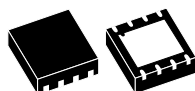
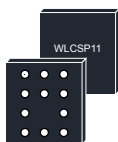


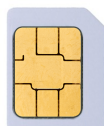
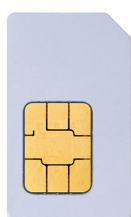
## SIM and eSIM system-on-chip solution for secure M2M industrial applications



VFDFPN8  
5 × 6 mm, Wettable  
flanks (MFF2)



WLCSP11



Card plugin 2FF, 3FF or 4FF (Based on  
D16 micromodule)

Product status link

[ST4SIM-111M](#)

### Features

- Cellular network connectivity configuration provided by trusted partners
- Compliant with 3G / 4G (LTE) / 5G / NB-IoT / CAT-M networks
- Network access applications supported: SIM / USIM / ISIM / CSIM
- Secure element access control (ARF / PKCS#15)
- OTA capability over SMS, CAT-TP & HTTPS (including DNS)
- Multi-interfaces able to combine (U)SIM + eSE

### Hardware

- Product available on ST33G1M2M
- ST33 product based on a 32-bit Arm® SecurCore® SC300™ RISC core
- Supply voltage: Class A (5 V), Class B (3 V), Class C (1.8 V)
- Asynchronous serial I/O port ISO/IEC 7816-3 compatible (T=0 protocol)
- Serial peripheral interface (SPI), depending on packages
- Industrial qualification (JEDEC JESD47)
- Operating temperature: -40°C to +105°C
- Common Criteria EAL5+

### ECOPACK-compliant packages

- 2FF, 3FF or 4FF plugin card
- DFN8 with wettable flanks (MFF2)
- WLCSP11

### Security

- Symmetric cryptography DES / 3DES / AES
- Asymmetric cryptography RSA (up to 2048 bits)
- HTTPS remote management TLS v1.0, v1.1 and v1.2
- Elliptic curve cryptography (up to 521 bits) including preloaded curve NIST P-256 and brainpool P256r1
- Authentication algorithm: Comp128-2/-3, MILENAGE, TUAK, CAVE

### Software standard compliancy

- Java® Cardv.3.0.5 Classic
- GlobalPlatform® card specification v2.3, including GP amendments A, B, C, D and E
- ETSI, 3GPP and 3GPP release 16 (for further information, contact the local STMicroelectronics sales office)
- Power saving features (PSM and eDRX) defined by ETSI

## Applications

- Cellular Connected Nodes
- LTE, 5G, LPWA (LTE-M, NB-IoT)
- Surveillance
- IoT for smart home and city such as gas metering
- IoT for smart industry such as tracking

## 1 Description

The **ST4SIM-111M** is an STMicroelectronics SIM and embedded SIM (eSIM or eUICC) product designed for all industrial devices.

The **ST4SIM-111M** pre-integrates a cellular connectivity configuration provided by trusted partners. In this way, the product is ready to be deployed to the field.

The device ensures the appropriate security level to all eSIM stakeholders (user, MNO, OEM, hardware integrator, service provider, and so on).

The device can include an embedded secure element to store credentials and/or independent applications directly managed by the MCU (or by another OEM element).

The device provides a secure and interoperable Java® Card environment compliant with Java® Card v3.0.5 Classic. Moreover, the device integrates the most advanced UICC features compliant with GlobalPlatform®, ETSI, 3GPP, 3GPP2 specifications.

The device integrates a dynamic memory management with Java® Card garbage collection mechanism optimizing the usage of the memory.

The device is based on the ST33G1M2M, an industrial grade hardware solution (JEDEC) supporting severe conditions. This solution is a tamper-resistant secure element certified by Common Criteria EAL5+, with a powerful 32-bit Arm® SecurCore® SC300™ RISC core.

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

*Note: Java is a registered trademark of Oracle and/or its affiliates.*

arm



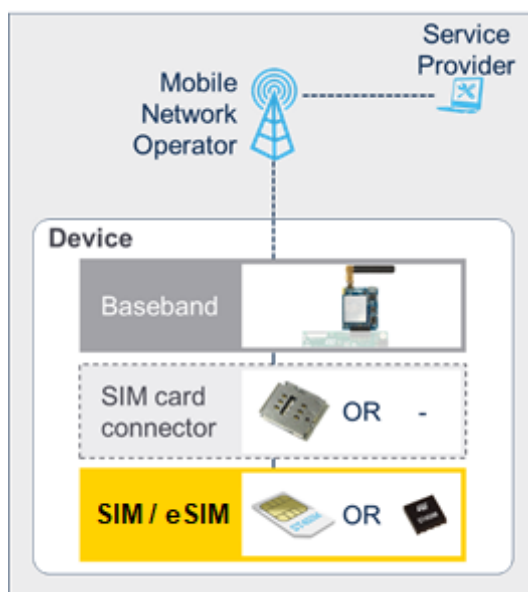
## 2 Cellular connectivity solutions overview

