

LS-TM8L 规格书/ Datasheet

GPS/GLONASS/BDS Module

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1. 概述/ General Description

LS-TM8L 是一款高性能的 GNSS 一体化解决方案模块，具有超灵敏度、超低功耗和较小的外形。将射频信号接入模块的天线输入端，在具有 NMEA 协议的串行接口上提供完整的位置、速度和时间信息的完整串行数据信息。它基于高性能的单芯片架构，其-162dBm 跟踪灵敏度扩展了定位覆盖到城市峡谷和茂密的树叶环境。支持 BDS/GPS/GLONASS 多系统联合定位和单系统独立定位。

The LS-TM8L is a high-performance GNSS all-in-one solution module that features super sensitivity, ultra low power and small form factor. The RF 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. It is based on the high performance features single-chip architecture, Its -162dBm tracking sensitivity extends positioning coverage into place like urban canyons and dense foliage environment. Support BDS/GPS/GLONASS multi-system joint positioning and single-system independent positioning.



Figure 1: LS-TM8L 产品图/ The LS-TM8L product picture

2. 应用/ Applications

- ◆ LBS (Location Based Service)
- ◆ PND (Portable Navigation Device)
- ◆ 车辆导航系统/ Vehicle navigation system
- ◆ 可穿戴设备/ Wearables
- ◆ 便携式设备/Portable devices

3. 特性/ Features

- ◆ GPS/GLONASS/BDS receiver
- ◆ 超高灵敏度/ Ultra high sensitivity: -162dBm
- ◆ 在低信号电平下极快的 TTFF/ Extremely fast TTFF at low signal level
- ◆ $\pm 10\text{ns}$ high accuracy time pulse (1PPS)
- ◆ RoHS compliance (Lead-free)
- ◆ FCC,CE compliance

