Teseo-ELE6A

Datasheet

Automotive quad-band GNSS module with open SDK

LGA 54 LD
(17.0 mm x 22.0 mm x 3.1 mm)

Prerelease product(s)

Product status link
Teseo-ELE6A

Product summary	
Order code	Teseo-ELE6ATR
Package	LGA 54 LD (17.0 x 22.0 x 3.1 mm)
Packing	Tape and reel

Features

- Qualified AEC-Q104
- GNSS features:
  - STMicroelectronics' sixth generation positioning receiver with six constellations: GPS, Galileo, GLONASS, BeiDou, QZSS, NavIC (former IRNSS)
  - 192 (96 data and 96 pilot) signal tracking channels
- Hardware features:
  - Dual core Arm® Cortex®-M7 to support positioning PPP/RTK algorithm and measurement engine in a single module
  - Automotive Teseo VI+ GNSS IC
  - ST Automotive 6-axis inertial sensor
  - Embedded flash
  - LGA 54 LD package (17.0 mm x 22.0 mm x 3.1 mm)
  - 3.3 V supply voltage range
  - Operating temperature: from -40° to +105°C
- Firmware features:
  - PE-SDK platform to embed PPP/RTK algorithm in the module
  - Standard PVT positioning supporting up to quad-band for submeter accuracy applications
  - Measurement engine with up to quad-band to support precise positioning algorithms
  - Code phase, carrier phase, doppler frequency measurement
  - Support any SBAS systems
  - Independent GPS/QZSS L5, Galileo E5a/b, BeiDou B2a acquisition and tracking
  - Signal integrity (antijamming/antispoofing)
  - ST Teseo-DRAW (dead-reckoning automotive way) supported
  - Firmware upgrade
  - Free firmware configuration

Description

The Teseo-ELE6A module is an easy-to-use quad-band multiconstellation global navigation satellite system (GNSS) standalone module, embedding Teseo VI single die standalone positioning receiver IC working simultaneously on multiple constellations (GPS/Galileo/GLONASS/BeiDou/QZSS/NavIC (IRNSS)).

The Teseo-ELE6A module brings the proven accuracy and robustness of the Teseo VI chip to the reach of everyone.

The Teseo-ELE6A module provides high level and quality GNSS measurement data to support the PPP/RTK algorithm on internal or external MCU.

Thanks to the dedicated SDK, the positioning Cortex®-M7 core for PPP/RTK algorithm the Teseo-ELE6A can embed precise positioning application with no need of an external host.

Within its 17.0 mm x 22 mm size, Teseo-ELE6A is offering superior accuracy thanks to the on-board temperature compensated crystal oscillator (TCXO) and a reduced time to first fix (TTFF) relying on its dedicated real-time clock (RTC) oscillator.

Teseo-ELE6A offers real-time assisted GNSS.

Teseo-ELE6A supports firmware configurability as well as firmware upgrades on both cores.

Teseo-ELE6A module, being a certified solution, optimizes the time to market of the final applications, the embedded firmware and the complete evaluation environment saving development time.

1 Module description

1.1 GNSS performance

Table 1. GNSS performance

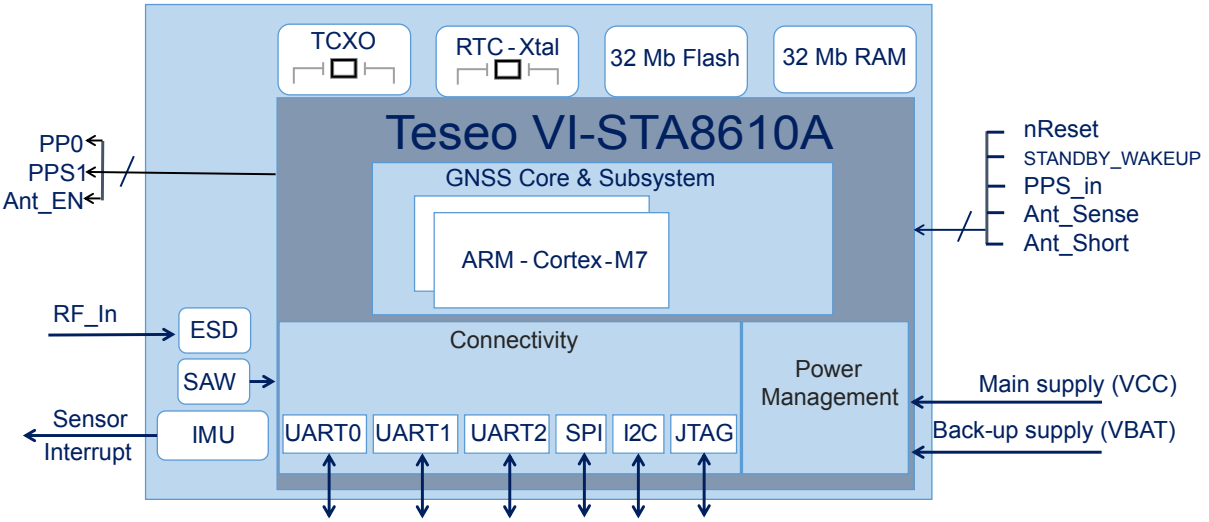
Parameter	Specification	GNSS(1) L1 + L5	GNSS (1) quad-band	Unit
Time to first fix(2)	Cold start	29	29	s
	Warm start	23	18	
	Hot start	1.8	1.8	
Sensitivity(3)(4)	Tracking	-162	-162	dBm
	Navigation(5)	-158	-158	
	Reacquisition(6)(7)	-151	-151	
	Cold start	-146	-146	
	Warm start	-148	-148	
	Hot start	-150	-150	
Max fix rate	-	20	20	Hz
Measurement message rate	-	10	10	Hz
Max DR fix rate	-	30	30	Hz
Sensor message rate	-	200	200	Hz
Velocity accuracy (50% at 30 m/s - linear path)	-	-	-	m/s
Velocity accuracy (50% at 0.5 g - shape path)	-	-	-	m/s
Heading accuracy (50% at 30 m/s - linear path)	-	-	-	°
Heading accuracy (50% at 0.5 g - shape path)	-	-	-	°
Horizontal position accuracy(8)	Autonomous	2.13	1.96	m
	SBAS	0.68	0.85	
Accuracy of time pulse	99%	32	36	ns
Frequency of time pulse	1			Hz
Operational limits(9) (10)	Dynamic(11)	< 4.5 g	< 4 g	
	Altitude	18000	18000	m
	Velocity	515	515	m/s

