

## Tiny Dual-Band GNSS Low Power and Measurement Engine modules



LCC-18  
(9.7 x 10.1 mm)

### Features

- Simultaneous multiconstellation and multi band GNSS (GPS/Galileo/Glonass/BeiDou/QZSS)
- IRNSS constellation ready (Teseo-LIV4F only)
- -162 dBm tracking sensitivity
- Submeter Positioning Accuracy
- Embedded Flash
- Firmware upgrade
- Free firmware configuration
- VCC/VBAT supply voltage range: 3.0 V to 3.63 V
- Tiny LCC-18 pin package (9.7 x 10.1 mm)
- Operating temperature (-40 °C ÷ 85 °C)
- 10 µA standby current consumption and 48.8 mA GNSS L1&L5 tracking current consumption
- GNSS Raw measurement data (Carrier phase data on Teseo-LIV4FM only)

### Description

The **Teseo-LIV4F** and **Teseo-LIV4FM** modules are an easy-to-use Global Navigation Satellite System (GNSS) standalone low power module, embedding Teseo IV single die GNSS receiver IC working simultaneously on multiple constellations GPS/Galileo/Glonass/BeiDou/QZSS) able to provide positioning (Teseo-LIV4F) or raw measurement data (Teseo-LIV4FM).

The Teseo-LIV4Fx modules bring the proven accuracy and robustness of Teseo IV multi bands chips to the reach of everyone: the embedded firmware and the complete evaluation environment save development time, while the compactness and cost-effectiveness of this solution make it ideal for several applications, such as insurance, goods tracking, drones, tolling, anti-theft systems, people and pet location, vehicle tracking, emergency calls, fleet management, vehicle sharing, diagnostics and public transportation.

Within its 9.7 x 10.1 mm tiny size, Teseo-LIV4Fx is offering superior accuracy thanks to the on-board Temperature Compensated Crystal Oscillator (TCXO) and a reduced Time To First Fix (TTFF) relying to its dedicated Real Time Clock (RTC) oscillator.

Teseo-LIV4Fx provides also the Real-Time Assisted GNSS able to predict satellite data based on previous observation of satellite.

Teseo-LIV4F module is a CE certified.

Teseo-LIV4Fx optimizes the time to market of the final applications with a temperature operating range from -40 °C to 85 °C.

#### Product status link

[Teseo-LIV4F, Teseo-LIV4FM](#)

#### Product summary

<b>Order code</b>	Teseo-LIV4F Teseo-LIV4FM
<b>Marking</b>	Teseo-LIV4F Teseo-LIV4FM
<b>Temperature range</b>	-40 °C ÷ 85 °C
<b>Package</b>	LCC-18 (9.7 x 10.1 mm)
<b>Packing</b>	Tape and Reel

## 1 Overview

### 1.1 GNSS performance

Receiver specification:

- GPS/QZSS L1C/A (1575.42 MHz), L5C (1176.45 MHz)
- GLONASS L1OF (1592.9525 ÷ 1610.485 MHz)
- BeiDou B1i (1561.098 MHz), B2a (1207.14 MHz)
- Galileo E1 (1575.42 MHz), E5a (1176.45 MHz)
- SBAS L1C/A

**Table 1. GNSS performance**

Parameter	Specification	GNSS	GPS&BD	Unit
Time To First Fix <sup>(1)</sup>	Cold start	28.5	28.5	s
	Warm start	20.0	21.0	
	Hot start	1.5	1.44	
Sensitivity <sup>(2)</sup>	Tracking <sup>(3)</sup>	-162	-162	dBm
	Cold start	-148	-148	
Max fix rate	-	10	10	Hz
Horizontal position accuracy <sup>(4)</sup>	-	0.8	0.7	m
Accuracy of time pulse	99%	20		ns
Frequency of time pulse	1	1	1	Hz
Operational ITAR limits <sup>(5)</sup>	Altitude	18000	18000	m
	Velocity	515	515	m/s