A cellular connectivity solution enables devices to be used by the edge mobile network operators (also called MNO) or mobile virtual network operators (MVNO). This solution increases network coverage and it maintains seamless connectivity.

Moreover, a cellular solution is simple to deploy. This solution is mainly composed of the modem (baseband), the SIM card connector and the plastic SIM card. This is the traditional SIM concept inherited from the mobile phone.

It is also possible to have an embedded SIM (eSIM) solution. In this case, there is no SIM card connector. It reduces the board footprint and there is no need for a SIM connector.

**Figure 1. SIM and eSIM architecture overview**

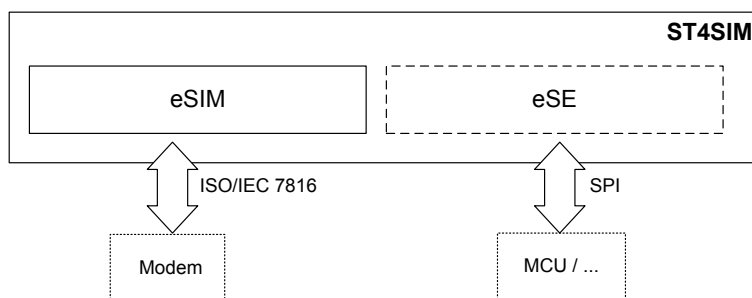


### 3 Additional embedded secure element (eSE)

The **ST4SIM-111M** is able to combine the eSIM solution with an embedded secure element (eSE) section inside the same chip.

This eSE section is used to provide secure storage, cryptographic services, and so on via Java® Card applets.

**Figure 2. ST4SIM-111M architecture eSIM & eSE overview**



The eSE section is accessible through a dedicated serial peripheral interface (SPI) protocol and the eSIM uses the ISO/IEC 7816 protocol in parallel. Consequently, the eSE is only available on packages including ISO and SPI protocols.

The embedded secure element is optional and configurable.

Contact the local STMicroelectronics sales office for more details on the pin configuration.

## 4 Card OS technical features

### 4.1 Supported standards and networks

The **ST4SIM-111M** solution complies with the standard networks (3G/4G LTE/5G) and low power networks (CAT-M / NB-IoT).

From a technical point of view, the **ST4SIM-111M** solution integrates all advanced NAAs for eSIM solution:

- USIM applications providing access to universal mobile telecommunications system (UMTS) networks,
- IP multimedia services identity module (ISIM) to access IP multimedia subsystem (IMS) networks,
- CDMA subscriber identity module (CSIM) including CAVE algorithm.

To grant mobile network operators (MNO) the best solution for UICC-centric services either owned by the MNO or by third parties, the **ST4SIM-111M** complies with GlobalPlatform® card specification v2.3 (depending on UICC configuration) and related amendments.

### 4.2 Algorithms and cryptography

The **ST4SIM-111M** supports the following standard authentication algorithms:

- CAVE
- MILENAGE
- TUAK

The MILENAGE algorithm enables authorized access to UMTS/LTE networks with an easy and flexible parameter customization, according to specific MNO requirements.

The TUAK authentication algorithm is supported with both 128-bit key length and 256-bit key length.

In addition to these algorithms, the **ST4SIM-111M** also supports the "3GPP test algorithm" for test profiles.

In order to increase security performance, the **ST4SIM-111M** also incorporates a ratification counter that limits the number of authentication attempts to prevent brute-force attacks designed to break algorithms. In addition, all algorithms support dedicated DPA/SPA attack countermeasures.

Besides standard symmetric cryptography and hashing algorithms (DES, Triple DES, AES, MD5, and so on), the **ST4SIM-111M** provides a cryptographic co-processor with asymmetric cryptography capabilities.

For applications requiring the strongest level of cryptography, the **ST4SIM-111M** supports:

- RSA with a key length of up to 2048 bits
- elliptic curve cryptography (ECC) with a key length of up to 521 bits.