1. *GPS + Galileo + BeiDou + QZSS.*
2. *All satellites at -130 dBm - TTFF at 50%.*
3. *For a hot start, all satellites have the same signal level except one (pilot satellite at -145 dBm).*
4. *For BeiDou tracking sensitivity, refer to MEO satellites. For GEO the tracking sensitivity is -151 dBm.*
5. *Configurable value.*
6. *All satellites at the same signal level.*
7. *Minimum level to get valid fix after reacquisition.*
8. *CEP 50%, 24 h static, roof antenna.*
9. *Verify the limit by checking the fix availability.*
10. *To comply with USA international traffic in arms regulations (ITAR), when both the ITAR altitude limit and the ITAR velocity limit are exceeded, the module stops providing the NMEA stream.*
11. *Special configuration for high-dynamic scenario.*

Note: Performance can change due to firmware version.

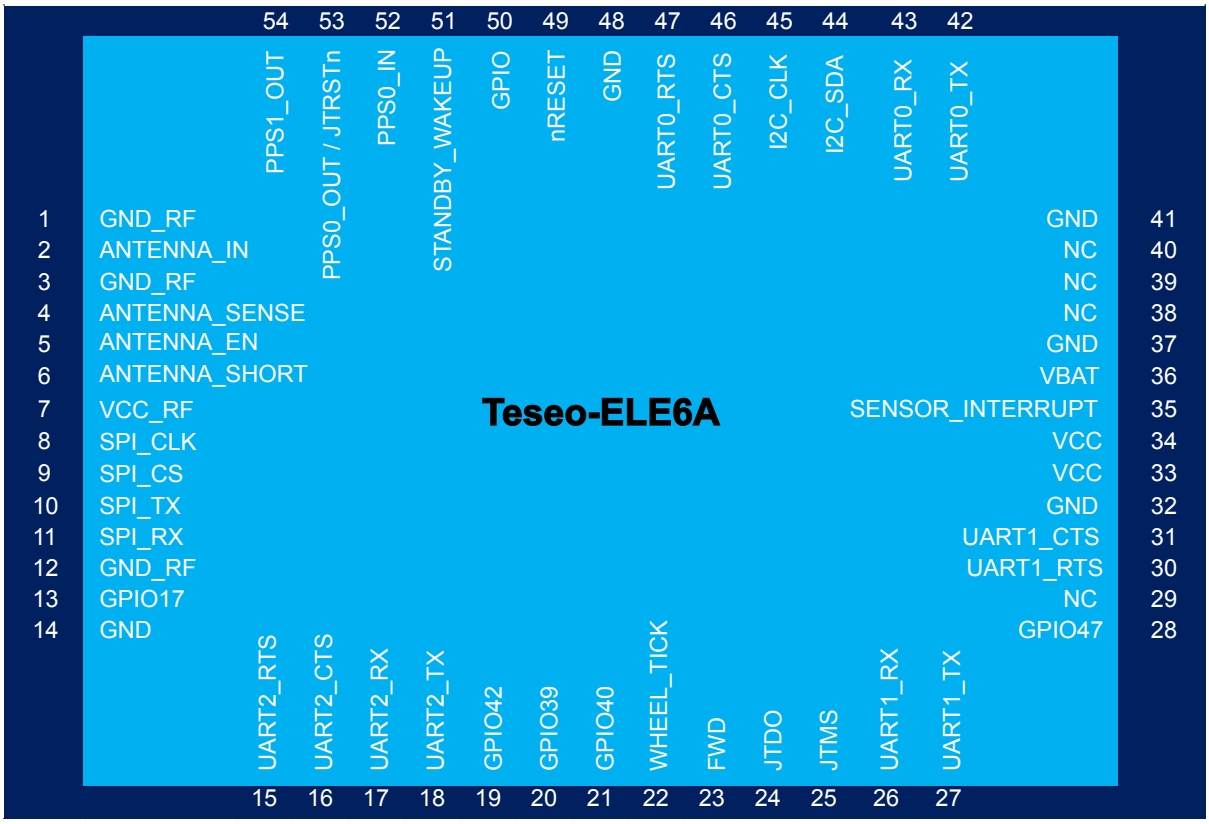
1.2 Block diagram

Figure 1. **Block schematic**



1.3 Pin configuration

Figure 2. **Module pins layout**



1.4 Pinout description

Table 2. Module pinout description

Number	Name	I/O	Description
1	GND_RF	Ground	Ground RF
2	ANTENNA_IN	I	Antenna input signal
3	GND_RF	Ground	Ground RF
4	ANTENNA_SENSE	I	Antenna sense signal
5	ANTENNA_EN	O	Antenna enable
6	ANTENNA_SHORT	I	Antenna short
7	VCC_RF	O	VCC_RF
8	SPI_CLK	I	SPI clock
9	SPI_CS	I	SPI chip selector
10	SPI_TX	O	SPI_TX
11	SPI_RX	I	SPI_RX
12	GND_RF	GND	Ground RF
13	GPIO	GND	GPIO - 41
14	GND	GND	Ground
15	UART2_RTS	I/O	UART2_RTS
16	UART2_CTS	I/O	UART2_CTS
17	UART2_RX	I	UART2_RX
18	UART2_TX	O	UART2_TX
19	GPIO	I/O	GPIO42
20	GPIO	I/O	GPIO39
21	GPIO	I/O	GPIO40
22	WHEEL_TICK	I	Wheel-tick - dead-reckoning input / JTDI
23	FWD	I	Forward - dead-reckoning input / JTCK
24	GPIO	I/O	GPIO 4 / JTDO
25	GPIO	I/O	GPIO 2 / JTMS
26	UART1_RX	I	UART1_RX
27	UART1_TX	O	UART1_TX
28	GPIO	I/O	GPIO 47
29	NC		
30	UART1_RTS	I/O	UART1_RTS
31	UART1_CTS	I/O	UART1_CTS
32	GND	GND	Ground
33	VCC	I	Input voltage supply
34	VCC	I	Input voltage supply
35	SENSOR_INTERRUPT	O	Sensor interrupt output
36	VBAT	I	Backup area voltage supply