1. All satellites at -130 dBm - TTFF at 50%.

2. For BEIDOU tracking sensitivity refers to MEO sats. For GEO the tracking sensitivity is -151 dBm.

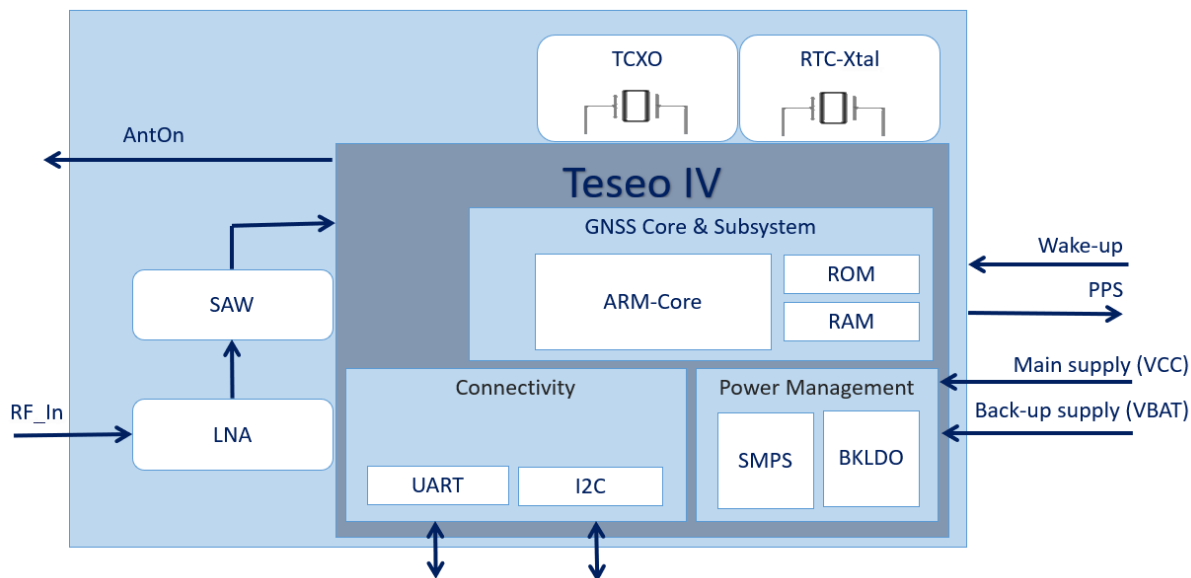
3. With external LNA.

4. CEP 50%, 24h static, Roof Antenna.

5. To be compliant with USA International Traffic in Arms Regulations (ITAR), when both the ITAR altitude limit and the ITAR velocity limit are overpass taken the Teseo-LIV4F stops providing NMEA stream.

## 1.2 Block diagram

Figure 1. Module block schematic



## 1.3 Pin configuration

Figure 2. Teseo-LIV4Fx module pins layout

10	GND_RF	Teseo-LIV4Fx	nRESET	9
11	RF_IN		VCC	8
12	GND_RF		Reserved	7
13	Reserved		VBAT	6
14	VCC_RF		WakeUP	5
15	Reserved		PPS	4
16	I2C_SDA		UART-RX	3
17	I2C_SCL		UART-TX	2
18	PRG		GND	1

## 1.4 Pin out description

Table 2. Module pin out description

Pin #	Name	I/O	Description
1	GND	Ground	Ground
2	UART-TX	O	Serial Port Tx (if not used, must be left floating)
3	UART-RX	I	Serial Port Rx
4	PPS	O	Time pulse (PPS) (if not used, must be left floating)
5	WakeUp	I	External Interrupt Pin (if not used, must be left floating)
6	VBAT	I	Backup voltage supply
7	Reserved	-	Reserved
8	VCC	I	Main voltage supply
9	nReset	I	nReset (if not used, must be left floating)
10	GND_RF	Ground	Ground
11	RF_IN	I	RF Input signal VCC voltage is available on the pin
12	GND_RF	Ground	Ground
13	Reserved	-	Reserved
14	VCC_RF	O	External Antenna Supply (voltage equals to VCC, pin 8)
15	Reserved	-	Reserved
16	I2C_SDA	I/O	I <sup>2</sup> C Data (if not used, must be left floating)
17	I2C_SCL	I/O	I <sup>2</sup> C Clock (if not used, must be left floating)
18	PRG	I	Program or WakeUp from DeepStandby

## 2 Supported GNSS constellation

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The embedded firmware supports all the GNSS constellations: GPS, GLONASS, GALILEO, BEIDOU and QZSS (ready for IRNSS). The user can select what the application needs by firmware configuration.

### 2.1 GPS

The Teseo-LIV4Fx GNSS module can receive and process the L1C/A and L5C signals provided by the Global Positioning System (GPS).

### 2.2 GLONASS

The Teseo-LIV4Fx module can receive and process the GLONASS L1OF signal.

### 2.3 BeiDou

The Teseo-LIV4Fx modules can receive and process BeiDou B1I and B2a signals.

### 2.4 Galileo

The Teseo-LIV4Fx can receive and process Galileo E1 and E5 signals.

### 2.5 IRNSS

The Teseo-LIV4Fx is ready for IRNSS using a dedicated firmware.

## 3 Augmentation systems

### 3.1 Satellite\_Based augmentation system

Teseo-LIV4Fx supports SBAS. SBAS is a Wide Area Differential GPS (WADGPS). It is a system which provides differential GPS corrections data; SBAS includes the WAAS within the United States, the EGNOS within Europe, the Multifunctional Transport Satellite (MTSAT)-based MSAS within Japan and Southeast Asia, and the GPS and GEO Augmented Navigation (GAGAN) system in India.

The SBAS data correction is used in the GNSS algorithm to provide a better position estimation. The overall SBAS differential correction mechanism can be conceived as built in 2 phases:

- The “Acquire and Tracking” phase.
- The “Decoding” phase.

The “Acquire and Track” phase relates to the capacity of the acquisition engine to reliably track the configured SBAS satellite; during decoding phase the SBAS message can be decoded to fetch the differential corrections.

