

General Description

The Skytop SM1513-MTBD is a complete GPS/BeiDou engine module that features super sensitivity, ultra low power and small form factor. The GPS/BeiDou signal is applied to the antenna input of module, and a complete serial data message with position, velocity and time information is presented at the serial interface with NMEA protocol or custom protocol.

Its -165dBm tracking sensitivity extends positioning coverage into place like urban canyons and dense foliage environment where the GPS/BeiDou was not possible before. The small form factor and low power consumption make the module easy to integrate into portable device like PNDs, mobile phones, cameras and vehicle navigation systems.

Applications

- LBS (Location Based Service)
- PND (Portable Navigation Device)
- Vehicle navigation system
- Mobile phone



Figure 1: SM1513-MTBD Top View

Features

- Build on high performance, low-power MT3333 chipset
- Ultra high sensitivity: -165dBm
- Extremely fast TTFF at low signal level
- Built in high gain LNA
- Low power consumption: Max $35\text{mA}@3.3\text{V}$
- NMEA-0183 compliant protocol or custom protocol
- Operating voltage: 2.8V to 4.3V
- Operating temperature range: -40 to 85°C
- SMD type with stamp holes
- Small form factor: $15 \times 13 \times 2.4\text{mm}$
- RoHS compliant (Lead-free)

