

Tiny low power GNSS module



Features

- Simultaneous multiconstellation
- -163 dBm tracking sensitivity
- 1.5 m CEP position accuracy
- 16 Mbit embedded Flash for data logging and FW upgrade
- V_{CC}/V_{BAT} supply voltage range from 1.75 V to 4.2 V
- V_{CC_IO} 1.8 V and 3.3 V
- Tiny LCC 18-pin package (9.7 x 10.1 x 2.3 mm)
- Operating temperature (from -40° to 85 °C)
- Free FW configuration
- Measurement data (carrier phase)
- 8 μ A standby current and 65 mW tracking power consumption

Description

The Teseo-LIV3FL module is an easy to use global navigation satellite system (GNSS) standalone module. It embeds the Teseo III single die standalone positioning receiver IC working simultaneously on multiple constellations (GPS/Galileo/Glonass/BeiDou/QZSS).

The Teseo-LIV3FL modules bring the proven accuracy and robustness of the Teseo chips within everyone's reach. The embedded firmware and the complete evaluation environment save development time. The compactness and economy of this solution make it ideal for multiple 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, the Teseo-LIV3FL offers superior accuracy because of the integrate temperature, compensated crystal oscillator (TCXO) and a reduced time to first fix (TTFF) through its dedicated real-time clock (RTC) oscillator.

Thanks to the embedded Flash, the Teseo-LIV3FL offers many extra features such as data logging. Seven days autonomous assisted GNSS, FW reconfigurability as well as FW upgrades.

The Teseo-LIV3FL also provides the autonomous assisted GNSS able to predict satellite data based on previous observation of a satellite.

The Teseo-LIV3FL module is a certified solution. It optimizes the time to market of the final applications with a temperature operating range from -40°C to 85°C.

Product status link

[Teseo-LIV3FL](#)

Product summary

Order code	Teseo-LIV3FL
Marking	Teseo-LIV3FL
Temperature range	from -40°C to 85°C
Package	LCC-18 (9.7 mm x10.1 mm)
Packing	Tape and reel

1 Overview

1.1 GNSS performance

Receiver specification:

- GPS L1C/A
- SBAS L1C/A
- QZSS L1C/A
- GLONASS L1OF
- BeiDou B1
- Galileo E1B/C

Table 1. GNSS performance

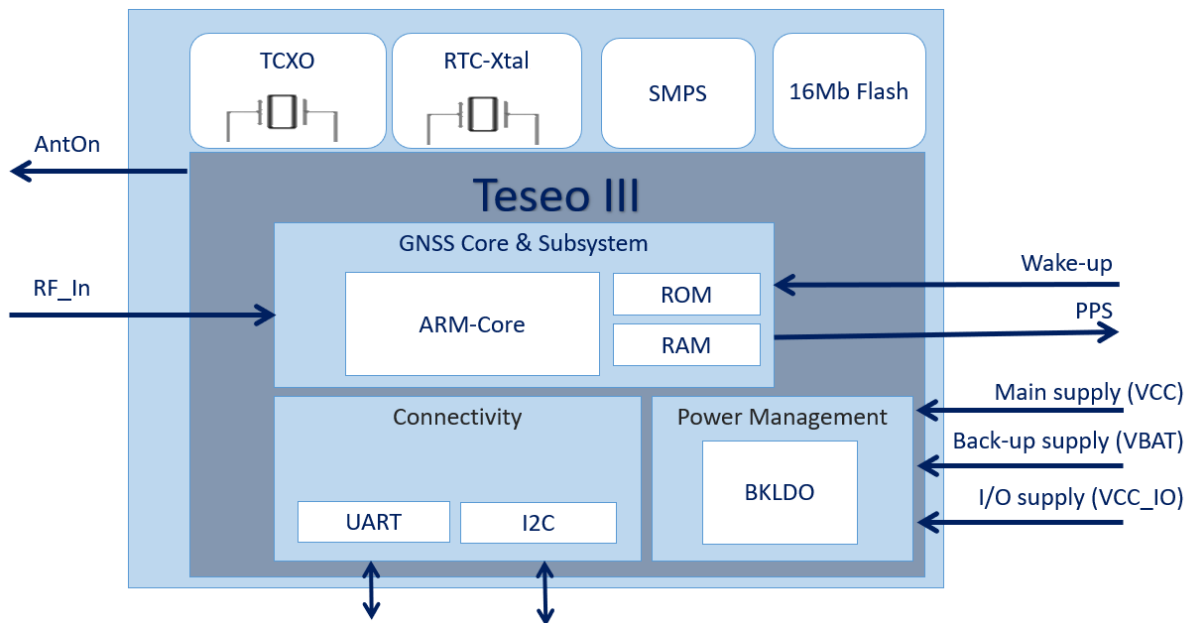
Parameter	Specification	GPS & GLONASS	GPS & BeiDou	GPS & Galileo	Unit
Time to first fix ⁽¹⁾	Cold start warm start	<32 <25	<36 <29	<30 <26	s
	Hot start	<1.5	<2.5	<2	
Sensitivity ⁽²⁾⁽³⁾⁽⁴⁾⁽⁵⁾	Tracking	-163	-163	-163	dBm
	Navigation ⁽⁶⁾	-158	-158	-158	
	Reacquisition ⁽⁷⁾⁽⁸⁾	-156	-156	-156	
	Cold start	-147	-147	-147	
	Warm start	-148	-148	-148	
	Hot start	-154	-151	-154	
Max fix rate	—	10	10	10	Hz
Velocity accuracy ⁽⁹⁾	—	0.01	—	0.01	m/s
Velocity accuracy ⁽¹⁰⁾	—	0.1	—	0.1	m/s
Heading accuracy	—	0.01	—	0.01	°
Heading accuracy	—	2.3	—	2.4	°
Horizontal position accuracy ⁽¹¹⁾	Autonomous	<1.8	<1.5	-	m
	SBAS	<1.5	-	-	
Accuracy of time pulse	RMS	-	-	-	-
	99%	±12.4	±29.0	±21.8	ns
Frequency of time pulse	—	1	1	1	Hz
Operational limits ⁽¹²⁾	Dynamic ⁽¹³⁾	<4.5g	<4g	<4.5g	m/s ²
	Altitude ⁽¹⁴⁾	18000	18000	18000	m
	Velocity	515	515	515	m/s

