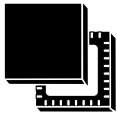
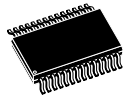


Flash-memory-based TPM 2.0 device with an SPI interface



VFQFPN32
(5 × 5 mm)



TSSOP28
(9.7 × 6.4 mm,
4.4 mm body width)

Features

TPM features

- Flash-memory-based Trusted Platform Module (TPM)
- Compliant with Trusted Computing Group (TCG) Trusted Platform Module (TPM) Library specifications 2.0, Level 0, Revision 138 and TCG PC Client Specific TPM Platform Specifications 1.03
- TPM firmware code can be upgraded thanks to a persistent Flash-memory loader application to support new standard evolutions
- Common Criteria (CC) certification according to the TPM 2.0 protection profiles at EAL4+
- FIPS 140-2 level 2 certification
- SPI support for up to 33 MHz in FIFO and CRB protocol modes
- Support for software and hardware physical presence

Hardware features

- Arm® SecurCore® SC300™ 32-bit RISC core
- Highly reliable Flash memory technology
- Extended temperature range: -40 °C to 105 °C
- ESD (electrostatic discharge) protection up to 4 kV (HBM)
- 1.8 V or 3.3 V supply voltage range
- 28-lead thin shrink small outline and 32-lead very thin fine pitch quad flat pack ECOPACK packages

Security features

- Active shield and environmental sensors
- Monitoring of environmental parameters (power)
- Hardware and software protection against fault injection
- FIPS-compliant random-number generator (RNG) built on an SP800-90A compliant SHA256 deterministic random bit generator (DRBG) and an AIS-31 Class PTG2 compliant true random number generator (TRNG)
- Cryptographic algorithms:
 - RSA (Rivest-Shamir-Adleman) key generation (1024 or 2048 bits)
 - RSA signature and encryption
 - Hash-based message authentication code (HMAC) SHA-1 & SHA-256
 - Advanced Encryption Standard (AES)-128-192-256
 - Elliptic curve cryptography (ECC) 224 & 256 bits
 - Elliptic curve Diffie–Hellman (ECDH) 224 & 256 bits
 - Elliptic curve direct anonymous attestation (ECDAA)

Product compliance

- TPM 2.0 compliant with Microsoft® Windows® 8.1 and 10
- Compliant with Intel® TXT
- TPM 2.0 compliant with the corresponding TCG test suites

Product status link

[ST33TPHF20SPI](#)



1 Description

The STSAFE-TPM (trusted platform module) family of products offers a broad portfolio of standardized solutions for embedded, PC, mobile and computing applications. STSAFE is an ST trademark.

It includes turnkey products compliant with the Trusted Computing Group (TCG) standards that provide services to protect the confidentiality, integrity and authenticity of information and devices.

These devices are easy to integrate thanks to the variety of supported interfaces and the availability of TPM ecosystem software solutions.

The STSAFE-TPM devices are all Common Criteria (EAL4+) and FIPS certified.

They embed an Arm® SecurCore SC300™ processor with additional security features to help protect against advanced forms of attack.

The **ST33TPHF20SPI** offers a slave serial peripheral interface (SPI) compliant with the TCG PC Client TPM Profile specifications.

The **ST33TPHF20SPI** supports TPM 2.0 commands exclusively, and offers 112 Kbytes of user-dedicated non-volatile memory.

The **ST33TPHF20SPI** operates in the –25 to +85 °C commercial temperature range with a supply and I/O voltage of 1.8 V, or in the –40 °C to 105 °C extended temperature range with a supply and I/O voltage of 3.3 V.

The device is offered in TSSOP28 and VFQFPN32 ECOPACK2 packages. ECOPACK is an ST trademark.

Note: Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

arm



2 Data brief scope

2.1 ST33TPHF20SPI products

This document covers the functionality of the [ST33TPHF20SPI](#) product family, the most recent of which has firmware version 4A.40 (74.64 in decimal) preloaded on ST TPM hardware with markings:

- P0AHD1

The information to order the supporting platforms is provided in [Section 8 Ordering information](#).

2.2 Firmware image

The firmware image version 4A.40 can be loaded to the ST TPM hardware of the [ST33TPHF20SPI](#) products, identifiable by their firmware version, which is of the form 4A.xx. The ordering codes of the products upgradable to firmware version 4A.40 are the following:

- ST33HTPH2ExxAAF3 (FW 4A.00)
- ST33HTPH2ExxAHC1 (FW 4A.08)

See [Section 9 Firmware image overview](#) for an overview of the available firmware images.

3 Pin and signal description

The two figures below give the pinouts of the two packages in which the devices are delivered. The table describes the associated signals.