The current longitude limits for each service are:

- WAAS -180 degrees to -25 degrees
- EGNOS -25 degrees to +50 degrees
- GAGAN +50 degrees to +100 degrees
- MSAS +100 degrees to +180 degrees

The Teseo-LIV4Fx software with SBAS capability implements a command interface at the NMEA level to allow interaction with the SBAS library. It supports commands to enable/disable the SBAS functionality.

### 3.2 QZSS

The Quasi-Zenith Satellite System (QZSS) is a Japanese regional communication services and positioning information for the mobile environment in the GPS L1C/A band. QZSS in conjunction with GPS signals provides GNSS augmentation service for the Pacific region covering Japan and Australia. QZSS satellites are placed in a periodic Highly Elliptical Orbit (HEO): these orbits allow the satellites to “dwell” for more than 12 hours a day at an elevation above 70° (it means that they appear almost overhead most of the time).

### 3.3 Differential GPS

Teseo-LIV4Fx supports differential GPS data according to RTCM v3 (radio technical commission for maritime services).

Teseo-LIV4Fx supports the RTCM input command RTCM SC-104 and the RTCM input commands in Table 3.

Teseo-LIV4FM supports the RTCM output message in the Table 3.

**Table 3. Differential GPS**

Message type	Description
1005	Stationary RTK Reference Station ARP
1006	Stationary RTK Reference Station ARP with Antenna Height
1033	Receiver and Antenna Descriptors
1019	GPS Ephemerides
1020	GLONASS Ephemerides
1042	BeiDou Satellite Ephemeris Data
1044	QZSS Ephemerides
1045	Galileo F/NAV Satellite Ephemeris Data
1046	Galileo I/NAV Satellite Ephemeris Data
1074	GPS MSM4
1075	GPS MSM5
1076	GPS MSM6
1077	GPS MSM7
1084	GLONASS MSM4
1085	GLONASS MSM5
1086	GLONASS MSM6
1087	GLONASS MSM7
1094	Galileo MSM4
1095	Galileo MSM5
1096	Galileo MSM6
1097	Galileo MSM7
1114	QZSS MSM4
1115	QZSS MSM5
1116	QZSS MSM6
1117	QZSS MSM7
1124	BeiDou MSM4
1125	BeiDou MSM5
1126	BeiDou MSM6
1127	BeiDou MSM7

## 4 Assisted GNSS

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GNSS receivers need accurate satellite position data from at least 4 satellites to produce a fix. Accurate satellite data, ephemeris data, is valid for several hours based on the active constellations. After that time, a receiver must download new ephemeris data. Ephemeris download can take from dozens of seconds to several minutes, hours or can fail to download. Assisted-GNSS is a mechanism to provide ephemeris assistance from external source; this reduces considerably the time to get fix especially in critical environments when the ephemeris download time could be very long. Teseo-LIV4Fx supports one types of Assisted GNSS: Real Time Assisted GNSS.

### 4.1 Real-Time Assisted GNSS

Real-Time Assisted GNSS (RT-AGNSS) solution is a server based Assisted GNSS. It requires a network connection to download assistance data from the server.

RT-AGNSS works downloading by an assistance server the real time ephemeris data. Server access is allowed thanks to internal keyword provided by Teseo-LIV4Fx to the Host processor and the acquired real-time data have to be provided to Teseo-LIV4Fx.

Proprietary NMEA commands are supported on Teseo-LIV4Fx to acquire the credential access to the external server and to inject the data to Teseo-LIV4Fx.

STMicroelectronics partner provides available server solution access on Teseo-LIV4Fx solution.

Real-Time A-GNSS allows continuous real-time satellite position determination.



## 5 Clock generation

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### 5.1 Temperature-Compensated Crystal Oscillator (TCXO)

Highly stable oscillator controls the down conversion process in RF block of the Teseo-LIV4Fx. Characteristics of this component are important factors for higher sensitivity to maximize performances especially in weak-signal environments, as well as to minimize the Time To First Fix (TTFF) and better navigation stability.

### 5.2 Real Time Clock (RTC)

This is an always-on power domain dedicated to RTC logic (backup system) and supplied with a dedicated voltage regulator.

The RTC provides a high-resolution clock. It keeps the time when the system is inactive and it is internally used to wake up the system when in low power mode. It has a clock trimming feature to compensate for the accuracy of the crystal and a secured time update.

## 6 I/O interfaces

Teseo-LIV4Fx supports the following I/O interfaces:

- UART port
- I<sup>2</sup>C port

NMEA protocol is supported on both UART and I<sup>2</sup>C ports.

### 6.1 UART

The Universal Asynchronous Receiver/Transmitter (UART) supports much of the functionality of the industry-standard 16C650 UART.

The UART performs serial-to-parallel conversion on data asynchronously received from a peripheral device on UART-RX pin, and parallel-to-serial conversion on data written by CPU for transmission on UART-TX pin. The transmit and receive paths are buffered with internal FIFO memories allowing up to 64 data bytes for transmission, and 64 data bytes with 4-bit status (break, frame, parity, and overrun) for receive.

### 6.2 I<sup>2</sup>C

Teseo-LIV4Fx includes a slave I<sup>2</sup>C interface configurable.