In addition, the **ST4SIM-111M** fully supports the PKCS#15 standard and offers a rule-based access control mechanism such as digital signature/certificates for data/applications requiring a strong level of cryptography.

The security algorithm implementation adheres to the chip security guidelines of the ST33G1M2M to guarantee the best security level (for more information, contact the local STMicroelectronics sales office).

### 4.3 Over the air (OTA) functionality

The **ST4SIM-111M** supports over the air protocol for remote application management (RAM) and remote file management (RFM) compliant with ETSI standard (ETSI TS 102 225 and ETSI TS 102 226 specifications Release 16).

The RAM application is also fully supported by GlobalPlatform v2.3 and the related amendment B (which enables remote applet management and remote file management over HTTP/TLS).

TLS v1.0, 1.1 and 1.2 are available in the **ST4SIM-111M**. In addition, the **ST4SIM-111M** integrates a DNS mechanism allowing the card to request the HTTPS server address from a DNS server.

The **ST4SIM-111M** is able to remotely control the execution of APDU commands over the air, to administrate the card content. It also allows proactive commands to interact with the host device.

The **ST4SIM-111M** supports the secured packet structure and the remote APDU structure for (U)SIM toolkit applications, conforming 3GPP TS 31.115 and TS 31.116 specifications.

The CAT-TP protocol defined by ETSI release 7 is supported.

As it is compliant with the ETSI, 3GPP and 3GPP2, the **ST4SIM-111M** can easily be integrated into any OTA platform compliant with relevant standards. STMicroelectronics cards are field-proven to be interoperable with the mainstream OTA platforms commonly chosen by mobile network operators.

## 4.4 Memory management

The OTA mechanism includes the support of administrative commands as specified by ETSI TS 102 222. These commands are integrated by a powerful dynamic memory management that allows complete smart memory defragmentation.

Dynamic memory management provides:

- Common space for files, packages, applets and objects
- Memory recovery on deletion operations
- Total free memory available in the select MF response.

The OTA mechanism is designed to allow a very fast and silent memory recovery, absolutely safe for the end user data.

The **ST4SIM-111M** is capable of enhancing intrinsic flash memory cells for files requiring intense update and high reliability.

Memory quota mechanism based on the GlobalPlatform Amendment C (CGM) is supported. The mechanism can be disabled at card configuration.

## 5 Electrical characteristics

This section summarizes the operating and measurement conditions, and the DC and AC characteristics of the device. The parameters in the DC and AC characteristics tables that follow are derived from tests performed under the measurement conditions summarized in the relevant tables.

The users must check that the operating conditions in their circuit match the measurement conditions when relying on the quoted parameters.

### 5.1 Absolute maximum ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply voltage	−0.3 to 6.5	V
$V_{IO}$	Input or output voltage relative to ground	−0.3 to $V_{CC} + 0.3$	V
$T_A$	Ambient operating temperature	−40 to +105	°C
$T_{STG}$	Storage temperature (Please refer to package specification)	−65 to +150	°C
$T_{LEAD}$	Lead temperature during soldering	See <sup>(1)</sup>	°C
$V_{ESD}$	Electrostatic discharge voltage according to JESD22-A114, Human Body Model	4000	V

1. Compliant with JEDEC standard J-STD-020D (for small-body, Sn-Pb or Pb-free assembly), the ST ECOPACK® 7191395 specification, and the European directive on Restrictions on Hazardous Substances (RoHS directive 2011/65/EU of July 2011).

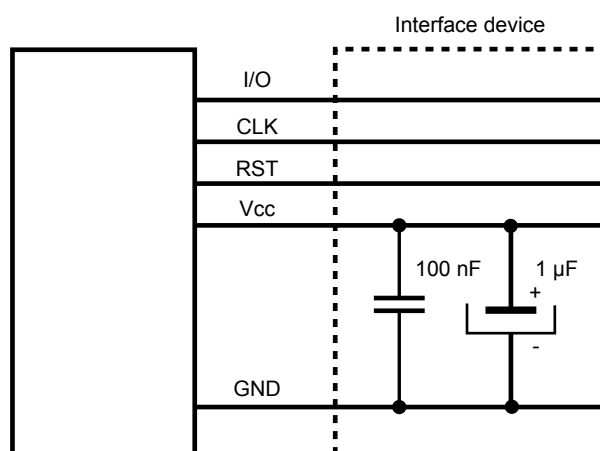
**Note:** Stresses listed above may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specification is not implied.

Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### 5.2 Recommended power supply filtering

The power supply of the circuit must be filtered using the circuit shown in the following figure.

**Figure 3. Recommended filtering capacitors on  $V_{CC}$**





**Table 2. Maximum  $V_{CC}$  rising slope**

Symbol	Parameter	Value	Unit
$S_{VCC}$	Maximum $V_{CC}$ rising slope	5	V / $\mu$ s

### 5.3

#### AC and DC characteristics

These characteristics are compliant with ETSI TS 102 671 release 16.

## 6 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](http://www.st.com). ECOPACK is an ST trademark.

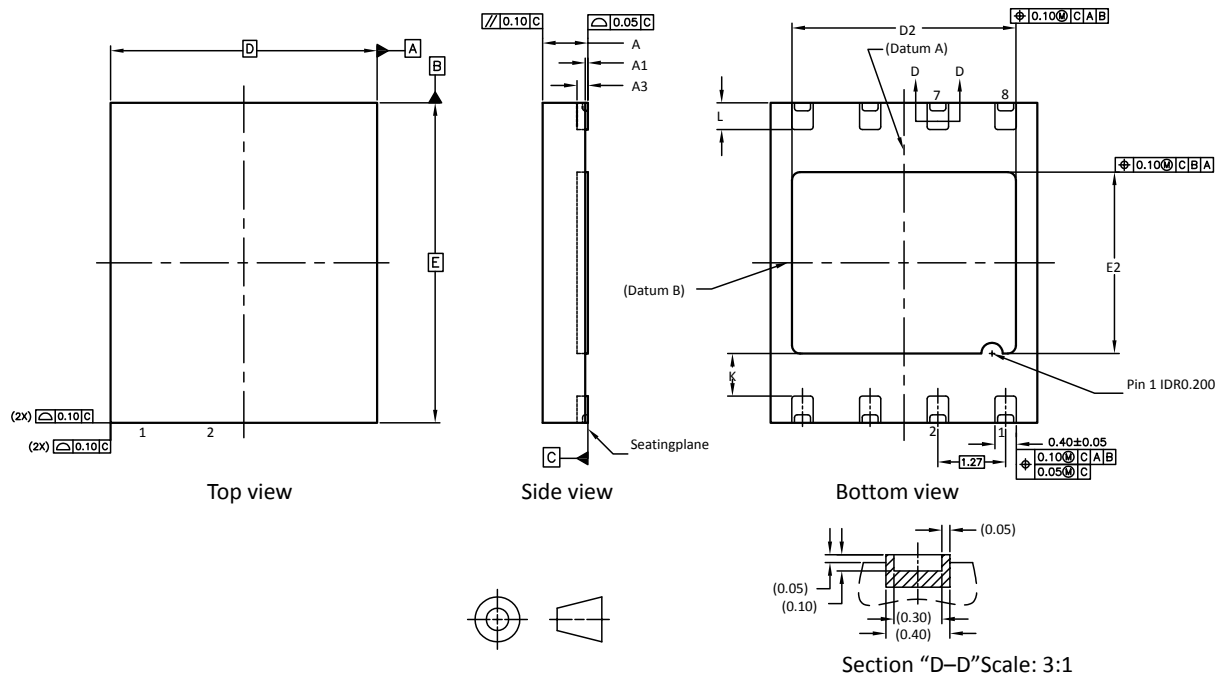
### 6.1 VFDFPN8 package information

VFDFPN8 is a "very thin fine pitch dual flat no lead package" with wettable flanks, dimensions  $5 \times 6$  mm and 1.27 mm pitch.

This package is compliant with JEDEC J-STD-020D and MSL 1 specifications.

It is also compliant with MFF2 (Machine-to-machine form factor 2) ETSI specifications (M2M UICC - TS102.671).

**Figure 4. VFDFPN8 - outline**



*Note:* Drawing is not to scale.