4. 引脚分配/ Pin Assignment

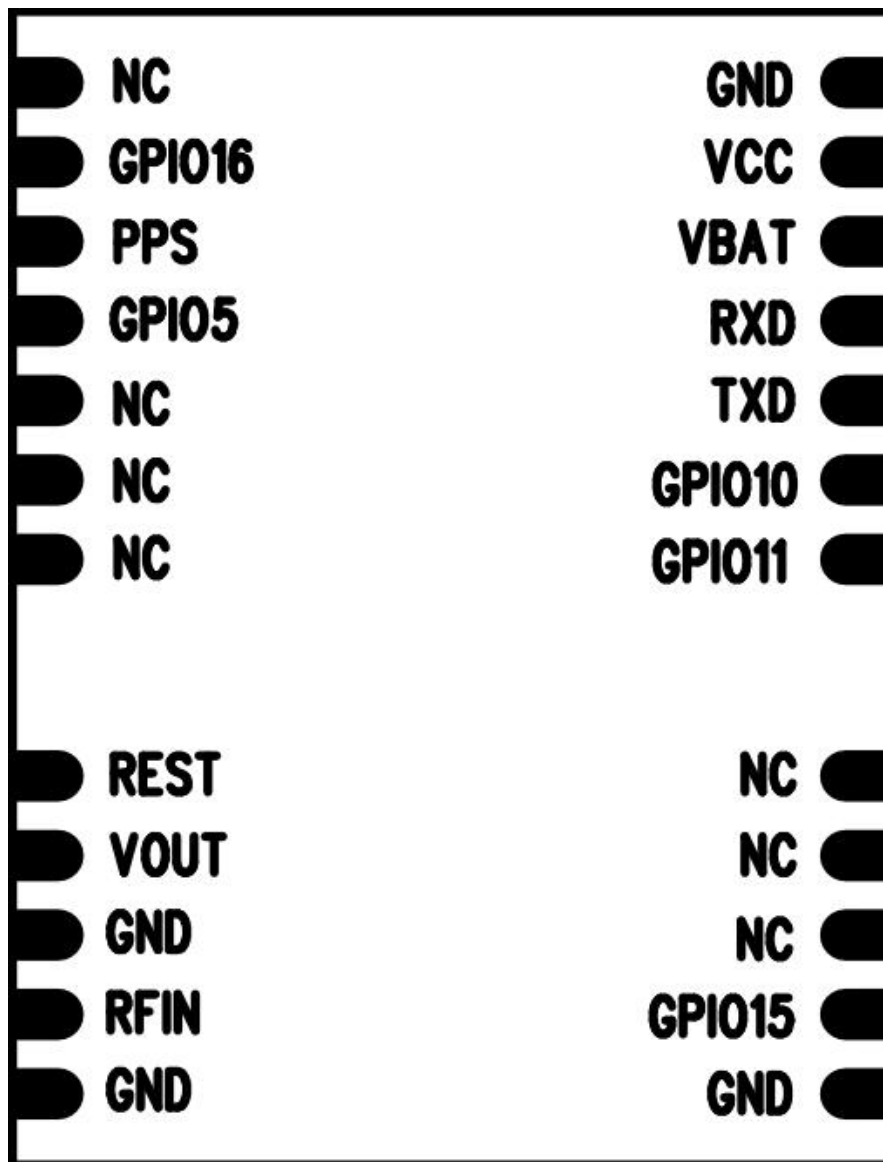


图 2: LS-TM8L PIN 分配/ Figure 2: LS-TM8L Pin Assignment

5. 引脚描述/ Pin Description

Pin No.	Pin name	I/O	Description	Remark
1	NC	-	NC	悬空/Leave open
2	GPIO16	I/O	GPIO	不用则悬空/Leave open if not used
3	PPS	O	Timepulse Signal	时间脉冲信号（默认情况下，每秒有一个脉冲）。如果不使用，请悬空/ Timepulse signal (one pulse per second by default). Leave open if not used
4	GPIO5	I/O	GPIO	不用则悬空/ Leave open if not used.
5	NC	-	NC	悬空/Leave open
6	NC	-	NC	悬空/Leave open
7	NC	-	NC	悬空/Leave open
8	RSET	I	Reset	复位信号输入引脚，不用则悬空/ Leave open. Reset the signal input pin.
9	VOUT	O	Output Voltage Of VCC	Vout 可以用来为外部有源天线供电/ Vout can be used to power an external active antenna.
10	GND	G	Ground	
11	RFIN	I	GNSS signal input from antenna	与天线的连接必须在 PCB 上进行连接。使用 50 Ω 阻抗将 RFIN 连接到天线或天线连接器上/ The connection to the antenna has to be routed on the PCB. Use a controlled impedance of 50 Ω to connect RFIN to the antenna or the antenna connector.
12	GND	G	Ground	
13	GND	G	Ground	
14	GPIO15	I/O	GPIO	不用则悬空/Leave open if not used
15	NC	-	NC	悬空/Leave open
16	NC	-	NC	悬空/Leave open
17	NC	-	NC	悬空/Leave open
18	GPIO11	I/O	GPIO	不用则悬空/Leave open, if not used.
19	GPIO10	I/O	GPIO	不用则悬空/Leave open, if not used.
20	TXD	O	UART TX	3.3V LVTTTL

21	RXD	I	UART RX	3.3V LVTTL
22	VBAT	P	Backup voltage supply	建议将一个备用电池连接到 V_BCKP 上，以便在接收器上启用热启动和热启动功能。不用则悬空/ It's recommended to connect a backup battery to V_BCKP in order to enable Warm and Hot Start features on the receivers. Leave open, if not used.
23	VCC	P	Power Supply	电源供电，额定最大纹波 = 50mVpp/Max allowed ripple on VCC=50mVpp
24	GND	G	Ground	

6. 接口/ Interfaces

电源/ Power Supply

LS-TM8L需要调节功率。输入电压VCC应为3.0V~3.6V范围内，电流不小于100mA。外部解耦电路（10uF和1uF）必须提供合适的解耦。这样可降低电源噪声，提高功率稳定性。

The LS-TM8L requires regulated power. The input voltage VCC shall be within 3.0V~3.6V, and the current shall not be less than 100 mA. The external decoupling circuit (10 uF and 1 uF) must provide suitable decoupling. This can reduce the power supply noise and improve the power stability.

主电源VCC电流随处理器负载和卫星采集而变化。采集期间的平均供应电流约为100mA。

Main power supply VCC current varies according to the processor load and satellite acquisition. Average supply current is about 100mA during acquisition.