Unlike all other interfaces, I<sup>2</sup>C is not able to communicate in full-duplex mode; it uses only two bidirectional open-drain lines, Serial Data Line on pin I2C\_SDA and Serial Clock Line on pin I2C\_SCL, pulled up with resistors.

Teseo-LIV4Fx receiver always acts as slave and it cannot initiate data transmission on the bus; host must periodically poll the receiver to check about data availability.

The main features are:

- Normal speed (100 kHz) and Fast speed (400 kHz) supported.
- I<sup>2</sup>C-slave address configurable using the firmware configurator.

## 7 Antenna voltage supply (VCC\_RF, pin 14)

Teseo-LIV4Fx has built-in LNA and SAW. It is recommended to use an active antenna with gain less than 36 dB and the noise figure less than 1.5 dB.

Teseo-LIV4Fx has built-in short circuit detection and open circuit detection function, which can detect the status of normal connection, and send out antenna status prompt message in NMEA data:

- Short circuit protection: once an overcurrent is detected at the VCC\_RF pin (pin 14), the module will cut off this power supply automatically to prevent permanent damages.
- Open circuit detection: Teseo-LIV4Fx can detect an open circuit in the antenna.

Table 4 reports the antenna status threshold.

**Table 4. Antenna Status current threshold**

Antenna Status	Status Output	VCC_RF on current range
Open circuit	OPEN	$0 < VCC\_RF \leq 1 \text{ mA}$
Regular circuit or open circuit	OK or OPEN	$1 \text{ mA} < VCC\_RF \leq 2 \text{ mA}$
Regular circuit	OK	$2 \text{ mA} < VCC\_RF \leq 40 \text{ mA} \pm 5 \text{ mA}$
Short circuit	SHORT	$40 \text{ mA} \pm 5 \text{ mA} < VCC\_RF \leq 55 \text{ mA}$

## **8      Firmware update support**

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The Teseo-LIV4Fx receiver module can be updated with new firmware releases. The latest firmware version is available at [www.st.com](http://www.st.com) and it can be installed on Teseo-LIV4Fx using the available PC Tool Teseo-Suite available at [www.st.com](http://www.st.com).

Detailed information is available on Teseo-LIV4Fx software user manual.

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## 9 Firmware configuration

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All configuration parameters are grouped in a data block. Each field is addressed by a unique ID. The IDs are made by three digits: the most significant one represents the parameter type and the others are used to identify different parameters of the same type.

Default setting of configuration data block is hard coded into the binary image file.

A new configuration can be built using the PC Tool Teseo-Suite, available at [www.st.com](http://www.st.com) or using runtime configuration commands raised by the host.

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## 10 Power mode

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Standby mode is the mode where only low power backup domain is running. It means VBAT (pin 22) must be always maintained.

It allows to have very low current consumption and fast GNSS reacquisition at the end of the standby time due to RTC.

## 11 Regulatory compliance

The Teseo-LIV4F module has been certified according to the following standards:

- Radio Equipment Directive (RED) 2014/53/EU
- EN 62368-1:2020+A11:2020
- ETSI EN 301 489-1 V2.2.3 + ETSI EN 301 489-19 V2.2.0
- ETSI EN 303 413 V1.2.1

The module is provided by CE marking:



The Certificate of Conformity is available/downloadable at the following webpage: [www.st.com](http://www.st.com) at the Teseo-LIV4F page.

For additional information refer to:

STMicroelectronics Via C. Olivetti, 2 Agrate Brianza (MB) 20864 (ITALY)

The Teseo-LIV4F module current production firmware release is:

\$PSTMVER,GNSSLIB\_8.6.x.xx\_ARM\*xx

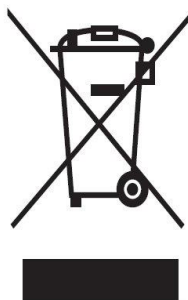
The manufacturer, STMicroelectronics, declares that the Teseo-LIV4F radio equipment complies with the 2014/53/UE directive.

The full text of the EU declaration of conformity is available at the following Internet address:

[www.st.com](http://www.st.com) at the Teseo-LIV4F page.

### 11.1 Approvals

The Teseo-LIV4F module is RoHS and WEEE compliant.



In the countries belonging to the European Union, the Teseo-LIV4F is subject to differentiated recycling at the end of its life cycle.

The Teseo-LIV4F must be disposed as an undifferentiated waste or with other domestic wastes.

The abandonment of this waste in the environment, or in landfills, or in waste-to-energy plants, has as consequence the pollution of soil, air and water, with repercussions on human health.

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## 12 Electrical characteristics

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### 12.1 Parameter conditions

Unless otherwise specified, all voltages are referred to GND.

### 12.2 Minimum and maximum values

Unless otherwise specified the minimum and maximum values are guaranteed in the worst conditions of ambient temperature, supply voltage and frequencies by tests in production on 100% of the devices with an operating ambient temperature at  $T_C = 25\text{ }^{\circ}\text{C}$ .