**Table 3. VFDFPN8 - mechanical data**

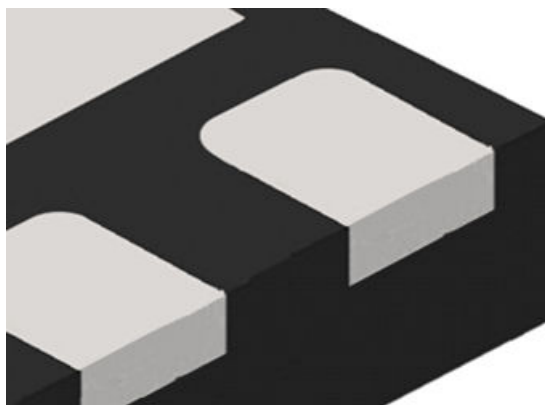
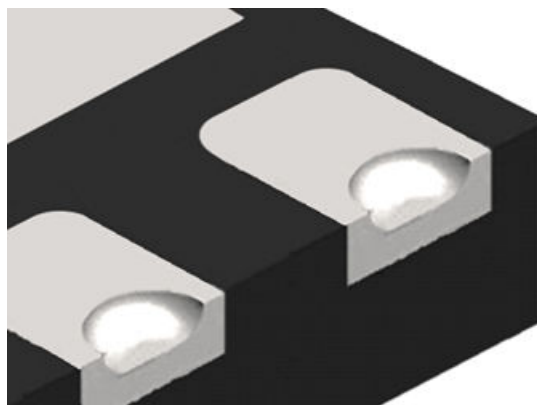
Symbol	Millimeters			Inches <sup>(1)</sup>		
	Min	Typ	Max	Min	Typ	Max
A	0.700	0.850	1.000	0.0276	0.0335	0.0393
A1	0	0.020	0.050	0	0.0008	0.0012
A3	-	0.200	-	-	0.0079	-
b	0.350	0.400	0.480	0.0138	0.0157	0.0189
D	-	5.000	-	-	0.1969	-
E	-	6.000	-	-	0.2362	-
e	-	1.270	-	-	0.0500	-
L	0.400	0.500	0.600	0.0157	0.0197	0.0236
D2	4.100	4.200	4.300	0.1614	0.1654	0.1693
E2	3.300	3.400	3.500	0.1299	0.1339	0.1378

1. The dimensions are converted from mm and rounded to 4 decimal digits.

### 6.1.1

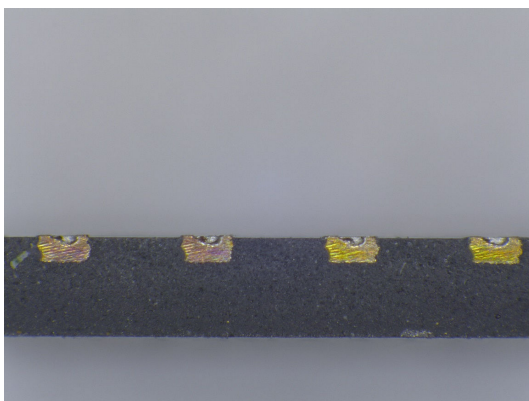
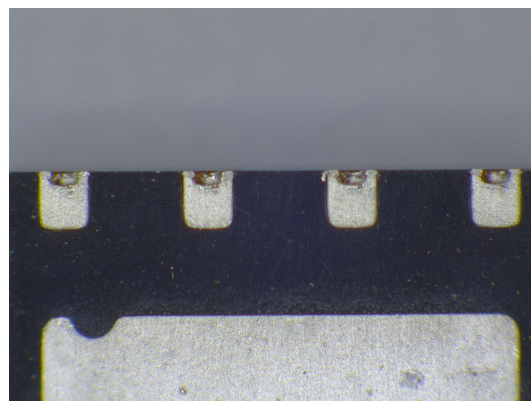
#### Wettable flank for manufacture of inspectable solder joint

Traditional lead free packages tend be critical components in high reliability application, due to inspection issues of the solder joint between the leads and the PCB pads.

**Figure 5. Regular DFN (non-wettable flank)**

**Figure 6. DFN wettable flank**


VFDFPN8 package is constructed with "WETTABLE" flanks, a "dimpled" pad formed during the half-etching step of the lead frame manufacturing process.

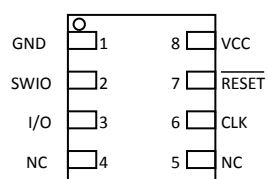
The wettable flank feature, in conjunction with an optimized board mount process, promotes formation of solder joints which can be easily inspected. The presence of a solder fillet improves the inspection capability of the solder joints by automated optical inspection.