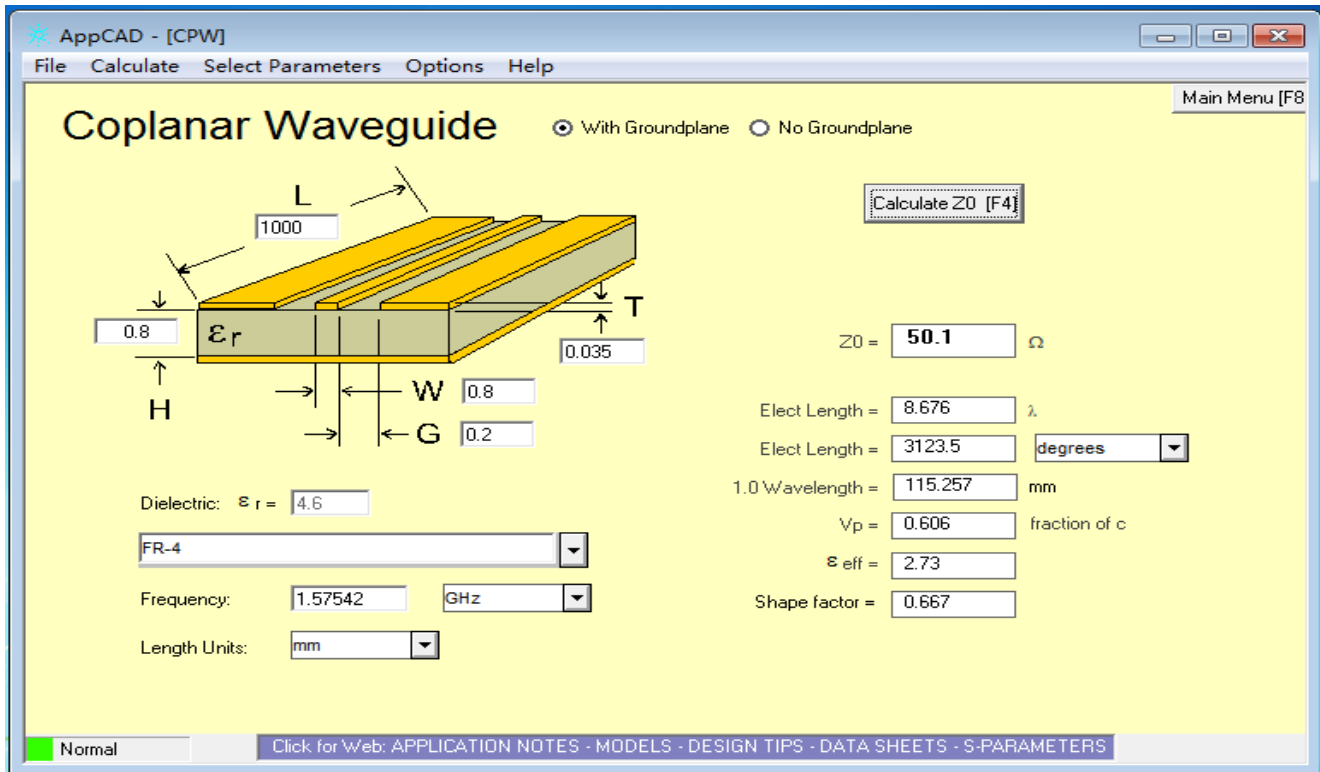
Performance Specification

Parameter	Specification	
Receiver Type	Gps/Glonass/Galileo/Beidou(afterICDreleased)receiver Supports multi-GNSS incl.QZSS,SBAS ranging Supports:WAAS/EGNOS/MSAS/GAGAN	
Sensitivity	Tracking	-165dBm
	Acquisition	-163dBm(hot) -148dBm(cold)
Accuracy	Position	5m CEP without SA
	Velocity	0.1m/s without SA
	Timing (PPS)	10ns RMS
Acquisition Time	Cold Start	38s
	Warm Start	35s
	Hot Start	1s
	Re-Acquisition	<1s
Power Consumption	Tracking	35mA @3.3V Vcc
	Acquisition	35mA
	Sleep/Standby	TBD
NavigationDataUpdate Rate	1Hz	
Operational Limits	Altitude	Max 18,000m
	Velocity	Max 515m/s
	Acceleration	Less than 4g

Interfaces Configuration

Power Supply: Regulated power for the SM1513-MTBD is required. The input voltage Vcc should be 3.3V \pm 10%, maximum, current is no less than 35mA. Suitable decoupling must be provided by external decoupling circuitry.

Antenna: The SM1513-MTBD GPS/BeiDou receiver is designed for supporting the active antenna or passive antenna connected with pin RF_IN. The gain of active antenna should be no less than 15dB. The maximum noise figure should be no more than 2.5dB and output impedance is at 50 Ohm.



UART Ports: The module supports two full duplex serial channels UART . All serial connections are at 3V CMOS logic levels, if need different voltage levels, use appropriate level shifters. The baud rate of both serial ports are fully programmable, the data format is however fixed: X, N, 8, 1, i.e. X baud rate, no parity, eight data bits and one stop bit, no other data formats are supported, LSB is sent first. The modules default baud rate is set up 9600bps, however, the user can change the default baud rate to any value from 4800 bps to 115kbps. UART is used e.g. for booting and NMEA interface.