UART

该模块支持一个全双工串行通道UART。串行连接在3.3V LVTTL逻辑电平，如果需要不同的电压电平，使用适当的电平移位器。但是数据格式是固定的：X,N,8,1,即X波特率，没有奇偶校验，8个数据位和1个停止位，不支持其他数据格式。

The module supports one full duplex serial channels UART. The serial connections are at 3.3V LVTTL logic levels, if need different voltage levels, use appropriate level shifters. 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.

7. 高级软件功能/ Advanced Software Features

Assisted GNSS

辅助信息的提供，如星历、年历、粗略的最后位置和时间，将显著减少首次修复的时间，提高采集灵敏度。

Supply of aiding information, such as ephemeris, almanac, rough last position and time, will reduce the time to first fix significantly and improve the acquisition sensitivity.

GNSS

LS-TM8L GNSS 模块可以接收和跟踪多个 GNSS 系统（如 GPS、BDS 和 GLONASS）。通过 UART 发命令，可以将系统模式切换为 BDS/GPS/ GLONASS 的组合，比如 BDS+GPS 双模，或者 GPS+GLONASS 双模，或者 GPS 单模等。默认情况下，接收器被配置为 GPS+BDS 模式。

The LS-TM8L GNSS modules can receive and track multiple GNSS systems (e.g. GPS, GLONASS, GALILEO and BDS signals). Through the UART command, the system mode can be switched to a combination of BDS/GPS/GLONASS, such as BDS+GPS dual-mode, or GPS +GLONASS dual-mode, or GPS single-mode, etc. By default the receivers are configured for concurrent GPS and BDS reception.

8. 性能说明/ Performance Specification

参数/ Parameter	说明/ Specification	
接收机类型/ Receiver Type	GPS, GLONASS, BD	
灵敏度/ Sensitivity	Tracking	-162dBm Typical
	Acquisition	-148dBm Typical
精度/ Accuracy	Position	3.0m CEP50 without SA
	Velocity	0.1m/s
Time To First Fix	Cold Start	32s(Typical Open Sky)
	Hot Start	1s
功耗/ Power Consumption	Tracking	28mA @3.3V Typical
	Acquisition	30mA @3.3V
Navigation Data Update Rate	Max 10Hz	Default 1Hz

操作限制/ Operational Limits	Altitude	Max 18,000m
	Velocity	Max 500m/s
	Acceleration	Less than 4g

9. 电气特性/ Electrical Characteristics

最大绝对额定值/ Absolute Maximum Rating

参数/ Parameter	符号/ Symbol	Min	Max	Units
电源/ Power Supply				
电源电压/ Power Supply Volt.	VCC	-0.3	3.6	V
输入引脚/ Input Pins				
输入电压/ Input voltage on any input connection	VIO	-0.3	VCC+0.2	V
射频输入功率/ RF input power	RF_IN		0	dBm
人体模型 ESD 能力/ Human Body Model ESD capability	RF_IN		2000	V
机器模型 ESD 能力/Machine Model ESD capability	RF_IN		100	V
环境/ Environment				
储存温度/ Storage Temperature	Tstg	-40	85	°C
峰值回流焊温度<10s/ Peak Reflow Soldering Temperature <10s	Tpeak		260	°C
湿度/ Humidity			95	%

注：绝对最大等级仅为应力等级，且不能保证准则下的功能运行。超过本表中规定的范围的压力可能会影响设备的可靠性或对设备造成永久性损坏。有关功能操作条件，请参见以下操作条件表。

LS-TM8L 模块为静电敏感装置（ESD），可能因 ESD 或峰值电压而损坏。虽然它内置 ESD 保护电路，请小心处理，以避免永久故障或性能下降。

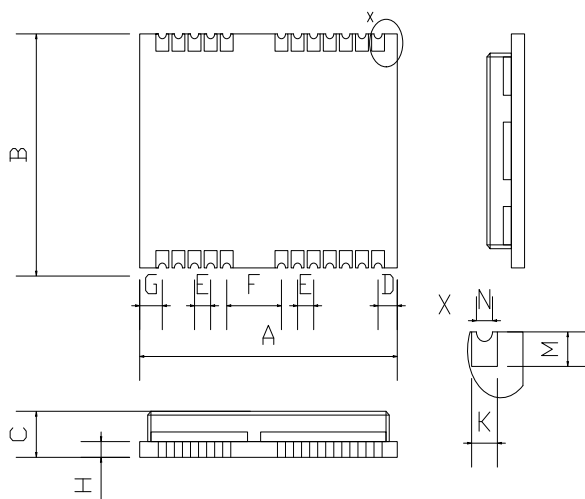
Note: Absolute maximum ratings are stress ratings only, and functional operation at the maxims is not guaranteed. Stress beyond the limits specified in this table may affect device reliability or cause permanent damage to the device. For functional operating conditions, refer to the operating conditions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

The LS-TM8L module is Electrostatic Sensitive Device (ESD) and may be damaged with ESD or spike voltage. Although it has built-in ESD protection circuitry, please handle with care to avoid permanent malfunction or performance degradation.