**Figure 7. Solder joint side view**

**Figure 8. Solder joint top view**


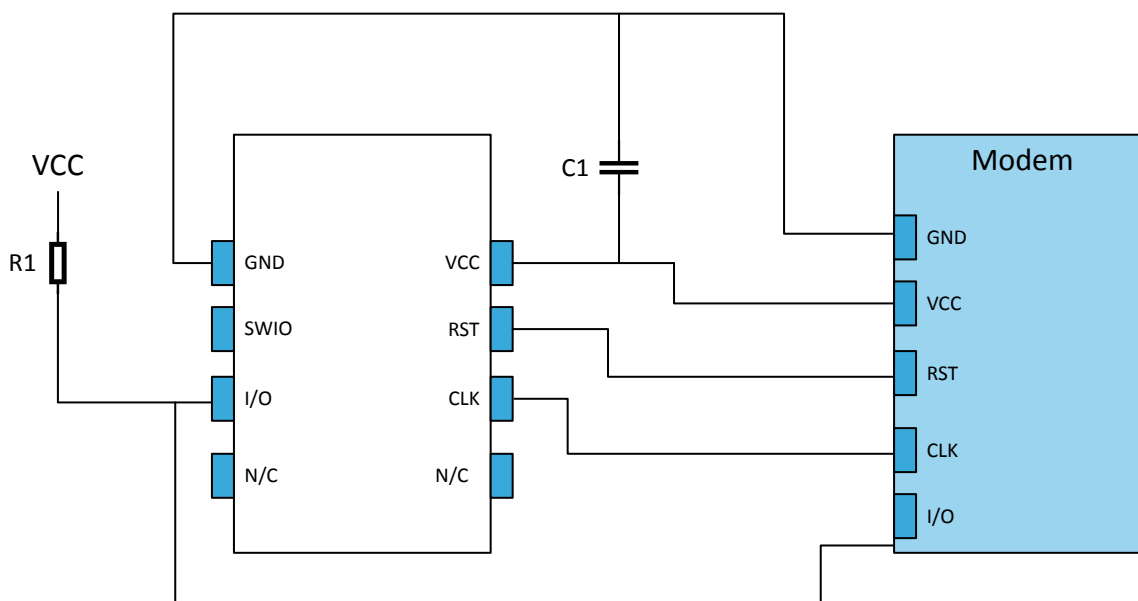
This package is compliant with machine to machine form factor defined by ETSI in TS 102 671.

### 6.1.2 Pinout information

This package is compatible with the MFF2 package defined by ETSI 102 671 release 12. The pinout details are described in the following figure and table together with PCB integrations recommendations in [Figure 10](#).

**Figure 9. VFDFPN8 pinout (top view)**

**Table 4. Pin descriptions**

Name	Description	Pin state
GND	Ground supply	-
SWIO	Not used	Input pull-up
RESET	External reset	Input pull-down
I/O	Input/output	Pull-down then pull-up after card activation
CLK	External clock	Pull-down
VCC	Power supply	-
NC	Not connected internally	-

**Figure 10. ST4SIM-111M PCB integration recommendations**


**Note:** C1 decoupling capacitors as recommended in [Figure 3](#). Recommended filtering capacitors on VCC.  
 R1: 20 kΩ external pull-up recommended on I/O.

### 6.1.3 Tape and reel packing

Surface-mount packages is available in tape and reel packing . The reels have a 13" nominal diameter and contain 4000 devices each.

Reels are in, either antistatic or conductive, plastic with a black conductive cavity tape. The cover tape is transparent antistatic or conductive.

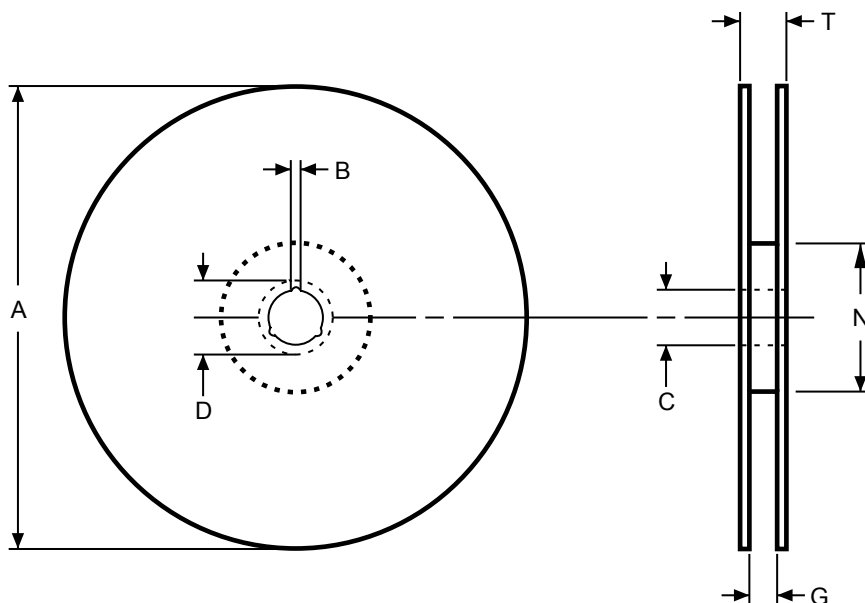
The devices are positioned in the cavities with the identifying pin (normally Pin "1") on the same side as the sprocket holes in the tape.