### 12.3 Typical values

Unless otherwise specified, typical data are based on  $T_C = 25\text{ }^{\circ}\text{C}$ ,  $V_{CC} = 3.3\text{ V}$  and  $V_{BAT} = 3.3\text{ V}$ .

They are given only as design guidelines and are not tested.

Unless otherwise specified, all typical curves are given only as design guidelines and are not tested.



## 12.4 Absolute maximum ratings

This product contains devices to protect the inputs against damage due to high static voltages, however it is advisable to take normal precautions to avoid application of any voltage higher than the specified maximum rated voltages.

**Table 5. Module supply voltage characteristics**

Symbol	Parameter	Min	Typ	Max	Unit
VCC	Digital supply voltage	3.0	3.3	3.63	V
VBAT	Backup input supply voltage	3.0	3.3	3.63	V

**Table 6. Module thermal characteristics**

Symbol	Parameter	Min	Max	Unit
T <sub>oper</sub>	Operative temperature range	-40	85	°C
T <sub>stor</sub>	Storage temperature range	-40	85	°C

**Table 7. Module current consumption**

Symbol	Parameter	Test condition	Typ	Unit
Power consumption	Test condition	GNSS L1 + L5; T <sub>C</sub> = 25 °C; VCC = VBAT = 3.3 V;	48.8	mA
	SW-STANDBY mode	RTC running @ 32.768 kHz; T <sub>C</sub> = 25 °C; VCC = VBAT = 3.3V	10	µA

## 12.5 Recommended DC operating conditions

**Table 8. Recommended DC operating conditions**

Symbol	Parameter	Min	Typ	Max	Unit
VCC	Power supply pins	3.0	3.3	3.63	V
VBAT	Power supply pins for backup internal logic	3.0	3.3	3.63	V

**Table 9. I/O voltage characteristic for nReset and PRG pins**

Parameter	Condition	Min	Typ	Max	Unit
Input high voltage	-	$VBAT \cdot 0.7$	-	VBAT	V
Input low voltage	-	0	-	$VBAT \cdot 0.3$	V
Pull-up resistance	-	18	-	84	k $\Omega$

**Table 10. I/O voltage characteristic for the other pins**

Parameter	Condition	Min	Typ	Max	Unit
Input high voltage	-	$VCC \cdot 0.7$	-	VCC	V
Input low voltage	-	0	-	$VCC \cdot 0.3$	V
Pull-up resistance	-	35	-	84	k $\Omega$
Output high voltage	VCC = 3.3 V	2.64	-		V
Output low voltage	VCC = 3.3 V		-	0.4	V



Temperature fall rate: max 4 °C/s

To avoid falling off, the Teseo module should be placed on the topside of the motherboard during soldering.

## 13.2 Repeated reflow soldering

Only single reflow soldering processes are recommended for boards populated with Teseo modules. To avoid upside down orientation during the second reflow cycle, the Teseo module should not be submitted to two reflow cycles on a board populated with components on both sides. In this case, the Teseo module should always be placed on that side of the board which is submitted into the last reflow cycle.

**Important:** *Repeated reflow soldering processes and soldering the Teseo module upside down are not recommended.*

## 13.3 Rework

The Teseo module can be unsoldered from the baseboard using a hot air gun. When using a hot air gun for unsoldering the module, a maximum of one reflow cycle is allowed. In general, we do not recommend using a hot air gun because this is an uncontrolled process and might damage the module.

**Attention:** *Use of a hot air gun can lead to overheating and severely damage the module. Always avoid overheating the module.*

After the module is removed, clean the pads before placing and hand soldering a new module.

**Important:** *Never attempt a rework on the module itself, for example, replace individual components. Such actions immediately terminate the warranty.*

## 14 Shipping information

Teseo-LIV4Fx is delivered as reeled tapes.

To protect it from physical damage, the reels are individually packed in cartons.

### 14.1 Reels

Teseo-LIV4Fx reel specification is as shown in Figure 4:

