Part 2: Structures - Level 00 Revision 01.83 - January 25, 2024
- [R3]** Trusted Platform Module Library Part 3: Commands - Level 00 Revision 01.83 - January 25, 2024
- [R4]** Trusted Platform Module Library Part 4: Supporting Routines - Level 00 Revision 01.83 - January 25, 2024
- [R5]** PC-Client-Platform-TPM-Profile-for-TPM-2.0-Version-1.06-Revision-32 - 5April24
- [R6]** TCG TPM I2C Interface Specification for TPM 2.0 Revision 1.0 - 2016
- [R7]** Errata version 1.0 - 2017 for TCG TPM I2C Interface Specification for TPM 2.0
- [R8]** TCG EK Credential Profile for TPM 2.0 - Version 2.5 Rev 2 - January 26, 2022
- [R9]** FIPS PUB 180-4. Secure Hash Standard. August 2015.



Revision History

Document Details

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- Revision B:
 - Correction of NV index values in [Table 3-5](#)
 - Update t_{CS} and t_{CSS} in [Table 5-6](#)
- Revision A:
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