1. All satellites at -130 dBm- TTFF@50%.
2. Demonstrated with a good external LNA
3. For hot start, all sats have the same signal level except one (pilot sat @-145 dBm)
4. For BEIDOU tracking sensitivity refers to MEO sats. For GEO the tracking sensitivity is -151 dBm .
5. For GALILEO the signal level refers to both pilot and data components
6. Configurable value
7. All satellites at the same signal level

8. Minimum level to get valid fix after reacquisition
9. 50% @ 30 m/s- linear path
10. 50% @0.5 g- shape path
11. CEP 50%, 24h static, roof antenna.
12. Verified the limit checking the fix availability
13. Special configuration for high dynamic scenario
14. ITAR limits

1.2 Block diagram

Figure 1. Teseo-LIV3FL block schematic



1.3 Pin configuration

Figure 2. Teseo-LIV3FL pin layout

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

1.4 Pin out description

Table 2. Teseo-LIV3FL pin out description

No	Name	I/O	Description
1	GND	Ground	Ground
2	TX	O	Serial port Tx (if not used, must be left floating)
3	RX	I	Serial port Rx
4	1PPS	O	Time pulse (1PPS) (if not used, must be left floating)
5	Wake-Up	I	External interrupt pin (if not used, must be left floating)
6	Vbatt	I	Backup voltage supply
7	VCC_IO	I	IO supply voltage
8	VCC	I	Supply voltage
9	nReset	I	RESET_N (if not used, must be left floating)
10	GND_RF	Ground	Ground
11	RF_IN	I	GNSS signal Input
12	GND_RF	Ground	Ground
13	Ant_OFF	O	External antenna control (if not used, must be left floating)
14	VCC_RF	O	Output voltage RF section. (if not used, must be left floating) ⁽¹⁾
15	Reserved	-	Reserved (must be left floating)
16	SDA	I/O	I2C Data (if not used, must be left floating)
17	SCL	I/O	I2C Clock (if not used, must be left floating)
18	Reserved	-	Reserved (must be left floating)

1. Can be used to supply external active antenna

2 Supported GNSS constellations

The embedded FW supports all the GNSS constellations (GPS, GLONASS, GALIELO, BEIDOU and QZSS). The user can select the active constellations in the firmware configuration based the applications needs; by default the active GNSS constellations are GPS and Glonass.

2.1 GPS

The Teseo-LIV3FL GNSS module is designed to receive and to track the L1C/A signals provided at 1575.42 MHz by the global positioning system (GPS). The Teseo-LIV3FL can receive and process GPS concurrently with Galileo and GLONASS or BeiDou (the last two are mutually exclusive).

2.2 GLONASS

The Teseo-LIV3FL module can receive and process GLONASS concurrently with GPS and Galileo. The Russian GLONASS satellite system (ГЛОНАСС; GLObal NAVigation satellite system) is an alternative to US's GPS and EU's Galileo.

2.3 BeiDou

The Teseo-LIV3FL modules can receive and process BeiDou in conjunction with GPS and Galileo. The B1 signals provided at 1561.098 MHz by the BeiDou navigation satellite system can be tracked by Teseo-LIV3FL positioning modules. The ability to receive and track BeiDou B1 satellite signals with GPS results in higher coverage, improved reliability, and better accuracy especially in the difficult urban environment of the significant far east cities like Shanghai, Taipei, Singapore.

2.4 Galileo

The Teseo-LIV3FL can receive and process Galileo concurrently with GPS and GLONASS or BeiDou (the last two are mutually exclusive).

3 Augmentation systems

3.1 Satellite-based augmentation system

The Teseo-LIV3FL 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.

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 two phases:

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

The “Acquire and Track” phase concerns the ability of the acquisition engine to reliably track the SBAS satellite path. During the decoding phase, the SBAS message can be decoded to fetch the differential corrections.

The current longitude limits for each service are:

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

The Teseo-LIV3FL 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 service and positioning information for the mobile environment in the GPS L1C/A band. QZSS with GPS signals provides the 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-LIV3FL supports differential-GPS data according to RTCM (radio technical commission for maritime services) 2.3.

Differential-GPS data improves position accuracy. The Teseo-LIV3FL supports the following RTCM message.

Table 3. Supported RTCM message on Teseo-LIV3FL

Message type	Description
1	Differential GPS corrections
9	GPS partial correction set
31	Differential GLONASS corrections
34	GLONASS partial correction set

4 Assisted GNSS

GNSS receivers need accurate satellite position data from at least four satellites to produce a fix.

Accurate satellite data-ephemeris data- is valid for 4hrs only for GPS and 30 min only for GLONASS.

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-AGPS is a mechanism to provide ephemeris assistance from an external source. This reduces considerably the time to get fix especially in critical environments when the ephemeris download time could be very long.

The Teseo-LIV3FL supports three types of assisted GNSS.