Figure 1. TSSOP28 pinout

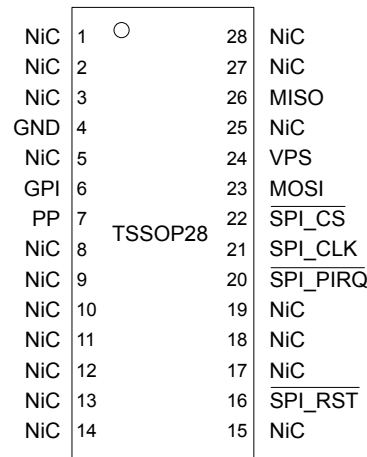


Figure 2. VQFN32 pinout

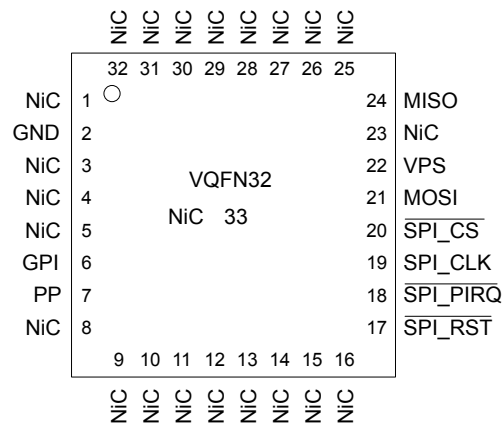


Table 1. Pin descriptions

| Signal | Type | Description |
|---------|--------|--|
| VPS | Input | Power supply. This pin must be connected to 1.8 V or 3.3 V DC power rail supplied by the motherboard. |
| GND | Input | GND has to be connected to the main motherboard ground. |
| SPI_RST | Input | SPI Reset , active low, used to re-initialize the device. Must not be unconnected. External pull-up resistor required if it cannot be driven. |
| MISO | Output | SPI Master Input, Slave Output (output from slave) |
| MOSI | Input | SPI Master Output, Slave Input (output from master) |
| SPI_CLK | Input | SPI Serial Clock (output from master) |
| SPI_CS | Input | SPI Chip (or Slave) Select , internal pull-up (active low; output from master) |

| Signal | Type | Description |
|----------|--------|--|
| SPI_PIRQ | Output | SPI IRQ , active low, open drain, used by TPM to generate an interrupt |
| PP | Input | Physical Presence , active high, internal pull-down. Used to indicate Physical Presence. |
| GPI | Input | Used for activation and deactivation of the TPM Standby mode (TPMLowPowerByGPIO). If this feature is not used, connect an external pull-up resistor (10 kΩ) to this pad. |
| NiC | - | Not internally connected : not connected to the die. May be left unconnected but no impact on TPM if connected. |

Note: The VQFN32 package has a central pad (PIN33) on the bottom, which is not connected to the die. This pin does not impact the TPM, be it connected or not.

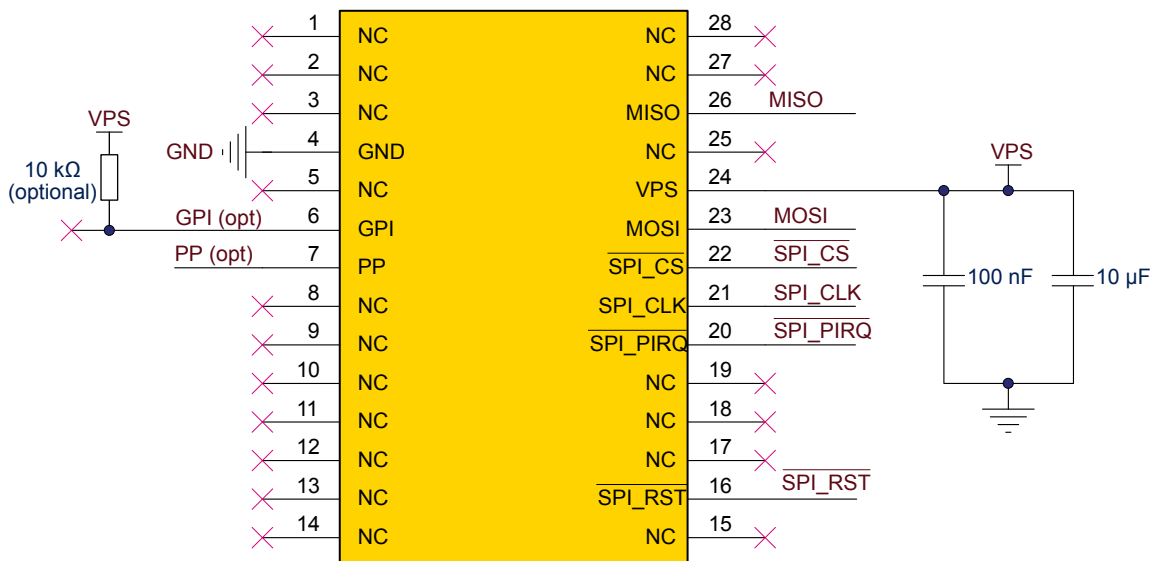
4 Integration guidance

4.1 Typical hardware implementation

The Physical Presence (PP) pin should be connected if platform implementation (at boot level) uses a hardware physical presence function.

The figure below shows the hardware implementation in the case of the TSSOP28 package. The same implementation is also valid for the TSSOP28 and QFN32 packages.

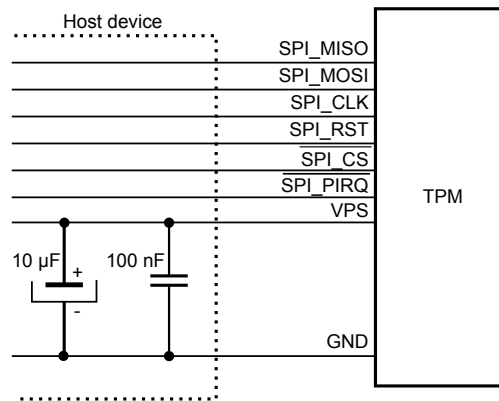
Figure 3. Typical hardware implementation (TSSOP28 package)



4.2 Power supply filtering

As mentioned in [Section 3 Pin and signal description](#), the power supply of the circuit must be filtered using the circuit shown in the figure below.