操作条件/ Operating Conditions

参数/ Parameter	符号/ Symbol	条件/ Condition	Min	Typ	Max	Units
供电电压/Power supply voltage	Vcc		3	3.3	3.6	V
备份电源/Backup Battery	V_BCKP		1.5	3.0	3.6	V
电源电压波纹/Power supply voltage ripple	Vcc_PP	Vcc=3.3V			30	mV
供应电流, 采集/Supply current, Acquisition	Icc	Vcc=3.3V		30		mA
电源电流, 跟踪/Supply current, Tracking	Icc	Vcc=3.3V		28		mA
VCC 峰值电流/ peak current	Ipeak				100	mA
V_BCKP 电流/ current	IRTC			12		uA
V_ANT_OUT 电源电压/ supply voltage	VANT			3.3		V
V_ANT_OUT 电流/current	IANT				50	mA
工作温度/ Operating temperature	Topr		-40		85	℃

10. 机械规范/ Mechanical Specification



Symbol	Min.(mm)	Typ.(mm)	Max.(mm)
A	16.0	16.3	16.6
B	12.0	12.2	12.4
C	2.2	2.4	2.6
D	0.9	1.0	1.3
E	1.0	1.1	1.2
F	2.9	3.0	3.1
G	0.9	1.0	1.3
H		0.8	
M	0.8	0.9	1.0
N	0.4	0.5	0.6
K	0.7	0.8	0.9
Weight		1.6g	