4.1 ST-assisted GPS

ST-assisted GPS[®] (STAGPS) software is able to provide predicted ephemeris to the GNSS engine. It reaches in less time than the normal time (about 30 seconds) needed to download real ephemeris from the sky. This reduces considerably the time to get fix especially in critical environments when the ephemeris download time could be very long.

The autonomous solution STAGPS works by using the real past ephemeris downloaded from the sky. It stores in its internal database to extrapolate the parameter of future ephemeris up to 5 days of forecast. For this reason, the STAGPS[®] autonomous performances (in terms of position accuracy using predicted ephemeris) are strictly dependent on the real ephemeris database content. In normal usage of STAGPS[®] autonomous, the system automatically uploads the real ephemeris into its database as soon as new ephemeris are downloaded from the sky. This means that the global content of the actual ephemeris input database is determined by the history of the device operating in the past periods.

The Teseo-LIV3FL software with STAGPS[®] capability implements a command interface at the NMEA level to allow interaction with the STAGPS[®] library. It supports commands to enable/disable the STAGPS[®] functionality or to upload ephemeris and seed into the STAGPS[®] working memory. Most of the implemented commands could be used for testing the STAGPS[®] performance in different working scenarios.

4.2 Predictive AGNSS

ST-assisted GPS[™] when used in systems with network data access is able to provide full-constellation long-term prediction taking advantage of an assistance server.

This only solution combines the advantage of universal assistance data protocol with lightweight data access. It needs only about 8 KB biweekly data transfers to maintain fast and accurate GPS performance.

From this uploaded payload called "seed", ST-assisted GPS[™] is able to generate satellite orbit forecasts for up to 14 days at the customer for the complete GPS constellation and the GLONASS constellation.

A unique feature of ST-assisted GPS is the dual-mode ability to perform seamless fallback from the 14-days server-based forecast to the 5-days self-sustaining in-field forecast capability depending on usage patterns.

This is very useful to keep the quality of the GNSS experience, if a connected device loses the ability to contact the server due to coverage or roaming problems or any other wireless connectivity problem.

4.3 Real-time AGPS

Real-time assisted GPS (RT-AGPS) solution is a server based assisted GPS, therefore it requires a network connection to download assistance data from the server.

RT-AGPS works downloading the real-time ephemeris data by an assistance server. Access to the server is allowed thanks to the internal password provided by Teseo-LIV3FL to the host processor. The data acquired in real-time must be provided to Teseo-LIV3FL.

Proprietary NMEA commands are supported on Teseo-LIV3FL to acquire the credential access to the external server and to inject the data to the Teseo-LIV3FL.

STMicroelectronics partner provides available server solution access for free on Teseo-LIV3FL solution.

Real-time A-GPS allows continuous /real-time satellite position determination.

5 **Clock generation**

5.1 **Temperature-compensated crystal oscillator (TCXO)**

Highly stable 26 MHz oscillator controls the down conversion process in the RF block of the Teseo-LIV3FL. Characteristics of this component are important factors for higher sensitivity to maximize performances especially in weak-signal environments. They minimize TTFF (time to first fix) and better navigation stability.

5.2 **Real time clock (RTC)**

This is an always-on power domain dedicated to RTC logic (backup system) with 32 kbyte SRAM. It supplied with a dedicated voltage regulator.

The RTC provides a high-resolution clock, which can be used for GPS. 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 32.768 kHz crystal and a secured time update.

6 I/O interfaces

Teseo-LIV3FL supports two I/O interfaces:

- UART
- I2C

Both interfaces support the NMEA protocol.

6.1 UART

The universal asynchronous receiver/transmitter (UART) supports much of the functionality of the industry-standard 16C450 UART.

The UART performs serial-to-parallel conversion on data asynchronously that receives from a peripheral device on an RX0 pin. They do parallel to serial conversion on data written by a CPU for transmission on a TX0 pin.

The transmit and receive paths are buffered with internal FIFO memories that allow up to 64 bytes of data for transmission and 64 bytes of 4-bit status data like interrupt, frame, parity, and overrun, for reception.

6.2 I2C

Teseo-LIV3FL includes a slave I2C interface configurable; I2C is a two-wire communication interface invented by Philips semiconductor.

Unlike all other interfaces, I2C is not able to communicate in full-duplex mode. It uses only two bidirectional open-drain lines, serial data line on pin SDA and serial clock line on pin SCL, pulled up with resistors.

Teseo-LIV3FL receiver always acts as slave. It cannot initiate data transmission on the bus; sometimes the host has to pull the receiver to check availability of the data.

The main features are:

- Normal speed (100 kHz) and fast speed (400 kHz) supported

7 FW update support

The Teseo-LIV3FL receiver module can be updated with new firmware releases. The latest firmware version is available at www.st.com and it can be installed on Teseo-LIV3FL using the available PC tool Teseo-suite. Detailed information is available on the Teseo-LIV3FL software user manual.

8 FW configuration

All configuration parameters are grouped in a data block. Each field is addressed in 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 or using runtime configuration commands raised by the host.

9 Power mode

Standby mode, is the mode where only a low-power backup domain is running. It means that VBAT must be always maintained. It allows to have a very low current consumption and fast GNSS reacquisition at the end of the standby time due to RTC.

Teseo-LIV3FL offers three different ways of standby:

- Hardware standby
- Software standby
- Hardware off standby

9.1 Hardware standby

This standby is ensured by setting nReset (pin 9) to 0 V.

During this standby, only VCC (pin#8), VBAT(pin#6) and VCC_IO(pin#7) are kept ON.