37	GND	GND	Ground
38	NC		

Number	Name	I/O	Description
39	NC		
40	NC		
41	GND	GND	Ground
42	UART0_TX	O	UART0_TX
43	UART0-RX	I	UART0-RX
44	I2C_SD	I/O	I²C data
45	I2C_SCL	I/O	I²C clock
46	UART0-CTS	I/O	UART0-CTS
47	UART0-RTS	I/O	UART0-RTS
48	GND	GND	Ground
49	nReset	I	nReset signal
50	GPIO	I/O	
51	STANDBY_WAKEUP	I/O	STANDBY-WAKEUP signal
52	PPS0_IN	I	PPS0_Input
53	PPS0_OUT	O/I	PPS0 / JTRESETn
54	PPS1_OUT	O	PPS1

2 Supported GNSS constellations

The module firmware supports all the GNSS constellations (GPS, GLONASS, Galileo, BeiDou, QZSS, and NavIC (IRNSS)). The user can select what the application needs by the firmware configuration.

Table 3. GNSS constellations and bands supported

Constellation	Bands acquired
GPS	L1C/A, L1C, L2C, L5
SBAS	EGNOS, WASS, MSAS, SDCM, GAGAN, KAZZ, South PAN SBAS
GLONASS	L1OF, L2OF
BeiDou	B1I, B1C, B2I, B2B, B3I
Galileo	E1B/C, E5b, E5a, E6
QZSS	L1C/A, L1C/b, L1C. L1S. L2C, L5
NavIC (IRNSS)	L5

2.1 GPS

The module is designed to receive and track the L1C/A (1575.42 MHz), L1C (1575.42 MHz), L2C (1227.6 MHz), L5 (1176.45 MHz) signals provided by the global positioning system (GPS).

The module can receive and process GPS concurrently with Galileo, GLONASS, BeiDou, QZSS and NavIC (IRNSS).

2.2 GLONASS

The module is designed to receive and track the L1OF (1598.0625 MHz–1605.375 MHz), L2OF (1242.9375 MHz–1248.625 MHz), signals provided by the Russian GLONASS satellite system.

The module can receive and process GLONASS concurrently with GPS, Galileo, BeiDou, QZSS and NavIC (IRNSS).

2.3 BeiDou

The module is designed to receive and track the B1I (1561.98 MHz), B1C, B2I (1207.14 MHz), B2B, B3I (1268.52 MHz) signals provided by the Chinese BeiDou satellites system.

The module can receive and process BeiDou concurrently with GPS, GLONASS, Galileo, QZSS, and NavIC (IRNSS).

2.4 Galileo

The module is designed to receive and track the E1B/C (1575.42 MHz), E5b (1207.14 MHz), E5a (1176.45 MHz), E6 (1278.75 MHz) signals provided by the European Galileo satellites system.