Backup Battery Power: In case of a power failure on pin Vcc, real-time clock and backup RAM are supplied through pin VBAT. This enables the SM1513-MTBD GPS /BeiDou Receiver to recover from power failure with either a hot start or a warm start (depending on the duration of Vcc outage). If no Backup Battery is connected, the receiver performs a cold start upon powered up.

Pin Description

Pin No.	Pin name	I/O	Description	Remark
1	RXB/SCK	I	2.8V,LVTTL I/O PPU,PPD,SMT2mA~16mA PDR,Serial input for UART2,Default:75Kpull-up Default: 8mA driving	
2	TXB/TXIND	O	2.8V,LVTTL I/O PPU,PPD,SMT2mA~16mA PDR,Serial input for UART2,Default:75Kpull-up Default:8mA driving	
3	P1PPS	O	Time Pulse(1PPS)	Leave Open in not used
4	TXA/I2C_DA/SO	O	2.8V,LVTTL I/O PPU,PPD,SMT2mA~16mA PDR,Serial input for UART1,Default:75Kpull-up Default:8mA driving	
5	RXA/I2C_CK/SI	I	2.8V,LVTTL I/O PPU,PPD,SMT2mA~16mA PDR,Serial input for UART1,Default:75Kpull-up Default:8mA driving	
6	GPIO11/SCS	I/O	2.8V,LVTTL I/O PPU,PPD,SMT2mA~16mA PDR JTAG interface clock Default:75Kpull-down Default:8mA driving	
7	GPIO9	I/O	Strap pin host_sel[0]Host_sel[1:0] Interfac	
8	GPIO10	I/O	Strap pin host_sel[0]Host_sel[1:0] Interfac	
9	NC		No connection	
10	NC		No connection	
11	V_BAT	P	Backup battery supply voltage	
12	VCC	P	DC supply voltage	
13	GPIO8	I/O	2.8V,LVTTL I/O PPU,PPD,SMT2mA~16mA PDR JTAG interface clock Default:75Kpull-down Default:8mA driving	
14	GPIO1	I/O	2.8V,LVTTL I/O PPU,PPD,SMT2mA~16mA PDR JTAG interface clock Default:75Kpull-down Default:8mA driving	
15	GPIO2	I/O	2.8V,LVTTL I/O PPU,PPD,SMT2mA~16mA PDR JTAG interface clock Default:75Kpull-down Default:8mA driving	
16	NC		No connection	
17	VCC_RF	P	Linear regulator power output, 3.0V (Do not use this as power source of backup battery)	
18	GND	G	Ground	
19	RF_IN	I	GPS&BeiDou Signal Input	
20	GND	G	Ground	
21	GND	G	Ground	