During this standby, mode VCC_RF (pin 14) is ON.

9.2 Software standby

Software standby is activated in the internal binary. Software standby can be:

- Host driven standby: where the host raises an NMEA command to force Teseo-LIV3FL in standby; the host can be woken up Teseo-LIV3FL using the wake-up pin (pin 5);
- Periodic standby: where Teseo-LIV3FL enters and exits from standby using the internal RTC. Periodic fixes are from 5 seconds up to 24 hours between two fixes.

Make sure that VCC_RF is active during this standby. In the case of active antenna or external LNA, it is important to turn them off.

9.3 Hardware off standby

This standby is ensured by switching OFF VCC (pin 8) and VCC_IO (pin#7) supplies and setting nReset (pin#9) to 0 V. It can be activated asynchronously from the GNSS track with a GPIO turning off power from a host.

During this standby, only VBAT (pin#6) is kept ON.

During this standby, mode VCC_RF (pin#14) is OFF.

10 Timing

Teseo-LIV3FL receivers can be used to provide highly accurate time information. The Teseo-LIV3FL timing module includes a specific time mode. It assumes a known antenna position and calculates a time pulse synchronized to either GPS/UTC(USNO)/GLONASS/UTC(SU).

Teseo-LIV3FL provides an accurate one pulse-per-second.

11 Data logging

Data logging allows the Teseo-LIV3FL receiver to locally save the resolved GNSS position on the flash to be retrieved on demand by the host.

Teseo-LIV3FL supports only one datalog at a time.

Data logging can be enabled, disabled, and erased using proprietary NMEA runtime commands.

Data logging subsystem supports both:

- Circular buffer
- Standard buffer

The recorded data is configurable; data logging supports three types of data logged.

Each type has a different size and different data logged. All the data logged types have: time stamp, latitude, and longitude while other fields depend on the type. See for details the following table.

Table 4. Datalog type description

Type	Size	Altitude	Odometer	Geo	Quality	Qual_idx	Fix	Speed
1	12	—	—	X	—	X	X	—
2	16	X	—	X	X	—	X	X
3	20	X	X	X	X	—	X	X

Teseo-LIV3FL can support until 12 hours logging using log-type 1 and fix rate at 1 Hz. Detailed information is available on the Teseo-LIV3FL software user manual.

12 Geofencing

Geofence feature allows the Teseo-LIV3FL receiver to raise an autonomous NMEA message when the resolved GNSS position is close to a specific circle, entering or exiting from a circle.

Teseo-LIV3FL receiver supports at least eight circular areas where four circular areas are configurable in the firmware.

Geofencing alarm can be notified over the proprietary NMEA message.

Geofencing can be configured and enabled in the firmware configurator or using the specific geofencing configuration command.

Detailed information is available on the Teseo-LIV3FL software user manual.

13 Odometer

Teseo-LIV3FL receiver supports the odometer feature.

Odometer provides information on the traveled distance using only positioning information. Odometer can be configured using specific odometer commands during the runtime.

While enabled the odometer reports the ground distance from the last reset.

Odometer is also able to raise an autonomous message alarm when a programmed distance is reached.

Detailed information is available on the Teseo-LIV3FL software user manual.

14 Regulatory compliance

14.1 CE certification for TESEO-LIV3FL

The TESEO-LIV3FL 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 at the Teseo-LIV3FL page.

For additional information refer to:

STMicroelectronics Via C. Olivetti, two Agate Brianza (MB) 20864 (ITALY) The TESEO-LIV3FL module current production firmware release is:

\$PSTMVER,GNSSLIB_8.x.x.xx_ARM*xx

The manufacturer, STMicroelectronics, declares that the Teseo-LIV3FL 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 at the Teseo-LIV3FL page.

14.2 Approvals

The Teseo-LIV3FL module is RoHS and WEEE compliant.



In the countries belonging to the European Union, the Teseo-LIV3FL is subject to differentiated recycling at the end of its life cycle.

The Teseo-LIV3FL has to be disposed as an undifferentiated waste or with other domestic wastes.

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

15 Electrical characteristics

15.1 Parameter conditions

Unless otherwise specified, all voltages are referred to GND.

15.2 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 ambient temperature at $T_c = 25^\circ\text{C}$.

15.3 Typical values

Unless otherwise specified, typical data are based on $T_c = 25^\circ\text{C}$, $V_{CC}=1.8\text{ V}$, $V_{CC_IO}=1.8\text{ V}$ and $V_{BAT}=1.8\text{ V}$.
 Unless otherwise specified, all typical curves are given only as design guidelines and are not tested.

15.4 Absolute maximum ratings

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

Table 5. Supply voltage characteristics when $V_{CC_IO}@1.8\text{ V}$

Symbol	Parameter	Min	Typ	Max	Unit
V_{CC}	Digital supply voltage	1.755	1.8	4.2	V
V_{BAT}	Backup input supply voltage	1.755	1.8	4.2	V
V_{CC_IO}	IO supply voltage	1.755	1.8	1.98	V

Table 6. Supply voltage characteristics when $V_{CC_IO}@3.3\text{ V}$

Symbol	Parameter	Min	Typ	Max	Unit
V_{CC}	Digital supply voltage	3.0	3.3	4.2	V
V_{BAT}	Backup input supply voltage	3.0	3.3	4.2	V
V_{CC_IO}	IO supply voltage	3.0	3.3	3.6	V

Take care that V_{CC_IO} has to be equal to or lower than V_{CC} and V_{BAT} .