The module can receive and process Galileo concurrently with GPS, GLONASS, Galileo, QZSS and NavIC (IRNSS).

2.5 NavIC (IRNSS)

The module is designed to receive and track the L5 (1575.42 MHz) signal provided by the indian NavIC (IRNSS) satellites system.

The module can receive and process NavIC (IRNSS) concurrently with GPS, GLONASS, Galileo, BeiDou, and QZSS.

2.6 QZSS

The module is designed to receive and track the L1C/A (1575.42 MHz) signal provided by the Japanese QZSS satellites system.

QZSS with GPS signals provide 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).

The module can receive and process QZSS concurrently with GPS, GLONASS, Galileo, BeiDou.and NavIC (IRNSS).

3 Augmentation systems

3.1 Satellite-based augmentation system

The module 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 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 the decoding phase the SBAS message can be decoded to fetch the differential corrections.

The current longitude limits for each service are:

- WAAS -180°C to -25°C
- EGNOS -25°C to +50°C
- GAGAN +50°C to +100°C
- MSAS +100°C to +180°C
- South PAN SBAS

The module 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 Differential GPS

The module supports differential-GPS data according to RTCM 2.3 (radio technical commission for maritime services).

Differential-GPS data improves position accuracy.

4 Dual core processor

The module embeds two independent CPU Arm Cortex®-M7:

- The measurement engine Cortex®-M7 Core
- The positioning Cortex®-M7 Core

4.1 Measurement engine Cortex®-M7 core

The module embeds a fully functional Cortex®-M7 running ST GNSS measurement engine software.

The measurement engine core can provide measurement data on any port or to the positioning core.

As an autonomous PVT, the module can also provide two PPS outputting signals up to 10 MHz.

4.2 Positioning Cortex®-M7 core

The module embeds a fully functional Cortex®-M7 core totally dedicated to run positioning PPP/RTK algorithm achieving decimeter-level positioning.

An SDK for the positioning core is available to embed the PPP/RTK algorithm in the positioning core.

The positioning core can run up to 314 MHz and it has:

- Double precision floating-point unit (FPU)
- Embedded cache (16 KB I-cache, 16 KB DCACHE)
- 512 KB RAM embedded
- 4 MB serial RAM
- 4 MB serial flash
- JTAG debug interface

Thanks to the positioning core in the module, the customer can fully support the PPP/RTK algorithm without an external host-MCU.

5 Firmware specification

The module embeds unified firmware able to operate in different modes based on the active configuration.

5.1 Standard PVT

In this operating mode, the module operates as a multi-band and multi-constellation GNSS module; the fix is only GNSS-based.

The PVT, the module can also provide one PPS output signal.

5.2 Dead reckoning mode

In this operating mode, the module operates as a multi-band and multi-constellation GNSS module with an integrated IMU, able to perform a sensor fusion of GNSS satellite data, IMU, and ODO information to provide a fix even in challenging scenarios such as tunnels and urban canyons.

The best module performance is guaranteed by providing odometer information using the pins FWD (pin #23) and WHEELTICK (pin #22).

5.2.1 High dead reckoning fix rate

With the Teseo dead reckoning firmware, the GNSS fix rate on the module is 1 Hz, but dead reckoning can achieve up to 30 Hz.

5.2.2 Map matching feedback

The module's position accuracy can also perform data fusion using data from the map navigation system available on the platform.

5.2.3 Sensor over UART

Odometer information can also be provided to the module through the UART port using a specific NMEA command.

5.3 Measurement engine mode

In this operating mode, the module operates as a multi-band and multi-constellation GNSS module able to provide high-quality GNSS raw measurement data to support a PPP/RTK algorithm. In this operating mode, the module also provides a fix using the internal PVT engine.

5.4 Firmware configuration

All configuration parameters are grouped in a data block.

Each parameter is addressed by a tuple: page, line, field.

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 http://www.st.com or using runtime configuration commands raised by the host.

5.5 Firmware update support

The module 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 the module using the available PC Tool TESEO-SUITE available at www.st.com.

The latest firmware is provided on ST web side (www.st.com); the customer has to check periodically if a new firmware is provided online.

ST aims at regularly providing new firmware through the ST web platform. However, there is no obligation for ST to update the production line and its related hardware.

6 Protocols specification

6.1 RTCM3 protocol

The module supports the RTCM v3 protocol, in detail it supports the following RTCM message.

Table 4. Supported RTCM message

Message number	Description
1077,1087, 1097,1117, 1127,1137	Multiple signal messages (MSM)
1019,1020, 1041,1042, 1044,1046	Satellite ephemeris data
1013	System parameters
4075	Navigation data frame (NDF) (1)

1. *Not in RTCM3 official standard.*

The module also supports ST proprietary RTCM v3 command/message identified by using the message number 4050.

Table 5. Supported proprietary RTCM message

Message number	Message subtype ID	Description
4050	1 to 64	ST proprietary messages identified by subtype ID

6.2 NMEA protocol

The module supports the NMEA v.4 protocol on any ports.