Figure 4. Mandatory filtering capacitors on V_{PS}



1. 10 µF and 100 nF are recommended values. The minimum required capacitor value is 2.1 µF (2 µF in parallel with 100 nF).

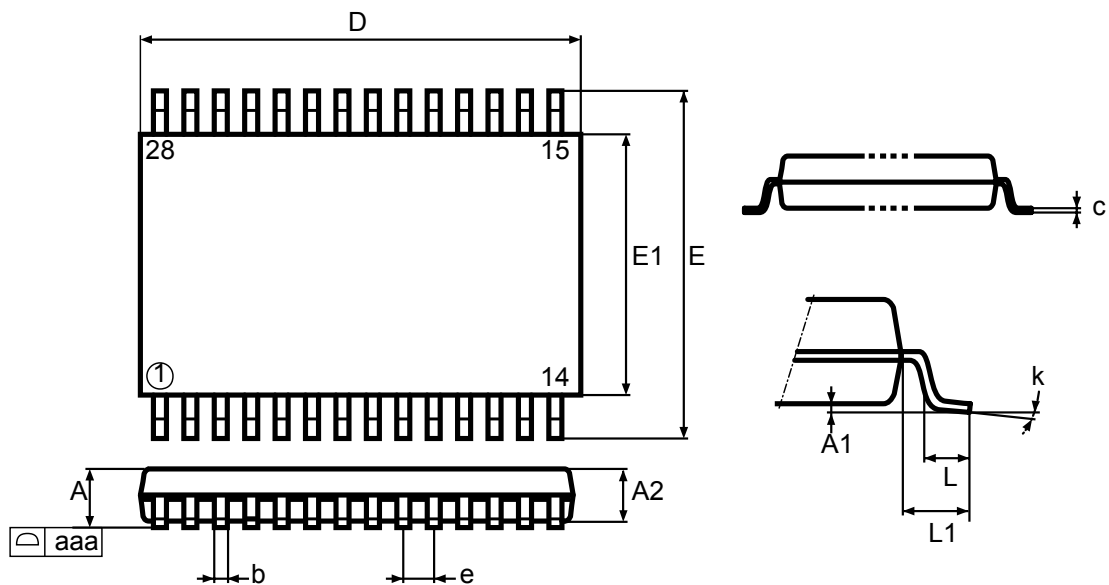
5 Package information

In order to meet environmental requirements, ST offers these devices in different grades of **ECOPACK** packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

5.1 TSSOP28 package information

TSSOP28 is a 28-pin, 9.7 × 6.4 mm, 4.4 mm body width, 0.65 mm pitch, thin shrink small outline package. Unless otherwise specified, general tolerance is ± 0.1 mm.

Figure 5. TSSOP28 - outline



1. Drawing is not to scale.

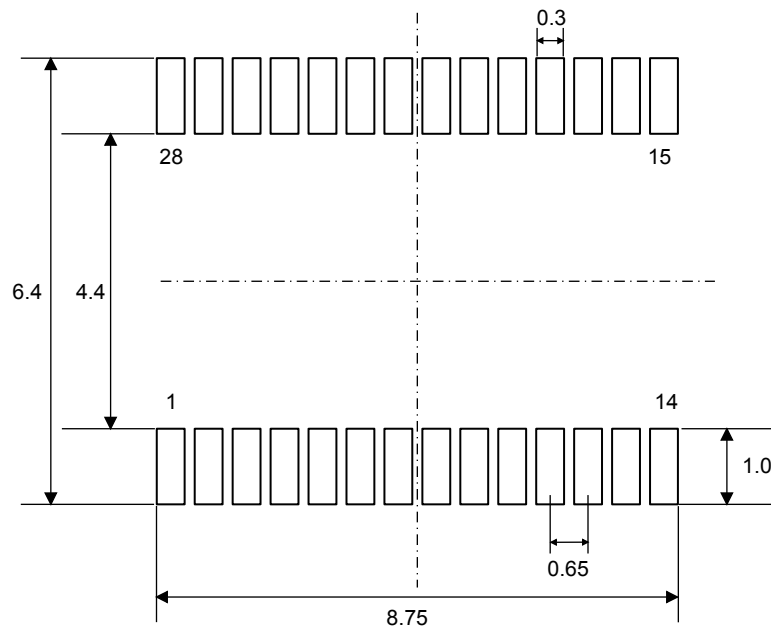
Table 2. TSSOP28 - mechanical data

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|--------|-------------|-------|-------|-----------------------|--------|--------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | - | - | 1.200 | - | - | 0.0472 |
| A1 | 0.050 | - | 0.150 | 0.0020 | - | 0.0059 |
| A2 | 0.800 | 1.000 | 1.050 | 0.0315 | 0.0394 | 0.0413 |
| b | 0.190 | - | 0.300 | 0.0075 | - | 0.0118 |
| c | 0.090 | - | 0.200 | 0.0035 | - | 0.0079 |
| D | 9.600 | 9.700 | 9.800 | 0.3780 | 0.3819 | 0.3858 |
| E | 6.200 | 6.400 | 6.600 | 0.2441 | 0.2520 | 0.2598 |
| E1 | 4.300 | 4.400 | 4.500 | 0.1693 | 0.1732 | 0.1772 |
| e | - | 0.650 | - | - | 0.0256 | - |
| L | 0.450 | 0.600 | 0.750 | 0.0177 | 0.0236 | 0.0295 |
| L1 | - | 1.000 | - | - | 0.0394 | - |