Table 7. Thermal characteristics

Symbol	Parameter	Min	Max	Unit
T_{oper}	Operative ambient temperature	-40	85	$^\circ\text{C}$
$T_{storage}$	Storage temperature	-40	85	$^\circ\text{C}$

Table 8. Current consumption

Symbol	Parameter	Test condition	Typ .	Unit
Current consumption	Test condition	GNSS = GPS only;	65	mW

Symbol	Parameter	Test condition	Typ .	Unit
Current consumption	GNSS tracking mode	Tc = 25 °C; V _{CC} = V _{CC_IO} = V _{BAT} = 1.8 V;		
		GNSS = GPS/Glonass; Tc = 25 °C; V _{CC} = V _{CC_IO} = V _{BAT} = 1.8 V	80	mW
		GNSS = GPS/BeiDou; Tc = 25 °C; V _{CC} = V _{CC_IO} = V _{BAT} = 1.8 V	80	mW
		GNSS = GPS only; Tc = 25 °C; V _{CC} = V _{CC_IO} = V _{BAT} = 3.3 V;	95	mW
		GNSS = GPS/Glonass; Tc = 25 °C; V _{CC} = V _{CC_IO} = V _{BAT} = 3.3 V;	120	mW
		GNSS = GPS/BeiDou; Tc = 25 °C; V _{CC} = V _{CC_IO} = V _{BAT} = 3.3 V	115	mW
Current consumption standby	HW-off mode	RTC running = 32.768 KHz; Tc = 25 °C; V _{CC} = V _{CC_IO} = nReset = 0 V V _{BAT} = ON	19 (V _{BAT} = 1.8 V) 17 (V _{BAT} = 3.3 V)	μA
		RTC running = 32.768 KHz; Tc = 25 °C; V _{CC} = V _{CC_IO} = V _{BAT} = 1.8 V; nReset = GND	19.5	μA
	HW-STANDBY mode	RTC running @ 32.768 KHz; Tc = 25 °C; V _{CC} = V _{CC_IO} = V _{BAT} = 3.3 V; nReset = GND	20.5	μA
		RTC running @ 32.768 KHz; Tc = 25 °C; V _{CC} = V _{CC_IO} = V _{BAT} = 1.8 V;	9.5	μA
	SW-STANDBY mode	RTC running @ 32.768 KHz; Tc = 25 °C; V _{CC} = V _{CC_IO} = V _{BAT} = 3.3 V	11	μA

15.5 Recommended DC operating conditions

Recommended DC operating conditions for the lowest power consumption.

Table 9. Recommended DC operating conditions

Symbol	Parameter	Min	Typ	Max	Unit
V _{CC}	Power supply pins	1.755	1.8	1.98	V
V _{CC_Bat}	Power supply pins for backup internal logic	1.755	1.8	1.98	V
V _{CC_IO}	IO Supply Voltage	1.755	1.8	1.98	V

16 Mechanical specifications

Figure 3. Teseo-LIV3FL mechanical specification

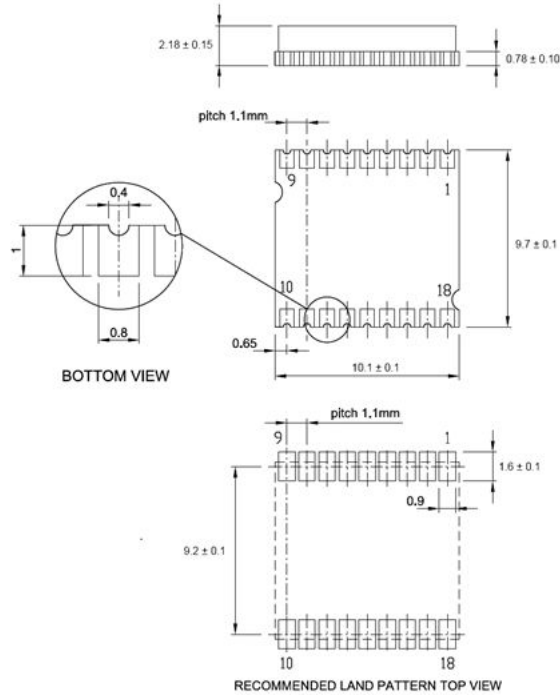


Table 10. Mechanical specifications tolerance

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

17 Shipping information

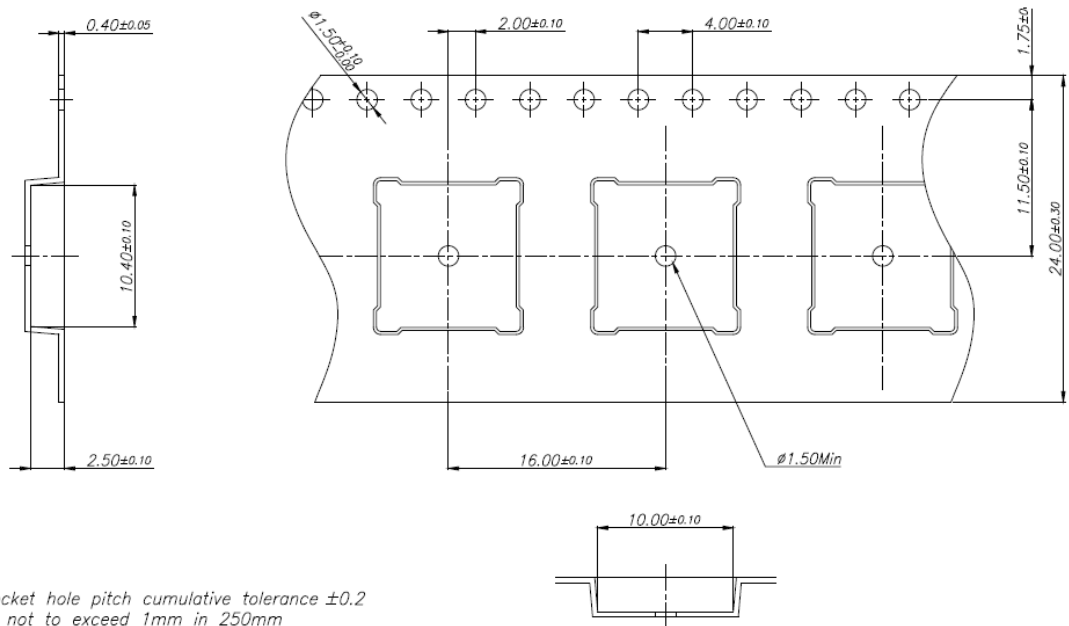
Teseo-LIV3FL is delivered as reeled tapes.