22	GND	G	Ground
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Pin Assignment

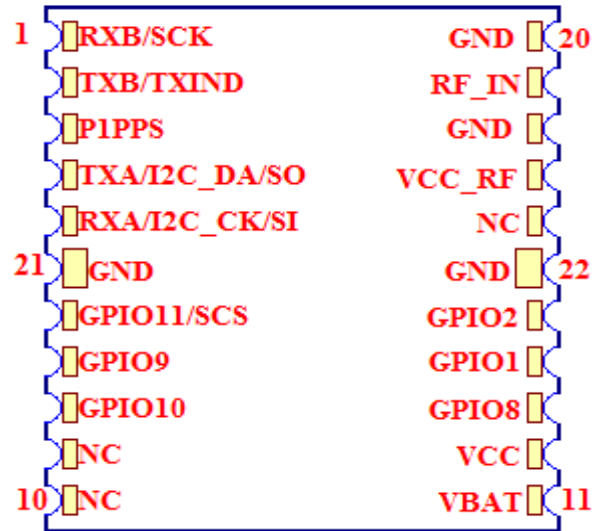


Figure 2: SM1513-MTBD Pin Package

Mechanical Specification

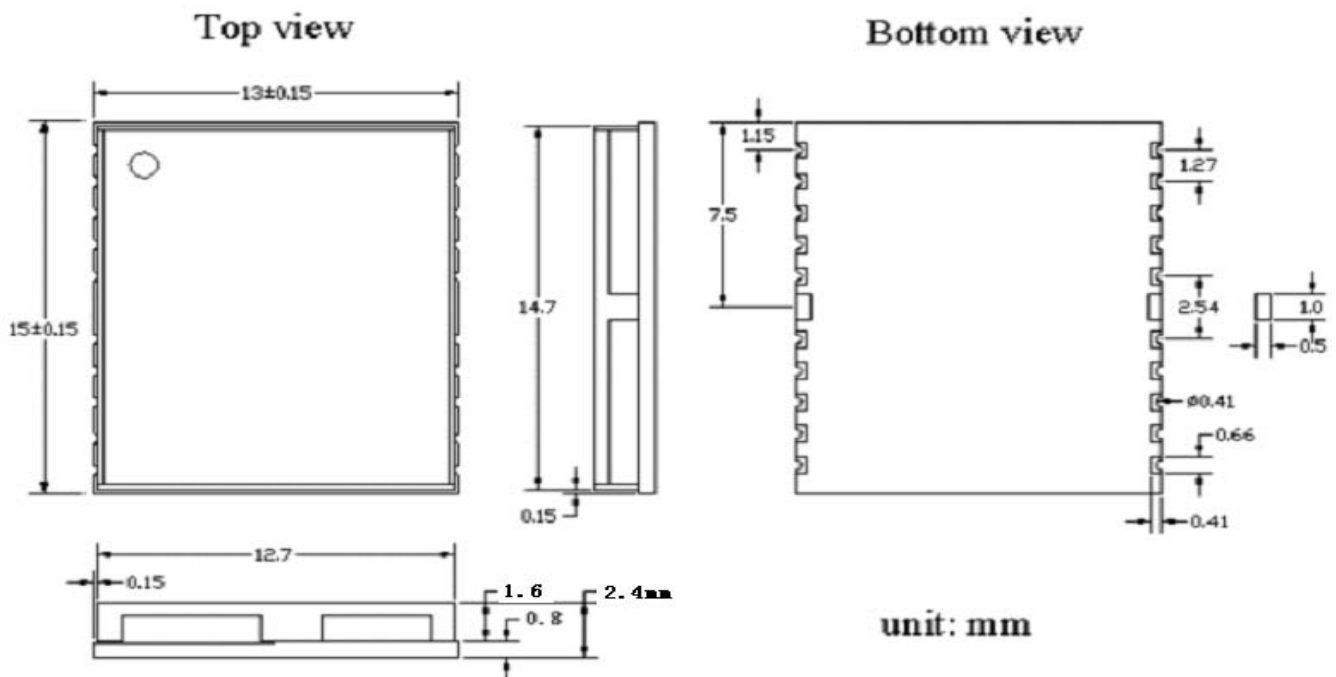


Figure 3: SM1513-MTBD Dimensions

Electrical Characteristics

Absolute Maximum Rating

Parameter	Symbol	Min	Max	Units
Power Supply				
Power Supply Volt.	Vcc	2.8	4.3	V
Input Pins				
Input Pin Voltage I/O	RXD/TXD	-0.3	3.6	V
Backup Battery	VBAT	2.0	3.6	V
Environment				
Storage Temperature	Tstg	-40	125	°C
PeakReflow Soldering Temperature	Tpeak		260	°C
Humidity			95	%

Note: Absolute maximum ratings are stress ratings only, and functional operation at the maxims is not guaranteed. Stress beyond the limits specified in this table may affect device reliability or cause permanent damage to the device. For functional operating conditions, refer to the operating conditions tables as follow.

Operating Conditions

Parameter	Symbol	Condition	Min	Typ	Max	Units
Power supply voltage	Vcc		2.8	3.3	4.3	V
Powersupplyvoltagegeripple	Vcc_PP	Vcc=3.0V			30	mV

Consumption current	I _{CC}	V _{CC} =3.0V		35	35	mA
Input high voltage	V _{IH}		0.7xV _{CC}		V _{CC} +1.0	V
Input low voltage	V _{IL}		-0.3		0.3xV _{CC}	V
Output high voltage	V _{OH}		0.8xV _{CC}		V _{CC}	V
Output low voltage	V _{OL}		0		0.2xV _{CC}	V
Operating temperature	T _{opr}		-40		85	°C

Software Protocol

NMEA 0183 Protocol

The NMEA protocol is an ASCII-based protocol, Records start with a \$ and with carriage return/line feed. GPS&BeiDou specific messages all start with \$GPxxx/GNxxx/BDxxx where xxx is a three-letter identifier of the message data that follows. NMEA messages have a checksum, which allows detection of corrupted data transfers.

The skytopSM1513-MTBD supports the following NMEA-0183 messages: GGA. RMC.GSA.GLL.GSV.VTG

Table 1: NMEA-0183 Output Messages

NMEA Record	DESCRIPTION
BD only mode NMEAOutPut: BDRMC.BDGGA.BDGSV.BDGSA.BDGLL.BDVTG	
GPS only mode NMEAOutPut: GPRMC.GPGGA.GPGSV.GPGSA.GPGLL.GPVTG	
GPS+BDonlymode NMEAOutPut: GNRMC.GNGGA.GPGSV.BDGSV.GPGSA.BDGSA.GPGLL.GPVTG	
xxGGA	Global positioning system fixed data
xxGLL	Geographic position—latitude/longitude
xxGSA	GNSS DOP and active satellites

xxGSV	GNSS satellites in view
xxRMC	Recommended minimum specific GNSS data
xxVTG	Course over ground and ground speed

GGA-Global Positioning System Fixed Data

Table 2 contains the values of the following example:

\$xxGGA, 161229.487,3723.2475,N, 12158.3416,W, 1,07,1.0,9.0,M.0000*18

Table 2: GGA Data Format

Name	Example	Units	Description
Message ID	\$xxGGA		GGA protocol header
UTC Position	161229.487		hhmmss.sss
Latitude	3723.2457		ddmm.mmmm
N/S indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
PositionFixIndicator	1		See Table 2-1
Satellites Used	07		Range 0 to 12
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude	9.0	meters	
Units	M	meters	
Geoids Separation		meters	
Units	M	meters	
Age of Diff.Corr.		second	Null fields when DGPS is not Used
Diff.Ref.Station ID	0000		
Checksum	*18		

<CR> <LF>			End of message termination
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Table 2-1: Position Fix Indicators

Value	Description
0	Fix not available or invalid
1	GPS &BDSPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3	GPS&BD PPS Mode, fix valid

GLL-Geographic Position – Latitude/Longitude

Table 3 contains the values of the following example:

\$xxGLL , 3723.2475, N,12158.3416, W,161229.487, A*2C.

Table 3: GLL Data Format

Name	Example	Units	Description
Message ID	\$xxGLL		GLL protocol header
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
UTC Position	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Checksum	*2C		
<CR> <LF>			End of message termination

GSA-GNSS DOP and Active Satellites

Table 4 contains the values of the following example:

\$xxGSA , A, 3, 07, 02, 26,27, 09, 04,15, , , , , , 1.8,1.0,1.5*33.

Table 4: GSA Data Format

Name	Example	Units	Description
Message	\$xxGSA		GSA protocol header
Mode 1	A		See Table 4-2
Mode 2	3		See Table 4-1
Satellite Used	07		Sv on Channel 1
Satellite Used	02		Sv on Channel 2
...
Satellite Used			Sv on Channel 66
PDOP	1.8		Position Dilution of Precision
HDOP	1.0		Horizontal Dilution of Precision
VDOP	1.5		Vertical Dilution of Precision
Checksum	*33		
<CR> <LF>			End of message termination

Table 4-1: Mode 1

Value	Description
1	Fix not available
2	2D
3	3D

Table 4-2: Mode 2

Value	Description
M	Manual-forced to operate in 2D or 3D mode
A	Automatic-allowed to automatically switch 2D/3D

GSV-GNSS Satellites in View

Table 5 contains the values of the following example:

\$xxGSV , 2, 1, 07, 07, 79,048, 42, 02, 51,062, 43, 26, 36,256, 42, 27, 27, 138,42*71

\$xxGSV, 2, 2, 07, 09, 23,313, 42, 04, 19, 159, 41, 15,12,041, 42*41.

Table 5: GGA Data Format

Name	Example	Units	Description
Message ID	\$xxGSV		GSV protocol header
Number of Message	2		Range 1 to 3
Message Number	1		Range 1 to 3
Satellites in View	07		
Satellite ID	07		Channel 1(Range 1 to 66)
Elevation	79	degrees	Channel 1(Maximum 90)
Azinmuth	048	degrees	Channel 1(True, Range 0 to 359)
SNR(C/NO)	42	dBHz	Range 0 to 99,null when not tracking
...			...
Satellite ID	27		Channel 4(Range 1 to 66)
Elevation	27	degrees	Channel 4(Maximum 90)
Azimuth	138	degrees	Channel 4(True, Range 0 to 359)
SNR(C/NO)	42	dBHz	Range 0 to 99, null when not tracking
Checksum	*71		
<CR> <LF>			End of message termination

Depending on the number of satellites tracked multiple messages of GSV data may be required.