参数/Parameter	规格/specification	单位/Units
Coplanarity	≤0.1	mm

图 3: LS-TM8L 尺寸/ Figure 3: LS-TM8L Dimensions

11. 推荐布局/ Recommend Layout

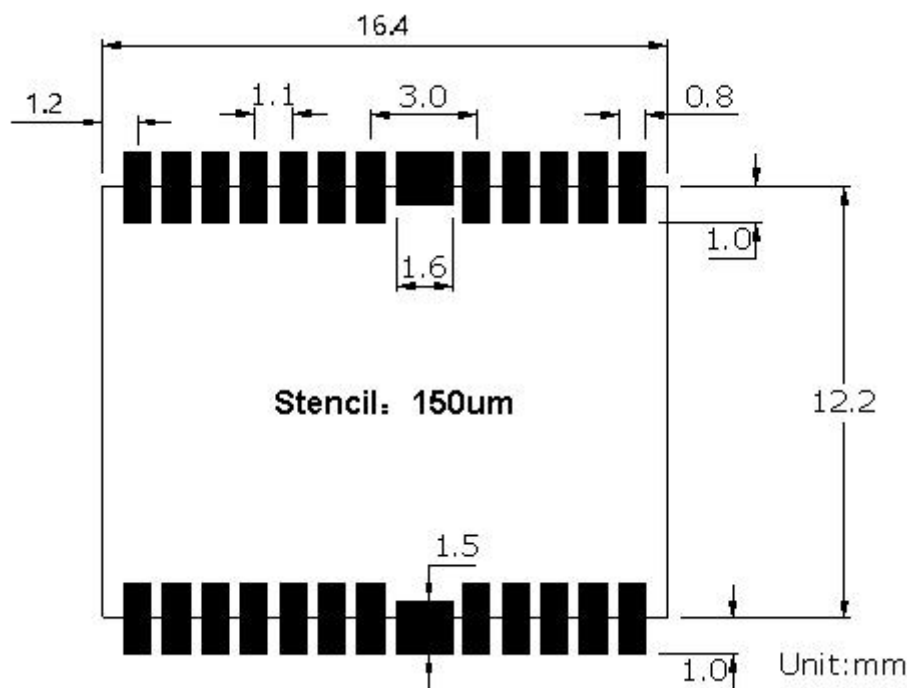


Figure 4: LS-TM8L Recommend Layout

12. 参考设计图/ Reference design schematic

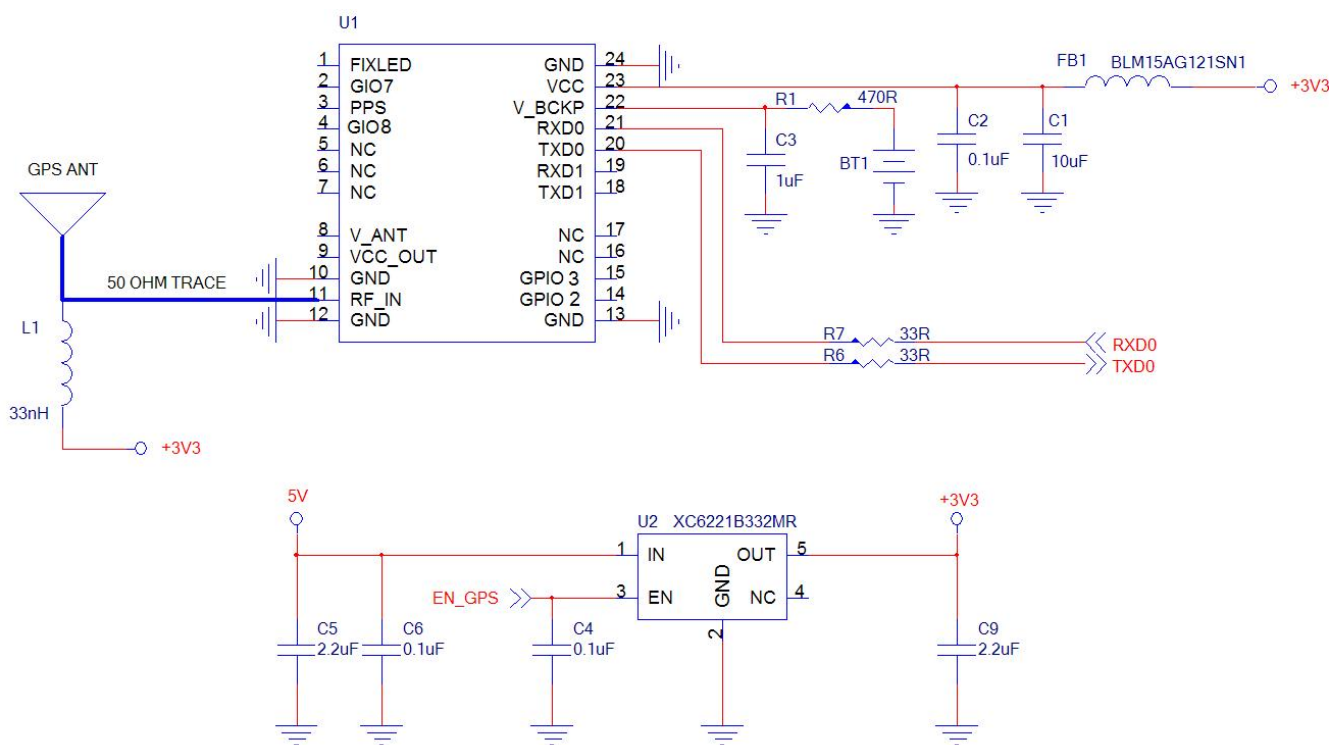


图 5: LS-TM8L 典型参考设计图/ Figure 5: LS-TM8L Typical Reference design schematic

13. 包装规范/ Packaging Specification

LS-TM8L 模块以卷轴装运，每卷轴有 1200 台。每个托盘都是“干燥”的包装。

LS-TM8L modules are shipped in reel and with 1200 units per reel. Each tray is 'dry' package.