For protection from physical damage, the reels are individually packed in cartons.

17.1 Reels

Teseo-LIV3FL reel specification is as shown in the following figure.

Figure 4. Carrier tape



NOTES:

1. 10 sprocket hole pitch cumulative tolerance ± 0.2
2. Camber not to exceed 1mm in 250mm
3. Material: Black conductive Polystyrene
4. A_o and B_o measured on a plane 0.3mm above the bottom of the pocket
5. K_o measured from a plane on the inside bottom of the pocket to the top surface of the carrier.
6. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.
7. Pocket center and pocket hole center must be same position.

Figure 5. Teseo-LIV3FL orientation

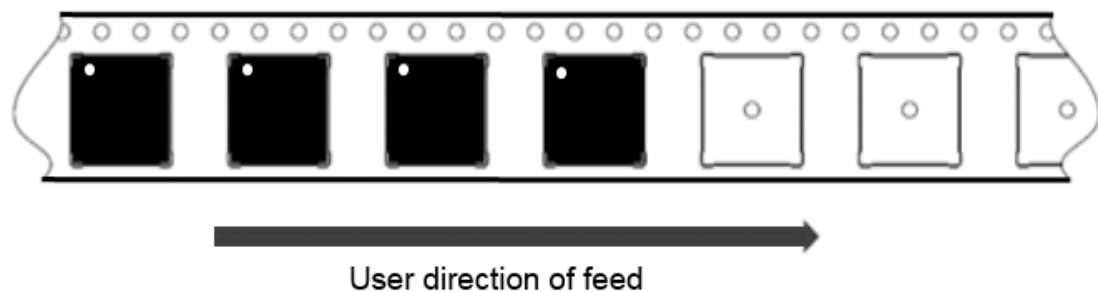
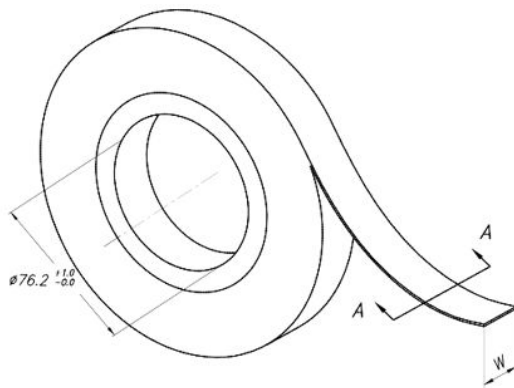


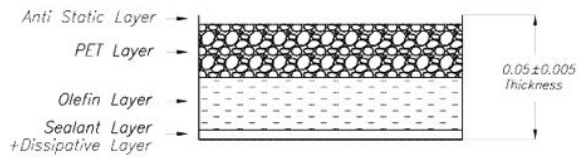
Figure 6. Cover tape



- NOTE:
1. MATERIAL : POLYESTER FILM
 2. COLOR : TRANSPARENT
 3. DESCRIPTION : HEAT ACTIVATED SEAL TAPE
 4. ALL DIMENSIONS ARE IN MILLIMETERS
 5. ESD : 10^9 to 10^{11} ohms/SQ.
 6. CORE MATERIAL : ABS

<Tape Size Information>

CARRIER TAPE WIDTH	COVER TAPE DIMENSION	
	WIDTH	LENGTH
24 mm	21.00 ± 0.1	500M



[SECTION A-A]