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|--------|-------------|------|-------|-----------------------|------|--------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| k | 0° | - | 8° | 0° | - | 8° |
| aaa | - | - | 0.100 | - | - | 0.0039 |

1. Values in inches are converted from mm and rounded to 4 decimal digits.

Figure 6. TSSOP28 - recommended footprint

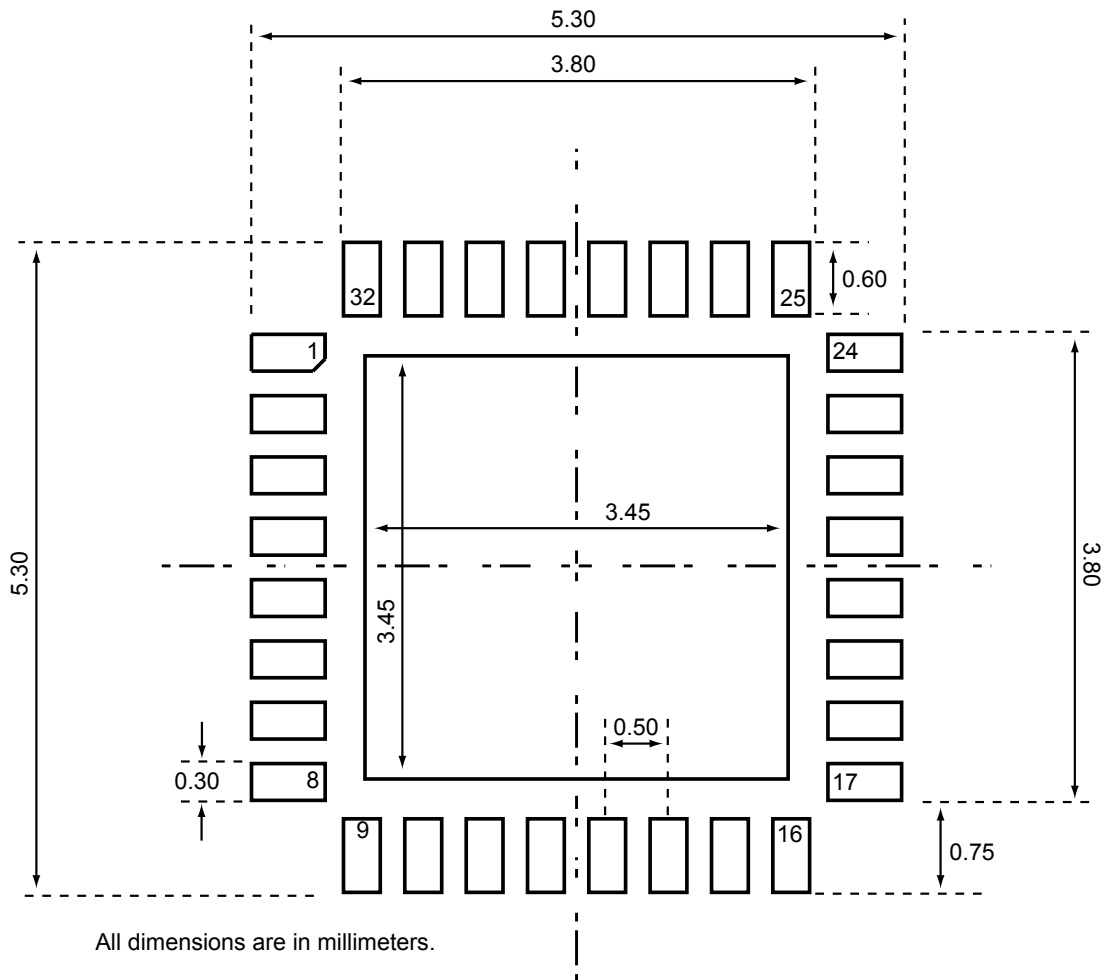


1. All dimensions are in millimeters.

| Symbol | millimeters | | | inches ⁽¹⁾ | | |
|--------|-------------|-------|-------|-----------------------|--------|--------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| E | 4.850 | 5.000 | 5.150 | 0.1909 | 0.1969 | 0.2028 |
| E2 | 3.500 | 3.600 | 3.700 | 0.1378 | 0.1417 | 0.1457 |
| e | - | 0.500 | - | - | 0.0197 | - |
| L | 0.300 | 0.400 | 0.500 | 0.0118 | 0.0157 | 0.0197 |
| ddd | - | - | 0.050 | - | - | 0.0020 |

1. Values in inches are converted from mm and rounded to 4 decimal digits.

Figure 8. VFQFPN32 - recommended footprint



5.3 Thermal characteristics of packages

The table below provides the thermal characteristics of the TSSOP28 and VFQFPN32 packages.

Table 4. Thermal characteristics

| Parameter | | Symbol | Value |
|---|--|---------------|-------------------------------|
| Recommended operating temperature range | Ambient temperature | T_A | -40 to 105 °C |
| | Case temperature | T_C | - |
| | Junction temperature | T_J | -43 to 108 °C |
| Absolute maximum junction temperature | | - | 125 °C |
| Maximum power dissipation | | - | 63 mW |
| Theta-JA, -JB and -JC | Junction to ambient thermal resistance | θ_{JA} | 35.8 at 0 lfpm ⁽¹⁾ |
| | Junction to case thermal resistance | θ_{JC} | 1.48 at 0 lfpm ⁽¹⁾ |
| | Junction to board thermal resistance | θ_{JB} | 13.9 at 0 lfpm ⁽¹⁾ |

1. Linear feet per minute.

6 Delivery packing

Surface-mount packages can be supplied with tape and reel packing. The reels have a 13" typical diameter. Reels are in plastic, either anti-static or conductive, with a black conductive cavity tape. The cover tape is transparent anti-static or conductive.