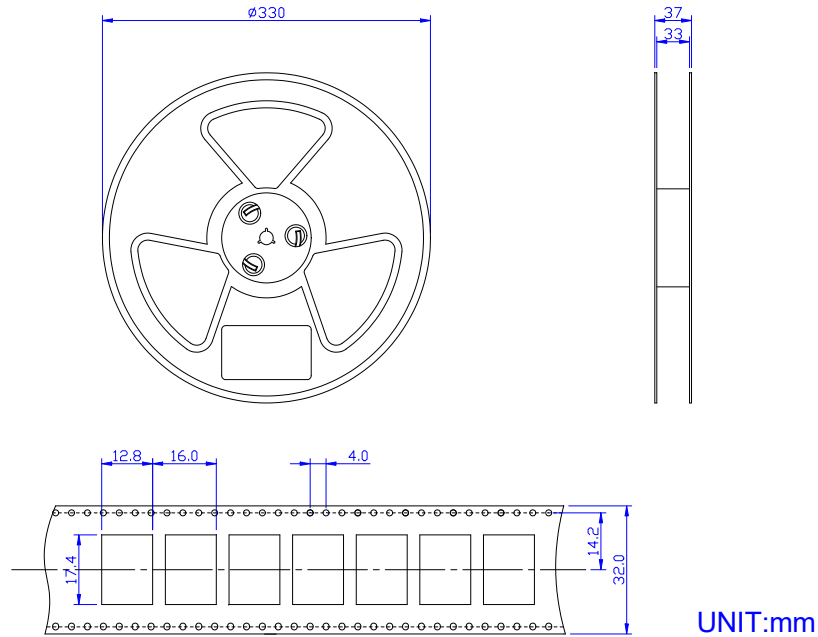


Figure 6: LS-TM8L Packaging

14. 制造工艺的建议/ Manufacturing Process Recommendations

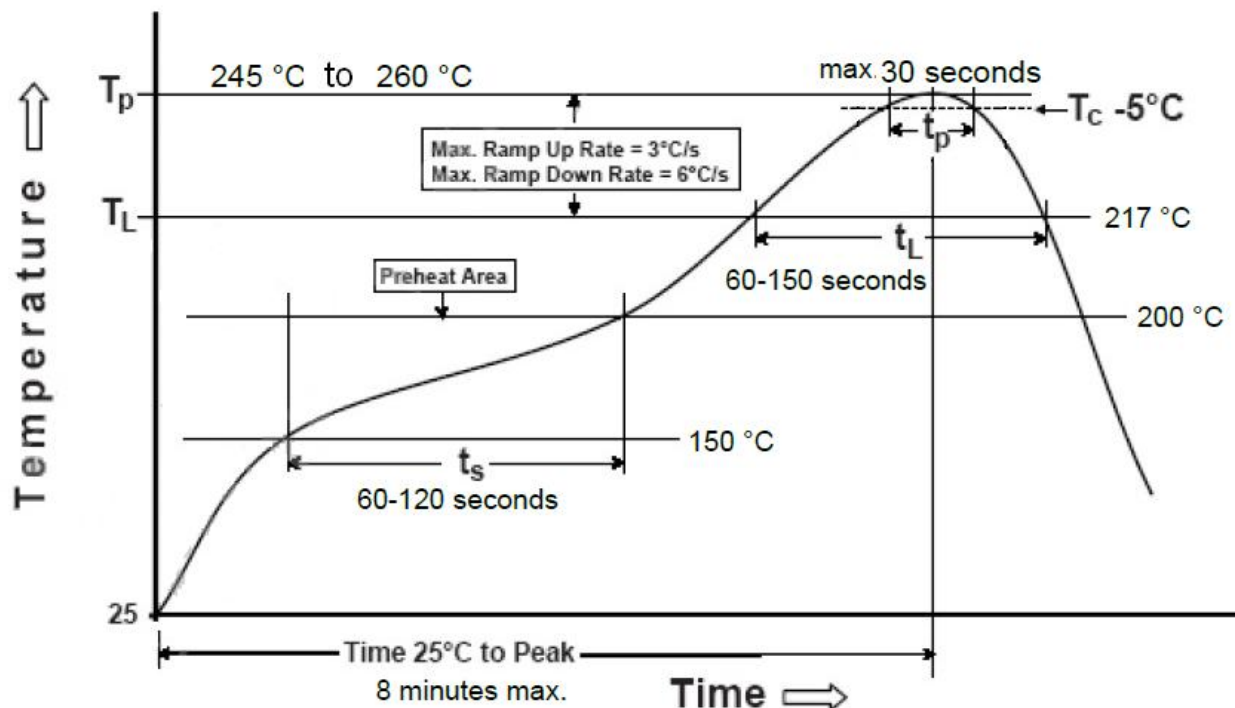


图 7: LS-TM8L 典型无铅焊接外形图/ Figure 7: LS-TM8L Typical Leadfree Soldering Profile

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.