Figure 7. Plastic reel

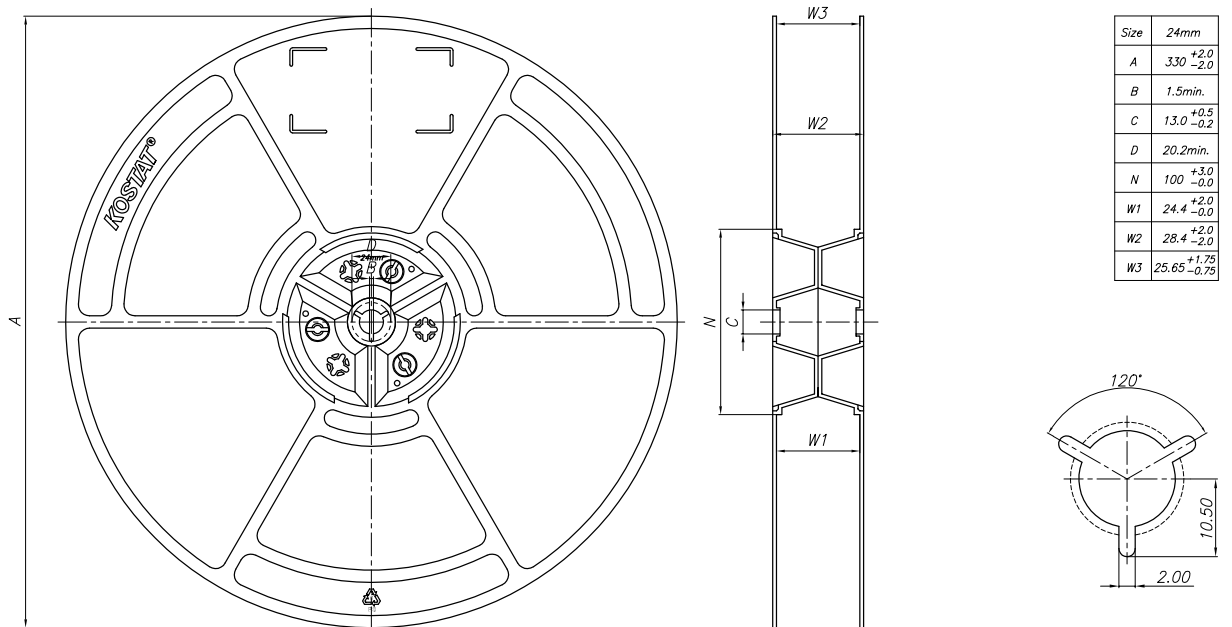
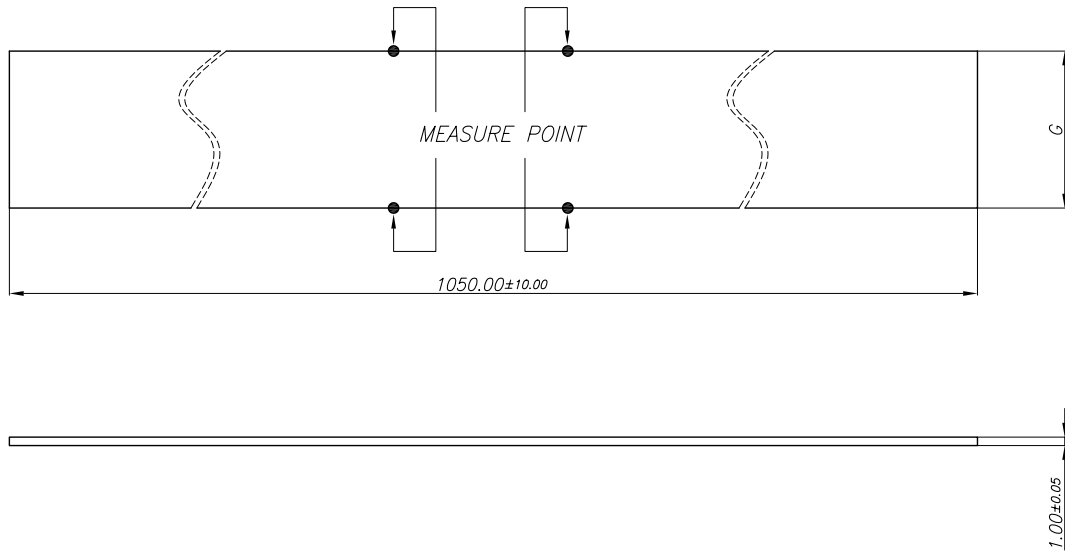


Figure 8. PB band



WIDTH(mm)	12	16	24	32	44	56
$G(\pm 0.10)$	12.20	16.20	24.20	32.20	44.20	56.20

UNIT : mm

17.2 Inner box

To avoid damage, each Teseo-LIV3FL reel has a dedicated cardboard box of 340 x 340 x 38 mm.

17.3 ESD handling precautions

Teseo-LIV3FL module is an electrostatic sensitive device (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. Particular care must be exercised when handling patch antennas, due to the risk of electrostatic charges.