Figure 4. Module carrier type specifications

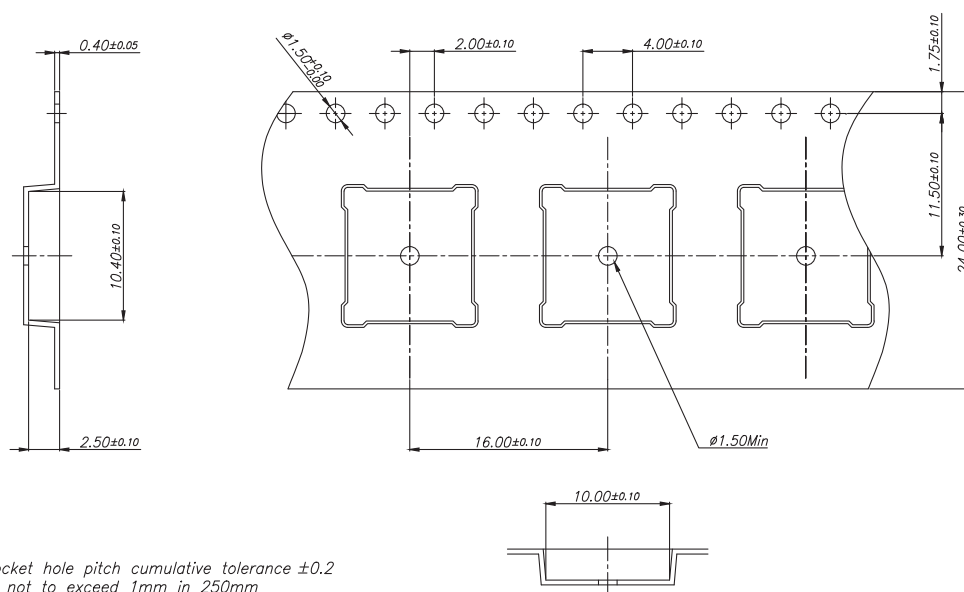


Figure 5. Module orientation specifications

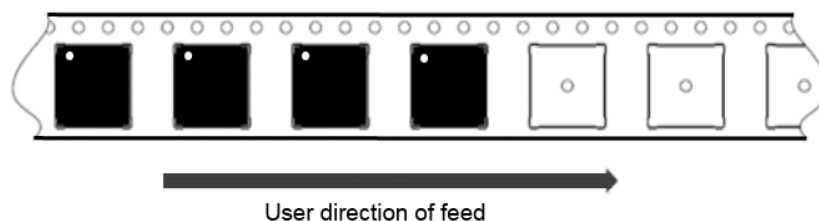


Figure 6. Module cover tape specifications

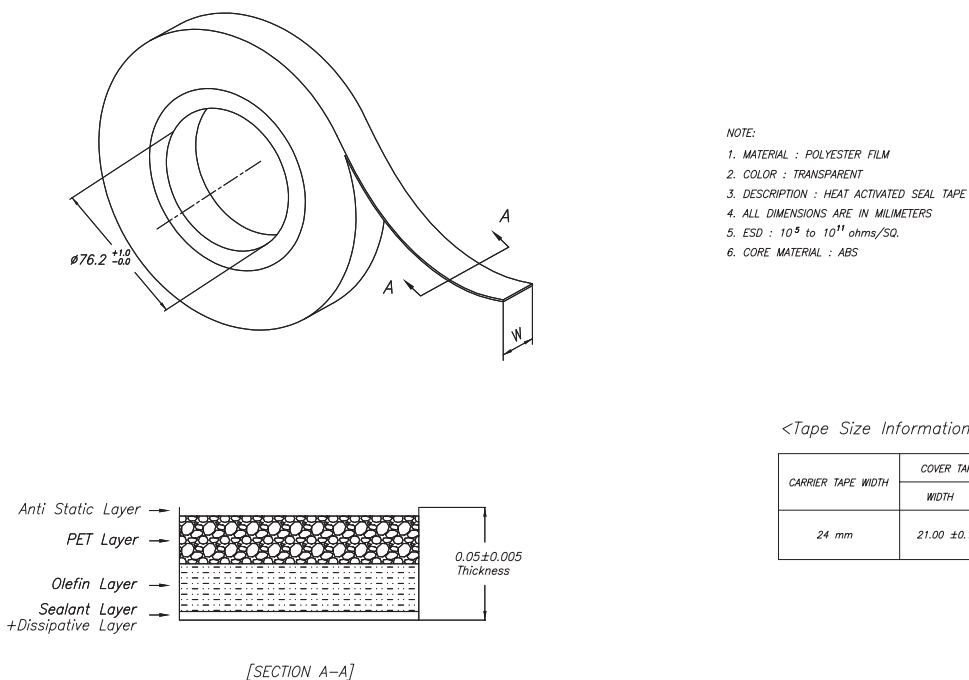


Figure 7. Module plastic reel specifications

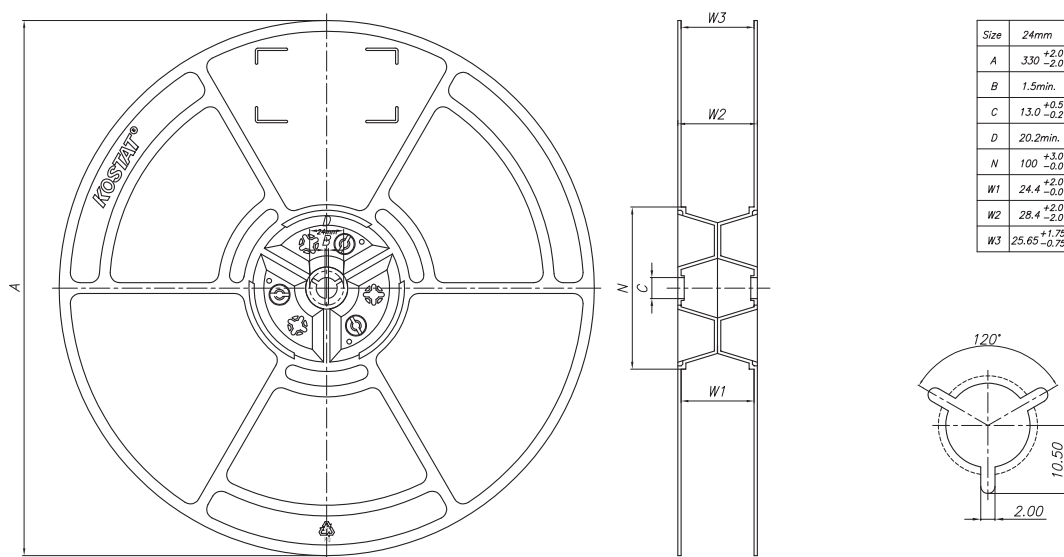
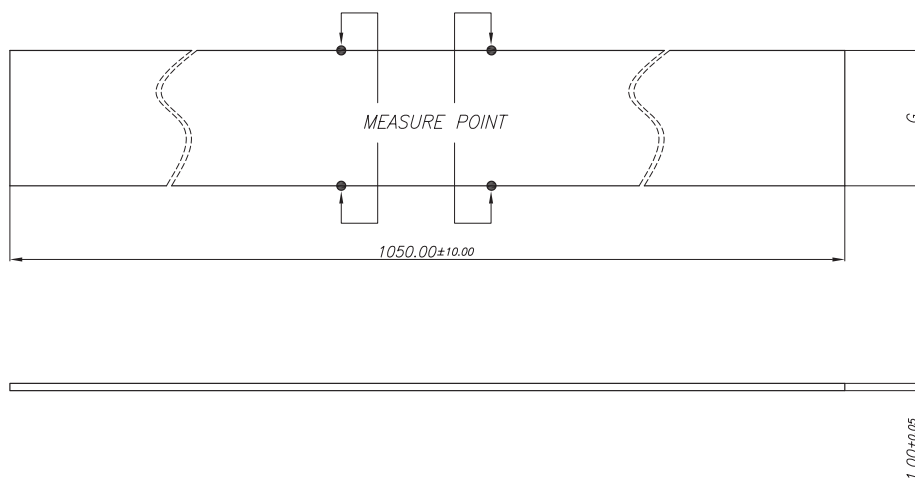


Figure 8. Module PB band specifications



UNIT: mm

WIDTH (mm)	8	12	16	24	32	44	56
G (± 0.10)	8.20	12.20	16.20	24.20	32.20	44.20	56.20

## 14.2 Packing cartons for reels

To avoid damage each Teseo-LIV4Fx reel has a dedicated carton box of 340 x 340 x 38 mm.

## 14.3 ESD handling precautions

Teseo-LIV4Fx module is Electrostatic Sensitive Devices (ESD). Observe precautions for handling! Failure to observe these precautions can result in severe damage to the GNSS receiver.