The devices are positioned in the cavities with the identifying pin (normally Pin "1") on the same side as the sprocket holes in the tape.

The STMicroelectronics tape and reel specifications are compliant to the EIA 481-A standard specification.

Table 5. Packages on tape and reel

| Package | Description | Tape width | Tape pitch | Reel diameter | Quantity per reel |
|-----------|---|------------|------------|---------------|-------------------|
| TSSOP 28 | Thin shrink small outline package | 16 mm | 8 mm | 13 in. | 2500 |
| VFQFPN 32 | Very thin fine pitch quad flat pack no-lead package | 12 mm | 8 mm | 13 in. | 3000 |

Figure 9. Reel diagram

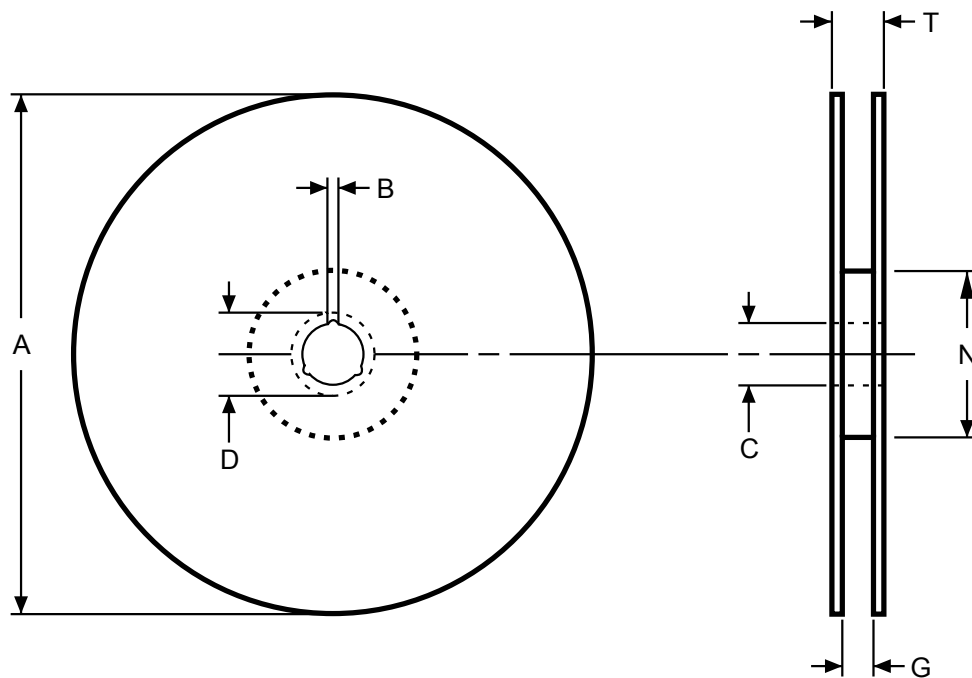
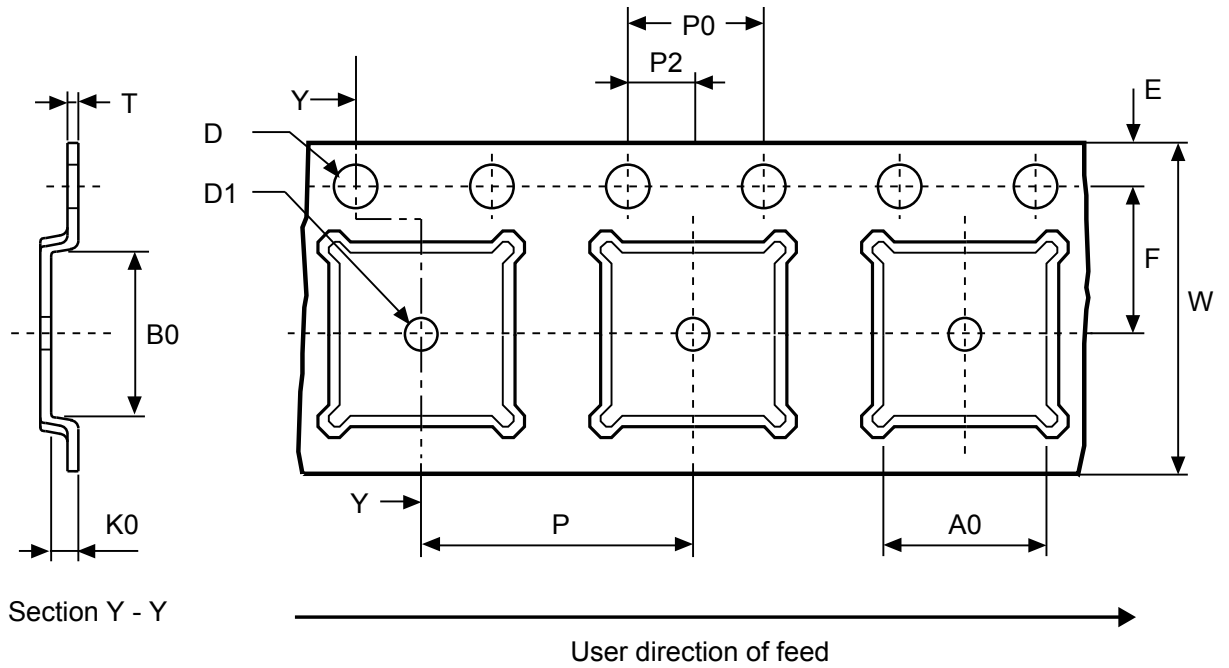