The STMicroelectronics Tape & Reel specifications are compliant to the EIA 481-A standard specification.

**Table 5. Packing on tape and reel**

Package	Description	Tape width	Tape pitch	Reel diameter	Quantity per reel
VFDFPN8 5 x 6	Flat package, no lead 5 x 6 mm.	12 mm	8 mm	13 in.	4000

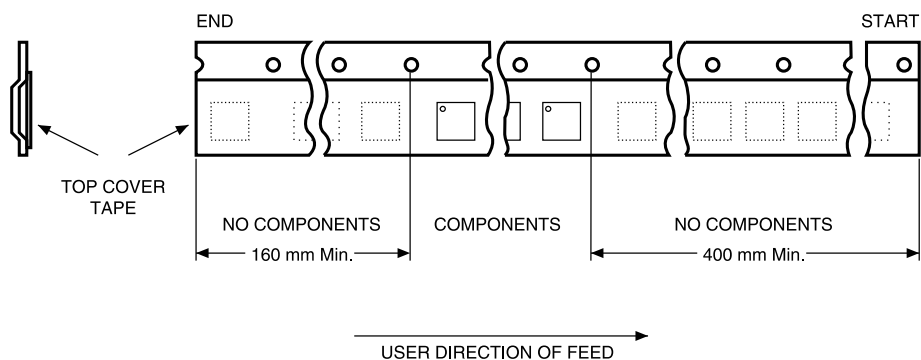
**Figure 11. 13 " reel diagram**



**Table 6. 13" reel dimensions**

Reel size	Tape size	A max	B min	C	D min	G max	N min	T max	Unit
13"	12 mm	330	1,5	13 ±0.25	20.2	12.6	100	18.4	mm

**Figure 12. Leader and trailer**



1. Cumulative tolerance of 10 sprocket hole pitch =  $\pm 0.20$  mm.
2. Pocket position relative to sprocket hole is measured as the true position of the pocket, not the pocket hole.
3. A0 and B0 are calculated on a plane at a distance "R" above the bottom of the pocket.
4. Unless otherwise specified, all dimensions are in millimeters, and decimal values of the form x.x are with  $\pm 0.2$  tolerance whereas values of the form x.xx are with  $\pm 0.10$  tolerance.
5. Drawing is not to scale

The diagram illustrates the components of a magnetic tape reel and its frame structure. On the left, a perspective view of a reel shows the tape wound around a central hub. Labels point to the 'Reel label' (a white rectangular area on the tape), the 'Top cover tape' (the outermost layer of tape), and the 'Carrier tape' (the tape wound around the hub). On the right, a top-down view of the tape frame shows the tape path between four reels. The frame is labeled with '#4000' at the top left and '#0001' at the top right, with an arrow indicating the direction of tape travel. An 'Index' point is marked on the rightmost reel, indicated by a red circle and an arrow.

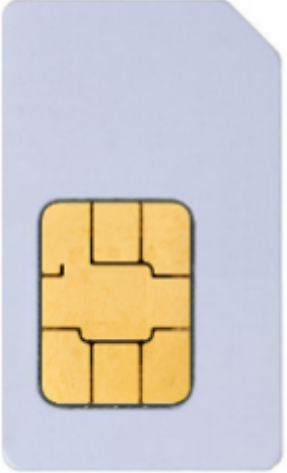

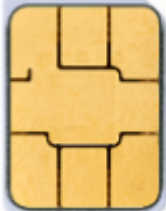
## 6.2 2FF, 3FF or 4FF plugin card package information (based on D16 micromodule)

The **ST4SIM-111M** card is based on flexible plastic chip cards, composed of ABS and Polycarbonate, improving all round resistance in an industrial environment. This card contains a STMicroelectronics industrial grade D16 micromodule.

All elements; card and micromodule, are designed to run at a temperature of -40 °C to +105 °C.

The **ST4SIM-111M** is available for different card plugin packages as detailed in the table below.