注: 在工厂选择的最终焊接温度取决于其他外部因素，如焊膏的选择、尺寸、厚度和底板的性能等。超过推荐焊接轮廓线中的最大焊接温度可能会永久损坏模块。

15. 软件协议/ Software Protocol

NMEA 0183 Protocol

NMEA 协议是一个基于 `ascii` 的协议，记录从\$开始，从回车/线路馈送开始。GPS 特定的消息都以\$GNxxx 开始，其中 xxx 是后面的消息数据的三个字母标识符。NMEA 消息有一个校验和，它允许检测到损坏的数据传输。

Skylab LS-TM8L 支持以下 NMEA-0183 消息：GGA、GLL、GSA、GSV、RMC VTG、ZDA。模块默认的 NMEA-0183 输出设置为 GGA、GSA、RMC、GSV，默认的波特率设置为 9600bps。

The NMEA protocol is an ASCII-based protocol, Records start with a \$ and with carriage return/line feed.

GPS specific messages all start with \$GNxxx 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 Skylab LS-TM8L supports the following NMEA-0183 messages: GGA, GLL, GSA, GSV, RMC VTG, ZDA. The module default NMEA-0183 output is set up GGA、GSA、RMC、GSV , and default baud rate is set up 9600bps

Table 1: NMEA-0183 Output Messages

NMEA Record	Description	Default
GNGGA	Global positioning system fixed data	Y
GNGLL	Geographic position—latitude/longitude	Y
GPGSA	GNSS DOP and active satellites for GPS	Y
GLGSA	GNSS DOP and active satellites for GLONASS	N
BDGSA	Beidou DOP and active satellites for BD	Y
GPGSV	GNSS satellites in view for GPS	Y
GLGSV	GNSS satellites in view for GLONASS	N
BDGSV	Beidou satellites in view for BD	Y
GNRMC	Recommended minimum specific GNSS data	Y
GNVTG	Course over ground and ground speed	Y
GNZDA	Date and Time	Y

GGA-Global Positioning System Fixed Datas

This sentence contains the position, time and quality of the navigation fix.

See RMC for Fix Status, Fix Mode, Fix Date, Speed, and True Course.

See GSA for Fix Type, PDOP, and VDOP.

\$GNGGA,021514.000,2232.1799,N,11401.1823,E,1,6,1.25,84.0,M,-2.2,M,,*6A

Table 2: GGA Data Format

Name	Example	Units	Description
Message ID	\$GNGGA		GGA protocol header

UTC Position	021514.000		hhmmss.sss
Latitude	2232.1799		ddmm.mmmm
N/S indicator	N		N=north or S=south
Longitude	11401.1823		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Table 2-1
Satellites Used	6		Range 0 to 12
HDOP	1.25		Horizontal Dilution of Precision
MSL Altitude	84.0	meters	Altitude (referenced to the Ellipsoid)
AltUnit	M	meters	Altitude Unit
GeoSep	-2.2	meters	Geoidal Separation
GeoSepUnit	M	meters	Geoidal Separation Unit
Age of Diff.Corr.	<Null>	second	Null fields when it is not Used
Diff.Ref.Station ID	<Null>		Null fields when it is not Used
Checksum	*6A		
EOL	<CR> <LF>		End of message termination

Table 2-1: Position Fix Indicators

Value	Description
0	Fix not available or invalid
1	fix valid
2	Differential GPS, fix valid

GLL-Geographic Position – Latitude/Longitude

This sentence contains the fix latitude and longitude.

\$GNGLL,2232.1799,N,11401.1824,E,021513.000,A,A*4E

Table 3: GLL Data Format

Name	Example	Units	Description
Message ID	\$GNGLL		GLL protocol header
Latitude	2232.1799		ddmm.mmmm

N/S Indicator	N		N=north or S=south
Longitude	11401.1824		dddmm.mmmm
E/W Indicator	E		E=east or W=west
UTC Position	021513.000		hhmmss.sss
Fix Status	A		A=data valid or V=data not valid
Fix Mode	A		A=autonomous, N = No fix, D=DGPS, E=DR
Checksum	*4E		
EOL	<CR> <LF>		End of message termination

GSA-GNSS DOP and Active Satellites

This sentence contains the mode of operation, type of fix, PRNs of the satellites used in the solution as well as PDOP, HDOP and VDOP.