The module also supports ST proprietary NMEA command/message identified using the $PSTM preamble.

7 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 four hours only for GPS and 30 minutes 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-GNSS 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 module supports two types of assisted GNSS:

- ST assisted GNSS
- Real time assisted GNSS

7.1 ST assisted GNSS

The ST assisted GNSS (ST-AGNSS) software can provide predicted ephemeris to the GNSS engine in under 30 s. This reduces considerably the time to get fix especially in critical environments when the ephemeris download time could be very long.

The ST-AGNSS autonomous solution uses past real ephemeris to predict future ephemeris for up to 5 days. For this reason, the ST-AGNSS autonomous performances (in terms of position accuracy using predicted ephemeris) are strictly dependent on the real ephemeris database content. In normal usage of ST-AGNSS 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 real ephemeris input database is determined by the history of the device's running periods in the past.

The module software with ST-AGNSS capability implements a command interface at the NMEA level to allow interaction with the ST-AGNSS library. It supports commands to enable/disable the ST-AGNSS functionality or to upload ephemeris and seed into the ST-AGNSS working memory.

7.2 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 the real-time ephemeris data by an assistance server. Server access is allowed thanks to internal keyword provided by the module to the host processor and the acquired real-time data have to be provided to the module.

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

The STMicroelectronics partner provides available server solution access on the Teseo module solution.

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

8 Clock generation

8.1 Temperature compensated crystal oscillator (TCXO)

A highly stable oscillator controls the down-conversion process in the RF block of the module. This component is characterized by an enhanced sensitivity, it maximizes performance in weak-signal environments, it minimizes time to first fix (TTFF), and it improves navigation stability.

8.2 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.

9 I/O interfaces

The module supports the following I/O interfaces:

- 3x UART ports with flow control
- SPI port
- I²C port
- GPIOs

NMEA and RTCM protocols are supported on both UART and SPI ports.

9.1 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 the RX pin, and parallel-to-serial conversion on data written by the CPU for transmission on the 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 reception.

The Teseo-ELE6A supports three UART ports with flow control.

9.2 SPI

The module includes a SPI interface configurable; SPI is a synchronous four-wire communication interface.

The module receiver always acts as SPI slave device.

SPI port can run up to 8 Mb/s.

9.3 I²C

The module includes an I²C interface configurable. I²C is a two-wire communication interface invented by Philips semiconductor.

I²C is not able to communicate in full-duplex mode; it uses two bidirectional open-drain lines, serial data line on pin I2C_SDA and serial clock line on pin I2C_SCL, pulled up with resistors.

The module receiver always acts as master of the I²C bus and it can be used by the positioning core to interact with external slave devices.

The I²C port can run at normal speed (100 kHz) and fast speed (400 kHz).

9.4 GPIOs

The module includes several GPIO pins available to the positioning PPP/RTK core:

- 2 x PPS (pin #53, #54)
- 1 x WHEELTICK (pin #22) for dead reckoning application
- 1 x FWD (pin #23) on for dead reckoning application
- 7 x GPIOs (pins #19. #20, #28, #35, #46, #47 #50)

10 Regulatory compliance

10.1 CE certification

The module has been certified according to the following standards:

- Radio equipment directive (RED) 2014/53/EU
- EN 62368-1:2020/A11:2020
- EN 62479:2010
- ETSI EN 301 489-1 V2.2.0 + ETSI EN 301 489-19 V2.1.0
- ETSI EN 303 413 V1.1.1

The module is provided by CE marking:

Figure 3. CE marking

The certificate of conformity is available/downloadable at the following webpage:

http://www.st.com at the Teseo-ELE6A page.

For additional information refer to:

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

The Teseo-ELE6A module current production firmware release is:

- $PSTMVER, GNSSLIB_8.6.x.xx_ARM*xx

The manufacturer, STMicroelectronics, declares that the Teseo-ELE6A 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-ELE6A page.

10.2 UKCA certification

The module has been certified UKCA .

Figure 4. UKCA marking

11 Power mode

The module offers three different low-power modes to reduce power consumption when GNSS is not needed.

- Software standby
- Hardware standby
- Power standby

All these modes share a common trait: V_BAT (pin #22) must always be maintained. It allows very low current consumption with GNSS off and fast GNSS reacquisition at the end of standby mode.

11.1 Software standby

Software standby is activated by the internal firmware.

Software standby can be:

- Host driven standby: where the host raises a NMEA command to force the module in standby; the host can wake up the module using the wake up pin #1;
- Periodic standby: where the module enters and exits from standby using internal RTC. Periodic fixes are from 5 s up to 24 hours between 2 fixes.

11.2 Hardware standby

Power supply configuration: VBAT and VCC are both maintained.

Hardware standby is driven by the level applied on STANDBY_WAKEUP pin (#1). To enter in hardware standby, it can be:

- either by an NMEA command with pull-down activated
- or by a GPIO set to low

To exit hardware standby, the GPIO level has to be set to high.

Be careful that the voltage of VCC_RF is present during this standby.

11.3 Power standby

Power supply configuration: VBAT is maintained and VCC is switched OFF. This standby mode offers the lowest possible current consumption.