**Table 7. SIM plugin package types and dimensions**

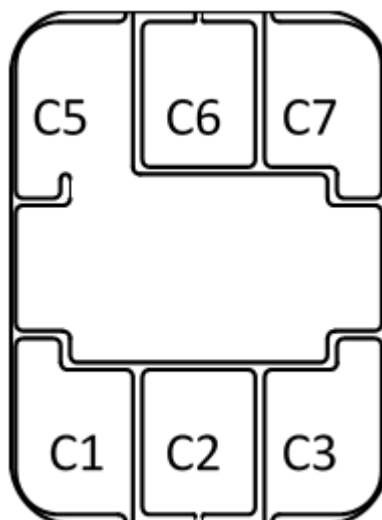
Package	Mini SIM (2FF)	Micro SIM (3FF)	Nano SIM (4FF)
Package format			
Height	25 mm (±0.1 mm)	15 mm (±0.1 mm)	12.3 mm (±0.1 mm)
Width	15 mm (±0.1 mm)	12 mm (±0.1 mm)	8.8 mm (±0.1 mm)
Thickness	0.76 mm (±0.08 mm)	0.76 mm (±0.08 mm)	0.67 mm (+ 0.03 mm / - 0.07 mm)

*Note:* These formats comply to the ISO/IEC 7810 and ETSI TS 102 221 standards.

### 6.2.1 D16 micromodule pinout information

The contact of D16 micromodule are compliant with ISO/IEC 7816-3 standard. The contact assignment layout is given in the figure below and contact description is in the following table.

**Figure 15. D16 micromodule contact assignment**





**Table 8. D16 contact descriptions**

Name	Contact number	Description
VCC	C1	Power supply
ISO_RST/GPIO5	C2	ISO 7816-3 interface reset
ISO_CLK/GPIO6	C3	ISO 7816-3 interface CLK
Reserved for future use	C4	Not used
GND	C5	Ground supply
SWIO	C6	Not used
ISO_IO0/GPIO7	C7	ISO 7816-3 interface serial input/output

### 6.2.2 WLCSP11 package information

For information on the wafer level chip scale package (WLCSP11) pinout, contact the local STMicroelectronics sales office.

## 7 Acronyms

**Table 9. Glossary**

Term	Description
3GPP	3rd Generation Partnership Project
AES	Advanced encryption standard
AID	Application identifier
APDU	Application protocol data unit
ARF	Access rule file
ASN.1	Abstract syntax notation 1
CAT-M	LTE card application toolkit (CAT) M
CAT-TP	Card application toolkit transport protocol
CAVE	Cellular authentication and voice encryption
CDMA	Code division multiple access
CSIM	CDMA subscriber identity module
DES	Data encryption standard
DFN	Dual flat no-lead package
DNS	Domain name server
EAL	Evaluation assurance level
eDRX	Extended discontinuous reception
eSE	Embedded secure element
eSIM	Embedded SIM
ETSI	European Telecommunications Standards Institute
eUICC	Embedded universal integrated circuit card
HTTPS	Secured HTTP
IEC	International electrotechnical commission
IMS	IP multimedia service or IP Multimedia Core Network Subsystem (IMS) is an architectural framework for delivering IP multimedia services
IoT	Internet of things
ISO	International organization for standardization
ISIM	IP multimedia services identity module
JEDEC	Joint electron device engineering council (semiconductor engineering standardization)
LTE	Long-term evolution
M2M	Machine to machine
MD5	The MD5 message-digest algorithm is a widely used hash function producing a 128-bit hash value
MNO	Mobile network operator
NAA	Network access application
NB-IoT	Narrow band Internet of Things
NIST	National Institute of Standards and Technology
OEM	Original equipment manufacturer
OTA	Over the air
PIN	Personal identification number

Term	Description
PKCS	Public key cryptographic standards
PoC	Proof of concept
PUK	PIN unlock key
RAM	Remote application management
RFM	Remote file management
RISC	Reduced instruction set computer
RSA	Ron Rivest, Adi Shamir and Leonard Adleman Public-key cryptosystem
SCP	Secure channel protocol
SE	Secure element
SIM	Subscriber identity module
SMS	Simple message system
TAR	Toolkit application reference
TLS	Transport layer security
UICC	Universal integrated circuit card
UMTS	Universal mobile telecommunications systems
USIM	Universal subscriber identity module

## Revision history

**Table 10. Document revision history**

Date	Version	Change
27-Jun-2023	1	Initial release.

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