GNSS receivers are Electrostatic Sensitive Devices (ESD) and require special precautions when handling. Care must be exercised when handling patch antennas, due to the risk of electrostatic charges.

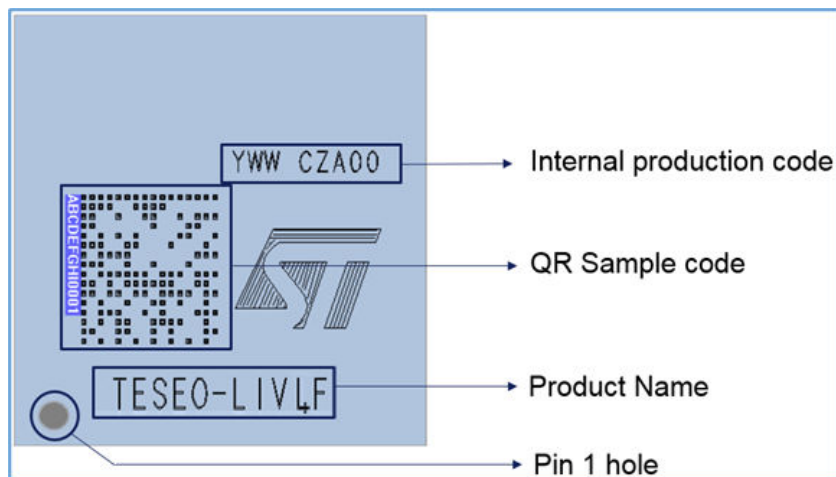
## 14.4 Moisture sensitivity levels

The Moisture Sensitivity Level (MSL) relates to the packaging and handling precautions required. Teseo-LIV4Fx modules are rated at MSL level 3 (three).

## 15 Labelling information

The labelling of Teseo-LIV4Fx reports product information.  
Information layout of the product is shown in Figure 9:

Figure 9. Module labelling information



Information descriptions are reported in the following table:

Table 12. Module labelling information description

Items	Description
Internal production code	Production date (YWW: years-week), lot identifier.
QR Sample code	QR Sample code used for traceability information of any parts.
Product Name	Official product name for Ordering Code.
Pin 1 hole	Hole on the shield to identify Pin 1.