To enter in power standby:

1. Set STANDBY_WAKEUP pin #1 to low level
2. Remove VCC
3. Set STANDBY_WAKEUP pin #1 to high level

To exit power standby:

1. VCC_RF is OFF during this standby
2. Reactivate VCC

12 Electrical characteristics

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 ambient temperature at T_C = 25°C.

12.3 Typical values

Unless otherwise specified, typical data are based on T_C = 25°C, VCC = 3.3 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 having the application of any voltage higher than the specified maximum rated voltages.

Table 6. Voltage characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit
VCC	Digital supply voltage	2.97	3.3	3.63	V
V_BAT	Backup input supply voltage	2.97	3.3	3.63	V

Table 7. Thermal characteristics

Symbol	Parameter	Min.	Max.	Unit
T_{oper}	Operative ambient temperature	-40	+105	°C

Table 8. Current consumption

Symbol	Parameter	Test condition	Typ.	Unit
Current	Current consumption in standard condition	GNSS(1) L1+L5 T_C = 25 °C;	141	mA
		GNSS(1) quad-band. T_C = 25 °C	144	mA
Low-power mode current	Software standby	T_C = 25 °C; VCC = 3.3 V V_BAT = 3.3 V STANDBY_WAKEUP pin high-Z (preferred state) or 0 V	3.3	mA
	Hardware standby	T_C = 25 °C; VCC = 3.3 V V_BAT = 3.3 V STANDBY_WAKEUP = 0 V	3.3	mA
	Power standby	Tc = 25 °C; VCC = 0 V	25	mA

Symbol	Parameter	Test condition	Typ.	Unit
Low-power mode current		V_BAT = 3.3 V STANDBY_WAKEUP = 0 V		

1. *GPS + GLONASS + Galileo + BeiDou+ QZSS.*

12.5 Recommended DC operating conditions

Table 9. Recommended DC operating conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
VCC	Power supply pins	2.97	3.3	3.63	V
V_BAT	Power supply pins for backup internal logic	2.97	3.3	3.63	V

Table 10. Electrical characteristics of digital input and output pins

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{IH_3V3}	CMOS input high level		2.0		VCC + 0.3	V
V_{IL_3V3}	CMOS input low level		-0.3		0.8	V
V_{OH_3V3}	CMOS output high level	At max I_{OH}	VCC - 0.4			V
V_{OL_3V3}	CMOS output low level	At max I_{OL}			0.4	V
I_{OL}/I_{OH}	Driving current to sustain V_{OL}/V_{OH}	LOWEMI disabled	0		4	mA
		LOWEMI enabled	0		2	mA
R_{PU}/R_{PD}	Pull-up/down resistors			50		kΩ
V_{ADC}	Voltage range of input ADC	ANTENNA_SENSE pin	0		1.8	V

Note: Pins #1, 2, 3, 4, 5, 7, 8, 9, 14, 15, 16, 17, 18, 19, 20, 21.

13 Package information

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.