RMC-Recommended Minimum Specific GNSS Data

Table 6 contains the values of the following example:

\$xxRMC, 161229.487, A, 3723.2475, N, 12158.3416, W, 0.13,309.62, 120598,, *10

Table 6: RMC Data Format

Name	Example	Units	Description
Message ID	\$xxRMC		RMC protocol header
UTS Position	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Speed Over Ground	0.13	Knots	
Course Over	309.62	Degrees	True
Ground			
Date	120598		Dummy
Magnetic variation		Degrees	E=east or W=west
Checksum	*10		
<CR> <LF>			End of message termination

VTG-Course Over Ground and Ground Speed

Table 7 contains the values of the following example:

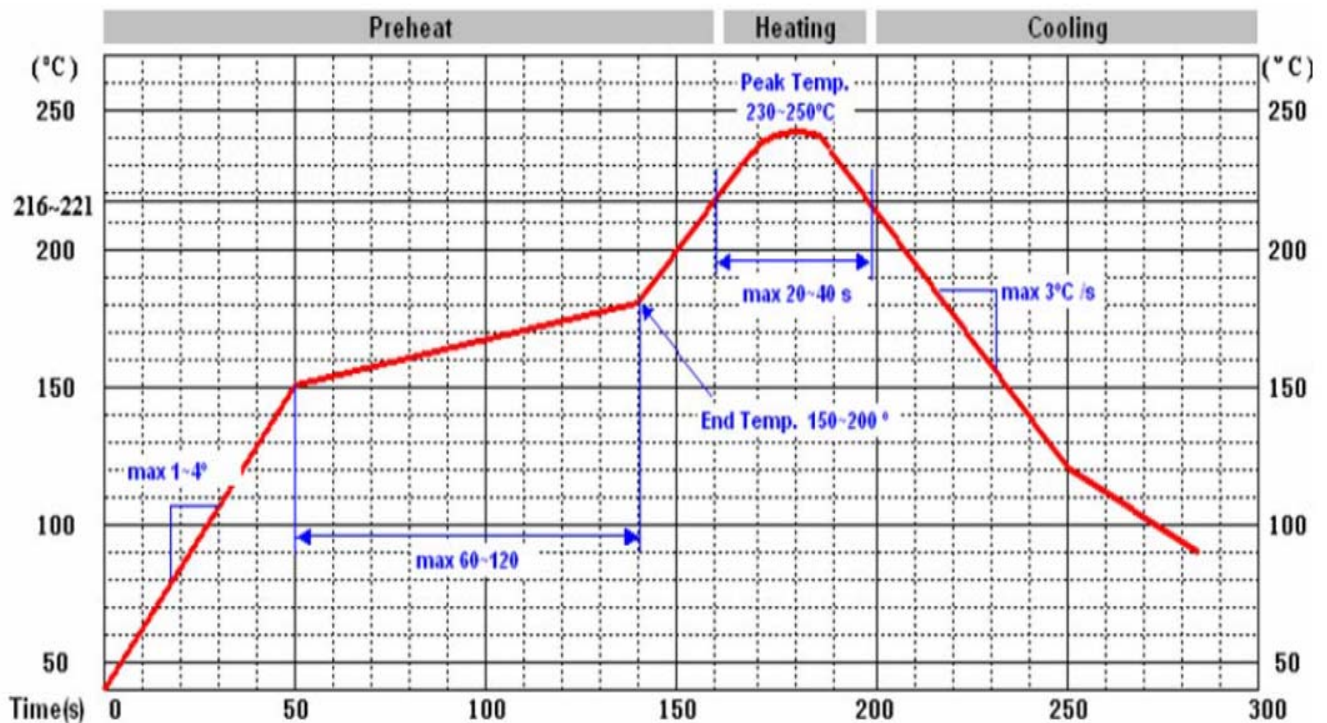
\$xxVTG, 309.62, T, M, 0.13, N, 0.2, K*6E

Table 7: VTG Data Format

Name	Example	Units	Description
Message ID	\$xxVTG		VTG protocol header
Course	309.62	Degrees	Measured heading
Reference	T		True
Course		Degrees	Measured heading

Reference	M		Magnetic
Speed	0.13	Knots	Measured horizontal speed
Units	N		Knots
Speed	0.2	Km/hr	Measured horizontal speed
Units	K		Kilometer per hour
Checksum	*6E		
<CR> <LF>			End of message termination

Manufacturing Process Recommendations



Note: The final soldering temperature chosen at the factory depends on additional external factors like choice of soldering paste, size, thickness and properties of the baseboard, etc. Exceeding the maximum soldering temperature in the recommended soldering profile may permanently damage the module.

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