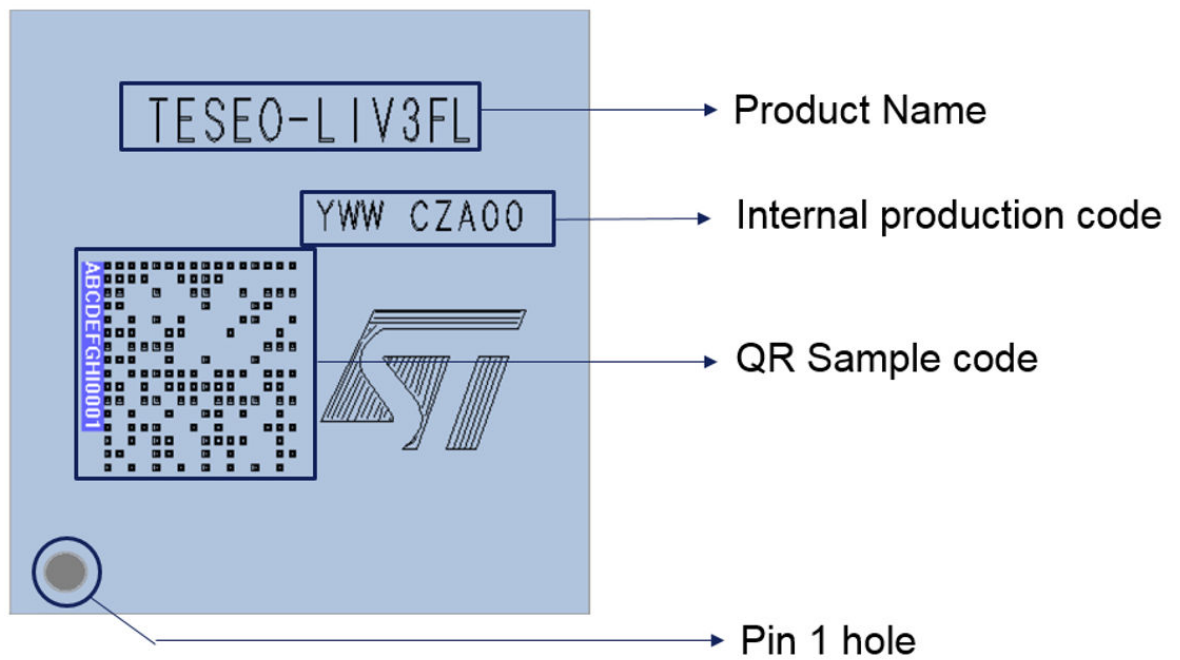
17.4 Moisture sensitivity levels

The moisture sensitivity Level (MSL) relates to the packaging and handling precautions required. Teseo-LIV3FL modules are rated at MSL level 3 (three).

18 Labeling information

The Teseo-LIV3FL marking—shown in the following figure—reports product information.

Figure 9. Labeling information of Teseo-LIV3FL



Item descriptions are reported in the following table.

Table 11. Labeling information description

Items	Description
Internal production code	Information code related only to the production line
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

19 Reflow-soldering profile

The Teseo-LIV3FL is a high temperature strength surface that mounts the GNSS module supplied on an 18 pin, 6-layer PCB. The final assembly recommended that reflows profiles is indicated here below.

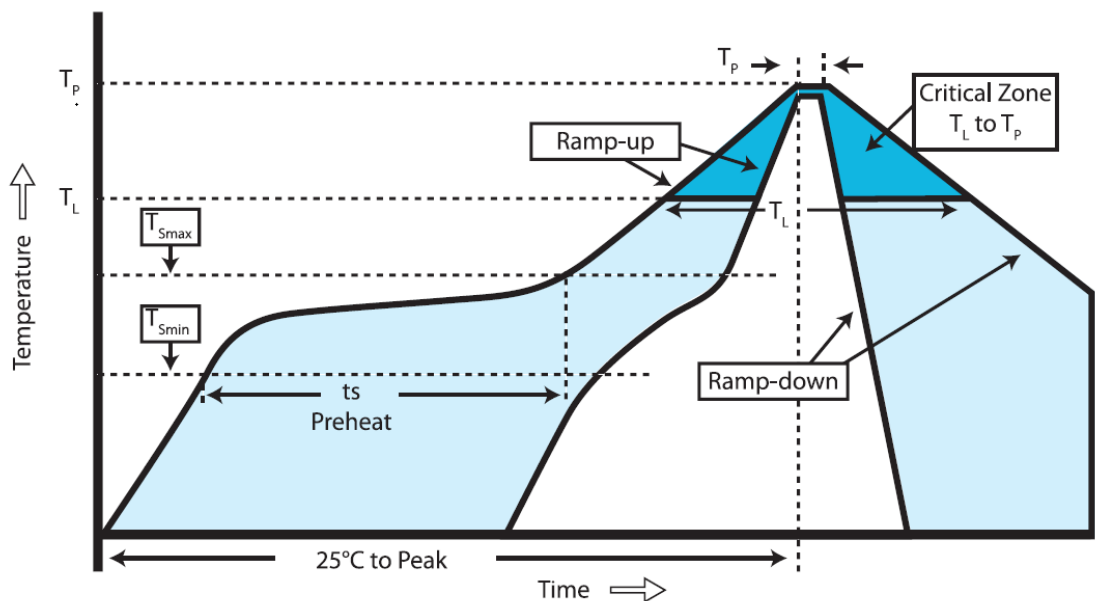
Soldering phase has to be executed with care in order to avoid undesired melting phenomena. Particular attention has to be taken on the setup of the peak temperature.

Here below some suggestions for the temperature profile based on the following recommendations.

Table 12. Soldering profile values

Profile feature	PB-free assembly
Average ramp-up rate (TSMAX to Tp)	3 °C/s max.
Preheat:	150 °C
• Temperature min (TSmin)	200 °C
• Temperature max (TSmax)	60-100 s
• Time (tSmin to tSmax) (tS)	
Time maintained above:	217° C
• Temperature (TL)	60-70 s
• Time (tL)	
Peak temperature (TP)	245 ±5 °C
Time within 5 °C of actual peak temperature (TP)	10-20 s
Ramp-down rate	4 °C/s
Time from 25 °C to peak temperature	8 minute max.

Figure 10. Soldering profiles



19.1 Cooling phase

A controlled cooling avoids negative metallurgical effects of the solder (solder becomes more brittle) and possible mechanical tensions in the products. Controlled cooling helps to achieve bright solder fillets with a good shape and low contact angle.

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.

19.2 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.

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

19.3 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.

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

20 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.

Revision history

Table 13. Document revision history

Date	Version	Changes
21-Mar-2022	1	Initial release.
06-Jun-2022	2	Updated Table 2. Teseo-LIV3FL pin out description; Section 9.1 Hardware standby; Section 9.3 Hardware off standby; Table 8. Current consumption; Figure 6. Carrier tape.
17-Aug-2022	3	Updated <i>Table 8. Current consumption</i> .
18-Oct-2023	4	Updated Table 12. Soldering profile values, Table 1. GNSS performance, Table 5. Supply voltage characteristics when VCC_IO@1.8 V, Table 6. Supply voltage characteristics when VCC_IO@3.3 V. Added Section 19.1 Cooling phase, Section 19.2 Repeated reflow soldering and Section 19.3 Rework.

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