13.1 LGA 17x22x3.1mm 54 LD

Figure 5. LGA 17x22x3.1mm 54 LD package outline

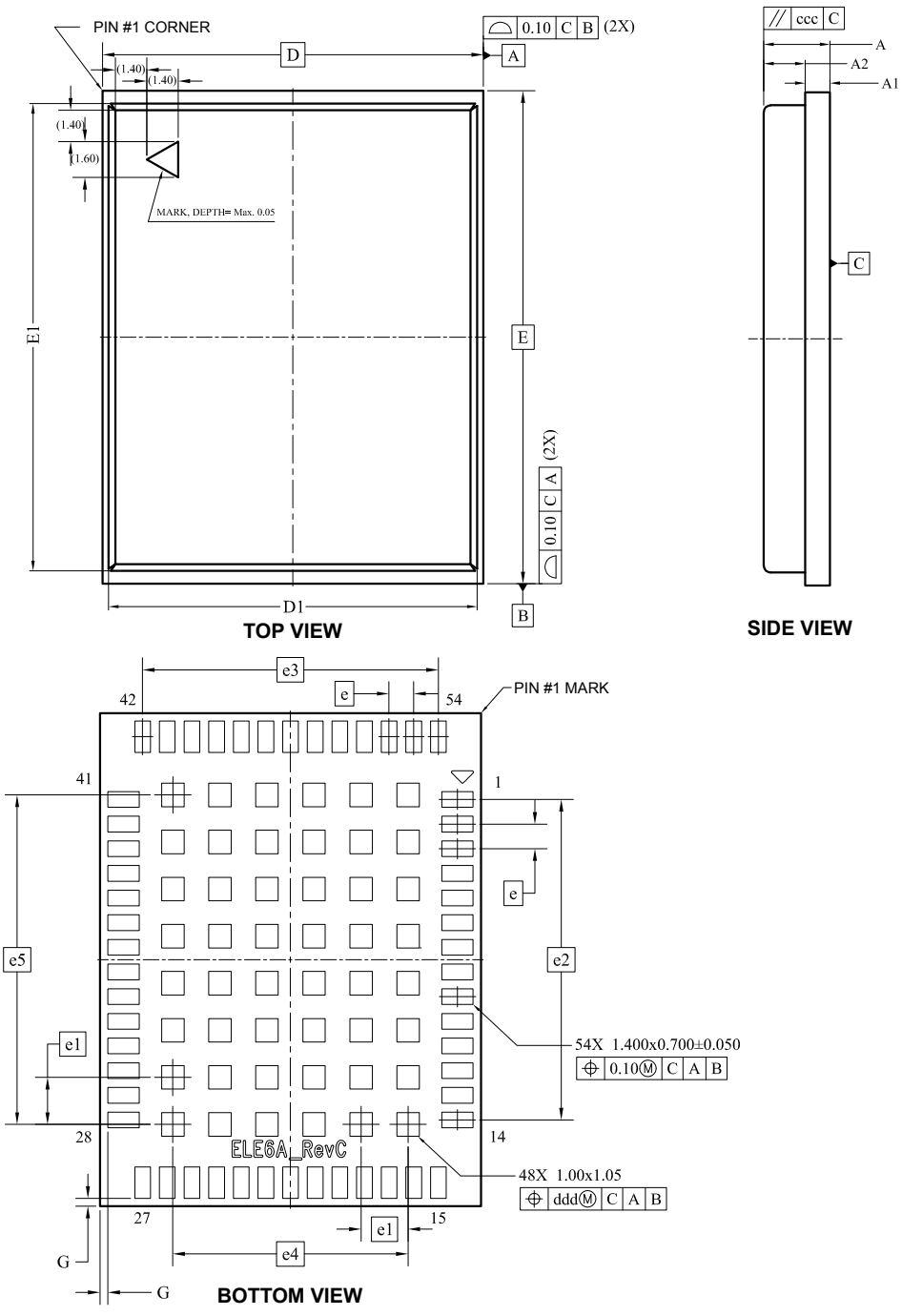


Table 11. **LGA 17x22x3.1mm 54 LD package mechanical data**

Symbol	Min.	Nom.	Max.
A	-	2.95	3.1
A1	1.0	1.1	1.2
A2	-	(1.85) Ref.	-
D	-	17.00	-
D1	16.35	16.45	16.55
E	-	22.00	-
E1	20.75	20.85	20.95
e	-	1.10	-
e1	-	2.10	-
e2	-	14.30	-
e3	-	13.20	-
e4	-	10.50	-
e5	-	14.70	-
G5	-	0.35	-

Table 12. **Tolerance of form and position**

Symbol	Tolerance of form and position [mm]
aaa	0.10
bbb	0.10
ccc	0.10
ddd	0.10

13.2 Shipping information

The module is delivered as reeled tapes.

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

13.2.1 ESD handling precautions

Teseo-ELE6A 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. Particular care must be exercised when handling patch antennas, due to the risk of electrostatic charges.

13.2.2 Moisture sensitivity levels

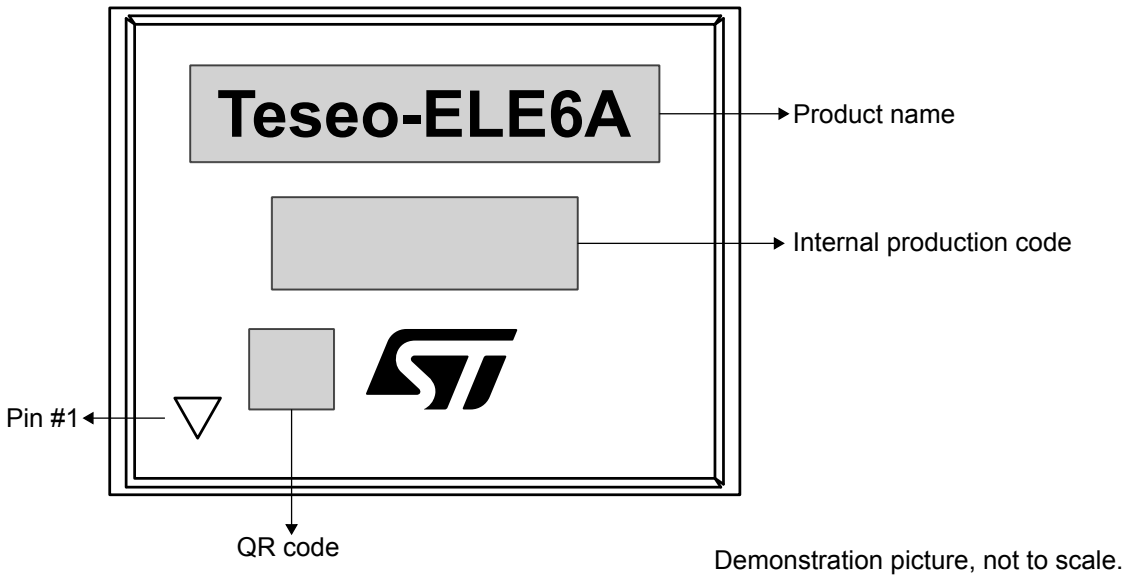
The moisture sensitivity level (MSL) relates to the packaging and handling precautions required.

Teseo-ELE6A modules are rated at MSL level 3 (three).