Table 6. Reel dimensions

| Reel size | Tape width | A Max. | B Min. | C | D Min. | G Max. | N Min. | T Max. | Unit |
|-----------|------------|--------|--------|---------|--------|------------|--------|--------|------|
| 13" | 16 | 330 | 1.5 | 13 ±0.2 | 20.2 | 16.4 +2/-0 | 100 | 22.4 | mm |
| | 12 | | | | | 12.6 | | 18.4 | |

Figure 10. Embossed carrier tape for VFQFPN 5 × 5 mm



1. Drawing is not to scale.

Figure 11. Chip orientation in the embossed carrier tape for VFQFPN 5 × 5 mm

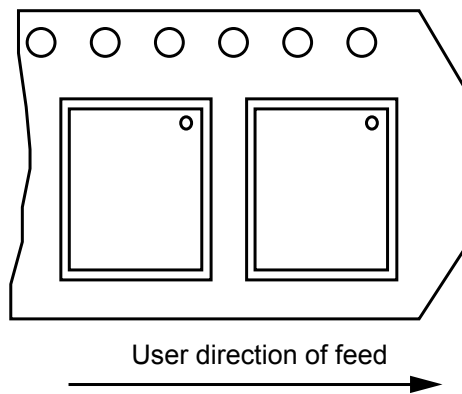
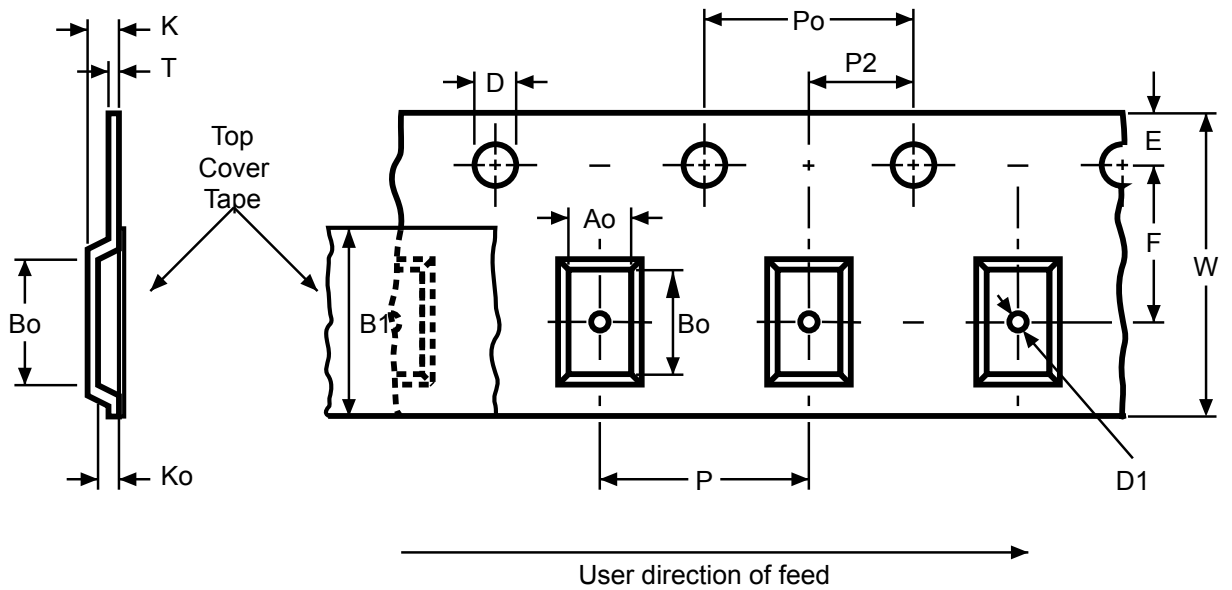


Table 7. Carrier tape dimensions for VFQFPN 5 × 5 mm

| Package | A0 | B0 | K0 | D1 Min. | P | P2 | D | P0 | E | F | W | T Max. | Unit |
|------------|-----------|-----------|----------|---------|--------|--------|------------|--------|-----------|----------|---------|-----------|------|
| VFQFPN 5x5 | 5.25 ±0.1 | 5.25 ±0.1 | 1.1 ±0.1 | 1.5 | 8 ±0.1 | 2 ±0.1 | 1.55 ±0.05 | 4 ±0.1 | 1.75 ±0.1 | 5.5 ±0.1 | 12 ±0.3 | 0.3 ±0.05 | mm |

Figure 12. Embossed carrier tape for TSSOP28 4.4 mm body width



1. Drawing is not to scale.

Figure 13. Chip orientation in the embossed carrier tape for TSSOP28 4.4 mm body width