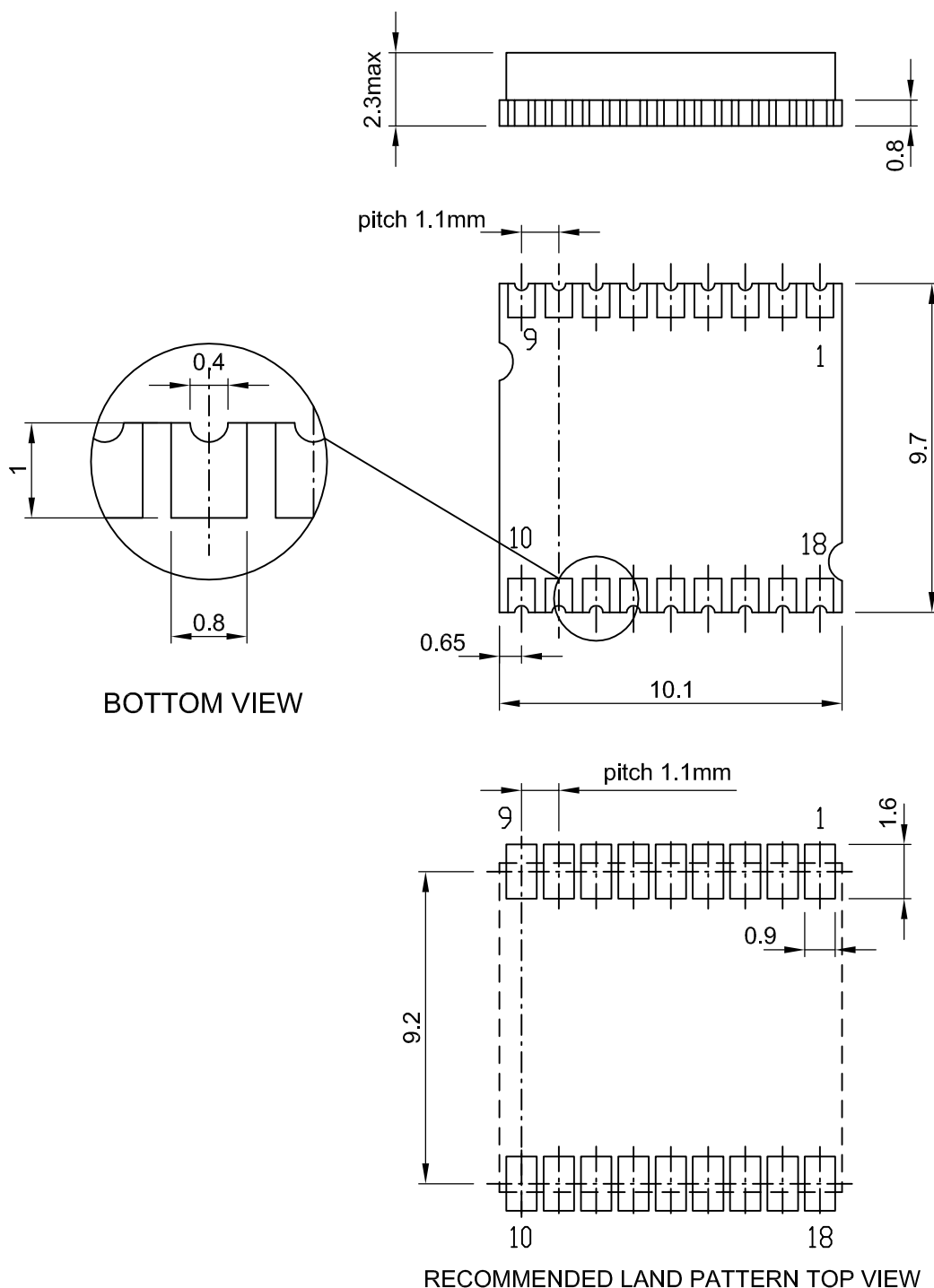


## 16 Package information

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.

### 16.1 LCC-18 (9.7 x 10.1 mm) package information

Figure 10. LCC-18 (9.7 x 10.1 mm) package outline



**Table 13. LCC-18 (9.7 x 10.1 mm) package specifications tolerance**

Linear Measures		Angle Measures	
No decimal	±1 mm	No decimal	±0.10°
.X	±0.2 mm	.X	±0.30°
.XX	±0.1 mm	-	-
.XXX	±0.05 mm	-	-
.XXXX	±0.025 mm	-	-

## Revision history

**Table 14. Document revision history**

Date	Version	Changes
04-Apr-2022	1	Initial release.
20-Mar-2023	2	Updated <i>Table 10. Module soldering profile values</i> .
30-Mar-2023	3	Updated <i>Table 11. Module soldering profile values</i> .
04-Jul-2023	4	Added <i>Section 3.3 Differential GPS</i> .
03-Oct-2023	5	<p>Added:</p> <ul style="list-style-type: none"> <li>• <a href="#">Section 13.1 Cooling phase</a>;</li> <li>• <a href="#">Section 13.2 Repeated reflow soldering</a>;</li> <li>• <a href="#">Section 13.3 Rework</a>.</li> </ul> <p>The device Teseo-LIV4FM has added and the document has been updated accordingly.</p>

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