13.3 Labeling information

The labeling of the module reports product information.
Information layout of the product is shown in the Figure 6.

Figure 6. Labeling information



Demonstration picture, not to scale.

Information description is reported in Table 13.

Table 13. Labeling information description

Items	Description
Product name	Official product name for ordering code
Internal production code	Information code related only to the production line
QR code	QR sample code used for traceability information of any parts
Pin 1	Identify pin 1

13.4 Reflow soldering profile

The module is a high-temperature strength surface-mount GNSS module supplied on a 24-pin, 6-layer PCB. The final assembly recommended that reflows profiles is indicated here below.

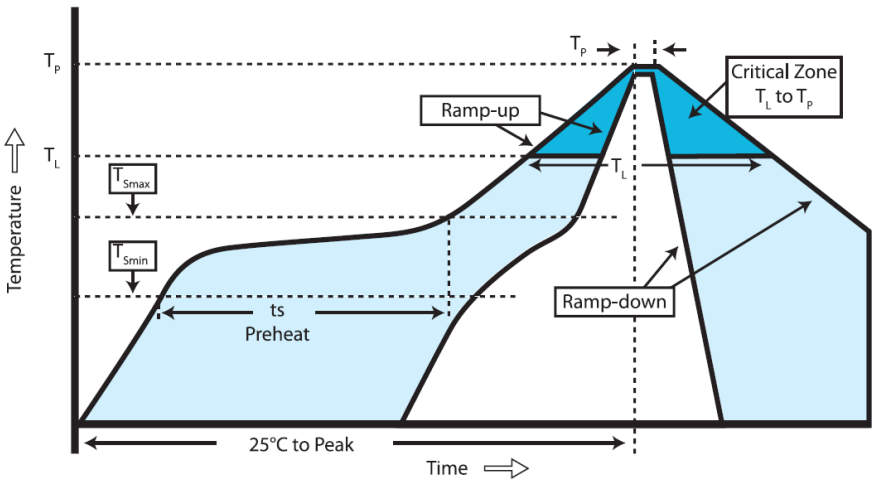
The soldering phase has to be executed with care: to avoid undesired melting phenomena, particular attention must be paid to the setup of the peak temperature.

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

Table 14. Soldering profile values

Profile feature	PB-free assembly
Average ramp-up rate (T_{Smax} to T_P)	3 °C/s max.
Preheat: – Temperature min (T_{Smin}) – Temperature max (T_{Smax}) – Time (t_{Smin} to t_{Smax}) (t_S)	 150 °C 200 °C 60-100 s
Time maintained above: – Temperature (T_L) – Time (t_L)	 217°C 60-70 s
Peak temperature (T_P)	245 ±5°C
Time within 5 °C of actual peak temperature (T_P)	10-20 s
Ramp-down rate	4 °C/s
Time from 25 °C to peak temperature	8 minutes max.

Figure 7. Soldering profile



13.4.1 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.

13.4.2 Repeated reflow soldering

Only single reflow soldering processes are recommended for boards populated with Teseo modules. Avoid subjecting the Teseo module to two reflow cycles on a double-sided component board to prevent upside-down orientation. 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.

13.4.3 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.*

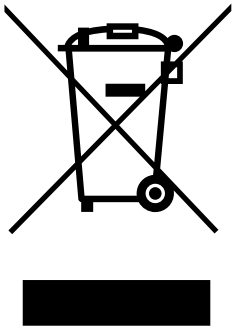
After the module is removed, clean the pads before placing and hand soldering a new module.

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

14 Product disposal

Disposal of this product: WEEE (Waste Electrical and Electronic Equipment)

(Applicable in Europe)



This symbol on the product, accessories, or accompanying documents indicates that the product and its electronic accessories must not be disposed of with household waste at the end of their working life.

To prevent possible harm to the environment and human health from uncontrolled waste disposal, separate these items from other types of waste and recycle them responsibly at a designated collection point to promote the sustainable reuse of material resources.

Household users:

Contact the retailer that you purchased the product from or your local authority for details of your nearest designated collection point.

Business users:

Contact your dealer or supplier for further information.

Revision history

Table 15. **Document revision history**

Date	Revision	Changes
25-Jun-2025	1	Initial release.
22-Aug-2025	2	Updated Cover image, Product summary, and Features on cover page. Updated Section 1.3: Pin configuration and Section 1.4: Pinout description. Updated Section 9: I/O interfaces and Section 9.1: UART. Updated Table 11. LGA 17x22x3.1mm 54 LD package mechanical data and split it into Table 12. Tolerance of form and position. Added Section 14: Product disposal. Minor text changes.

Contents

List of tables

List of figures

IMPORTANT NOTICE – READ CAREFULLY

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice.

In the event of any conflict between the provisions of this document and the provisions of any contractual arrangement in force between the purchasers and ST, the provisions of such contractual arrangement shall prevail.

The purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgment.

The purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of the purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

If the purchasers identify an ST product that meets their functional and performance requirements but that is not designated for the purchasers' market segment, the purchasers shall contact ST for more information.

ST and the ST logo are trademarks of ST. For additional information about ST trademarks, refer to www.st.com/trademarks. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.