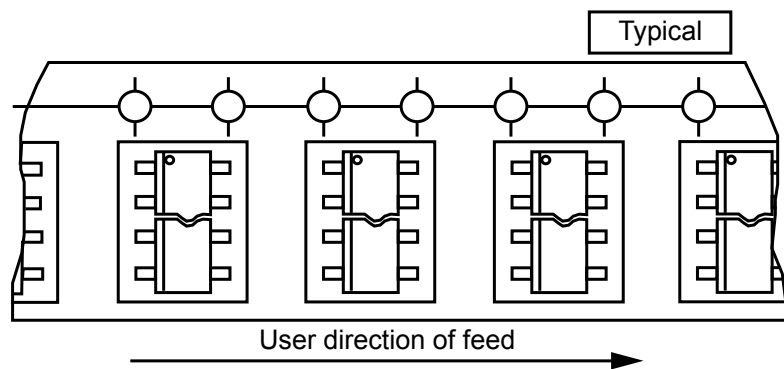


Table 8. Carrier tape constant dimensions for TSSOP 4.4 mm body width

| Tape size | Ao, Bo, Ko ⁽¹⁾ | D | E | Po | T Max. | Unit |
|-----------|---------------------------|---------------|-----------|--------|--------|------|
| 16 mm | See note. | 1.5 +0.1 / -0 | 1.75 ±0.1 | 4 ±0.1 | 0.4 | mm |

1. Ao, Bo, Ko, are determined by components sizes. The clearance between the component and the cavity must be within 0.05 mm (Min.) to 0.90 mm (Max.)

7 Package marking information

The two figures below illustrate the typical markings of the TSSOP28 and the VQFN32 device packages, respectively.

Figure 14. TSSOP28 device package marking area

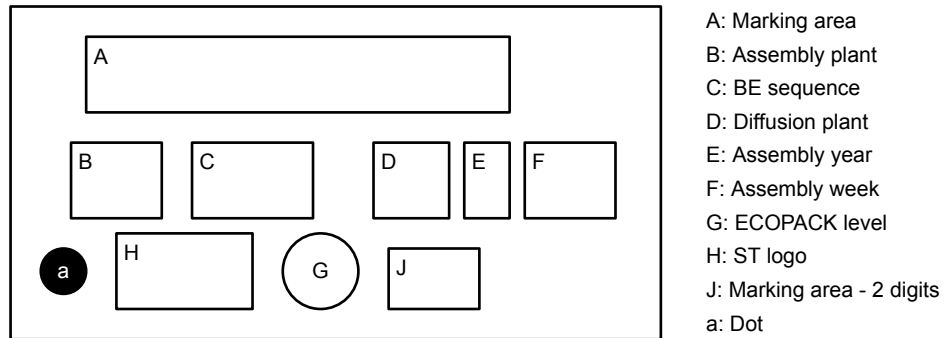
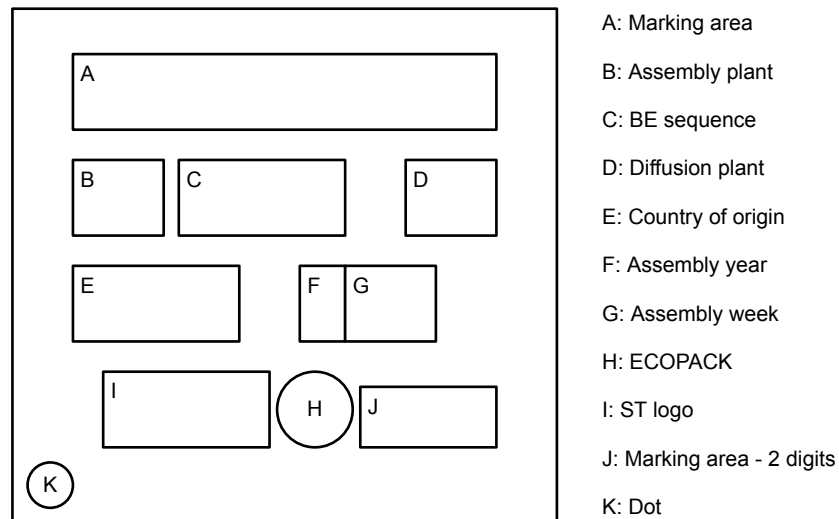


Figure 15. VQFN32 device package marking area



For both packages, the 8-digit 'A' marking area is equal to "P68XYZZZ", with:

- X = Hardware product
- Y = Hardware revision
- ZZZ = Firmware revision

8 Ordering information

Table 9. Ordering information for ST33TPHF20SPI products

| Ordering code | TPM library revision & firmware version | Operating temperature range ⁽¹⁾ | Maximum SPI clock frequency | Package | Marking area A | Product status |
|------------------|---|--|-----------------------------|---------|----------------|---------------------------------------|
| ST33HTPH2028AHD1 | TPM2.0 Rev 1.38 | -40 °C to +105 °C | 33 MHz | TSSOP28 | P0AHD1 | Active |
| ST33HTPH2032AHD1 | 0x00 0x4A 0x00 0x40 (74.64) | | | VQFN32 | | |
| ST33HTPH2028AHC9 | TPM2.0 Rev 1.38 | -40 °C to +105 °C | 33 MHz | TSSOP28 | P0AHC9 | NRND (not recommended for new design) |
| ST33HTPH2032AHC9 | 0x00 0x4A 0x00 0x10 (74.16) | | | VQFN32 | | |
| ST33HTPH2028AHC1 | TPM2.0 Rev 1.38 | -40 °C to +105 °C | 33 MHz | TSSOP28 | P0AHC1 | NRND (not recommended for new design) |
| ST33HTPH2032AHC1 | 0x00 0x4A 0x00 0x08 (74.08) | | | VQFN32 | | |
| ST33HTPH2028AAF3 | TPM2.0 Rev 1.16 | -40 °C to +105 °C | 33 MHz | TSSOP28 | P68HAAF3 | NRND (not recommended for new design) |
| ST33HTPH2032AAF3 | 0x00 0x4A 0x00 0x00 (74.00) | | | VQFN32 | | |

1. Refer to [Section 1 Description](#) for the operating voltages associated with the different operating temperature ranges.

9 Firmware image overview

Table 10. Firmware image overview for the ST33TPHF20SPI products

| Firmware version | Firmware version (TPM capability) | TPM 2.0 library revision | Product status |
|------------------|-----------------------------------|--------------------------|---------------------------------------|
| 74.00 | 0x00 0x4A 0x00 0x00 | 1.16 | NRND (not recommended for new design) |
| 74.04 | 0x00 0x4A 0x00 0x04 | 1.16 | NRND (not recommended for new design) |
| 74.08 | 0x00 0x4A 0x00 0x08 | 1.38 | NRND (not recommended for new design) |
| 74.16 | 0x00 0x4A 0x00 0x10 | 1.38 | NRND (not recommended for new design) |
| 74.20 | 0x00 0x4A 0x00 0x14 | 1.16 | Active |
| 74.64 | 0x00 0x4A 0x00 0x40 | 1.38 | Active |

Table 11. Commercial product supporting the update with firmware image version 74.20

xx = 28 for products delivered in TSSOP28, and 32 for products delivered in QFN32 packages.

| Commercial products | Firmware preloaded in factory | TPM2_Clear required before firmware update |
|---------------------|-------------------------------|--|
| ST33HTPH2ExxAFF3 | 74.00 0x00 0x4A 0x00 0x00 | No |

Table 12. Commercial product supporting the update with firmware image version 74.64

xx = 28 for products delivered in TSSOP28, and 32 for products delivered in QFN32 packages.

| Commercial products | Firmware preloaded in factory | TPM2_Clear required before firmware update |
|---------------------|-------------------------------|--|
| ST33HTPH20xxAAFF3 | 74.00 0x00 0x4A 0x00 0x00 | Yes |
| ST33HTPH20xxAHC1 | 74.08 0x00 0x4A 0x00 0x08 | No |
| ST33HTPH20xxAHC9 | 74.16 0x00 0x4A 0x00 0x10 | No |

10 Support and information

Additional information regarding ST TPM devices can be obtained from the www.st.com website.
For any specific support information you can contact STMicroelectronics through the following e-mail:
TPMsupport@list.st.com.

Appendix A Terms and abbreviations

Table 13. List of abbreviations

| Term | Meaning |
|--------|--|
| AES | Advanced Encryption Standard |
| CC | Common Criteria |
| DES | Data Encryption Standard |
| DRBG | Deterministic random-bit generator |
| EAL | Evaluation assurance level |
| EC | Elliptic curve |
| ECC | Elliptic curve cryptography |
| ECDAAs | Elliptic curve direct anonymous attestation |
| ECDH | Elliptic curve Diffie–Hellman |
| ESD | Electrostatic discharge |
| FIPS | Federal Information Processing Standard |
| FW | Firmware |
| GPI | General-purpose input |
| HBM | Human body model |
| HMAC | Keyed-Hashing for message authentication |
| MPU | Memory protection unit |
| NIST | National Institute of Standards and Technology |
| NRND | Not recommended for new design |
| RNG | Random number generator |
| RSA | Rivest Shamir Adelman |
| SHA | Secure Hash algorithm |
| SPI | Serial Peripheral Interface |
| ST | STMicroelectronics |
| TCG | Trusted Computed Group |
| TIS | TPM interface specification |
| TPM | Trusted Platform Module |
| TRNG | True random number generator |

Revision history

Table 14. Document revision history

| Date | Version | Changes |
|-------------|---------|---|
| 04-Mar-2016 | 1 | Initial release. |
| 15-Mar-2016 | 2 | <p>Updated TPM features related to certification and updated Section 1.1: Security certifications.</p> <p>Updated references in Section 1: Description.</p> <p>Added Figure 38: Chip orientation in the embossed carrier tape for VFQFPN 5 × 5 mm and Figure 40: Chip orientation in the embossed carrier tape for TSSOP28 4.4 mm body width.</p> |
| 06-Feb-2018 | 3 | <p>Updated Appendix B: Referenced documents. The device is compliant with these revisions of the TCG documentation.</p> <p>The device has obtained FIPS 140-2 level 2 certification.</p> <p>Updated Section 1.1: Security certifications.</p> <p>Updated TPM 2.0 compliance with Microsoft Windows 8.1 and 10.</p> <p>Updated Section 2: Pin and signal description.</p> <p>Added Section 3: Integration guidance.</p> <p>Updated Arm logo and trademark.</p> <p>Reference modified at bottom of pages.</p> <p>Small text changes.</p> |
| 15-Nov-2019 | 4 | <p>Updated document for firmware version 4A.40 (74.64 in decimal):</p> <ul style="list-style-type: none"> Updated Section 1 Description. Added Section 2.1 ST33TPHF20SPI products and Section 2.2 Firmware image. Changed GPIO pin to GPI in Section 3 Pin and signal description. Updated Figure 3. Typical hardware implementation (TSSOP28 package). Added θ_{JC} and θ_{JB} values to Table 4. Thermal characteristics. Updated Section 7 Package marking information. Added Section 8 Ordering information. Added Section 9 Firmware image overview. <p>Added Section 5.3 Thermal characteristics of packages.</p> <p>Updated Section Appendix A Terms and abbreviations.</p> <p>Removed <i>Referenced documents</i> section.</p> <p>Small text changes.</p> |

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