GPS GSA message: \$GPGSA,.....

\$GPGSA,A,3,28,20,04,17,10,193,08,,,,,1.14,0.75,0.85*31

GLONASS GSA message: \$GLGSA,.....

\$GLGSA,A,3,67,81,80,66,82,79,,,,,1.14,0.75,0.85*11

BD GSA message: \$BDGSA,.....

\$BDGSA,A,3,10,,,,,,,,,1.54,1.26,0.88*17

Table 4: GSA Data Format

Name	Example	Units	Description
Message	\$GPGSA		GSA protocol header
Mode 1	A		See Table 4-2
Mode 2	3		See Table 4-1
ID of satellite used	28		Sv on Channel 1
ID of satellite used	20		Sv on Channel 2
...	...		...
ID of satellite used	<Null>		Sv on Channel 12 (Null fields when it is not Used)
PDOP	1.14		Position Dilution of Precision
HDOP	0.75		Horizontal Dilution of Precision

VDOP	0.85		Vertical Dilution of Precision
Checksum	*31		
EOL	<CR> <LF>		End of message termination

Table 4-1: Mode 2

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

Table 4-2: Mode 1

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

This sentence contains the PRNs, azimuth, elevation, and signal strength of all satellites in view.

GPS GSV message: \$GPGSV,.....

\$GPGSV,4,1,14,28,86,009,35,193,70,056,38,04,44,258,29,17,44,338,44*48

GLONASS GSV message: \$GLGSV,.....

\$GLGSV,3,1,10,79,42,239,15,66,40,076,31,67,37,143,29,81,33,025,14*66

BD GSV message: \$BDGSV,.....

\$BDGSV,1,1,03,10,46,329,31,08,43,161,,09,40,217,*52

Table 5: GSV Data Format

Name	Example	Units	Description
Message ID	\$GPGSV		GSV protocol header
Number of Message	4		Total number of GSV sentences (Range 1 to 3)
Message Number	1		Sentence number of the total (Range 1 to 3)
Satellites in View	14		Number of satellites in view
Satellite ID	28		Channel 1
Elevation	86	degrees	Channel 1(Range 00 to 90)

Azinmuth	009	degrees	Channel 1(Range 000 to 359)
SNR(C/NO)	35	dB-Hz	Channel 1(Range 00 to 99, null when not tracking)
...			...
Satellite ID	17		Channel 4
Elevation	44	degrees	Channel 4(Range 00 to 90)
Azimuth	338	degrees	Channel 4(Range 000 to 359)
SNR(C/NO)	44	dB-Hz	Channel 4(Range 00 to 99, null when not tracking)
Checksum	*48		
EOL	<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

This sentence contains the recommended minimum fix information.

See GGA for Fix Quality, Sats Used, HDOP, Altitude, Geoidal Separation, and DGPS data.

See GSA for Fix Type, PDOP and VDOP.

\$GNRMC,023345.000,A,2232.1767,N,11401.1953,E,0.18,151.55,100410,,,A*76

Table 6: RMC Data Format

Name	Example	Units	Description
Message ID	\$GNRMC		RMC protocol header
UTS Position	023345.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2232.1767		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	11401.1953		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Speed Over Ground	0.18	Knots	
Course Over Ground	151.55	Degrees	True Course
Date(UTC)	100410		ddmmyy
Magnetic variation	<Null>	Degrees	Null fields when it is not Used
Magnetic Variation Direction	<Null>		E=east or W=west (Null fields when it is not Used)

Fix Mode	A		A=autonomous, N = No fix, D=DGPS, E=DR
Checksum	*76		
EOL	<CR> <LF>		End of message termination

VTG-Course Over Ground and Ground Speed

This sentence contains the course and speed of the navigation solution.

\$GNVTG,148.81,T,,M,0.13,N,0.24,K,A*23

Table 7: VTG Data Format

Name	Example	Units	Description
Message ID	\$GPVTG		VTG protocol header
Tcourse	148.81	Degrees	True Course
Reference	T		T = True
Mcourse	<Null>	Degrees	Magnetic Course (Null fields when it is not Used)
Reference	M		M = Magnetic (Null fields when it is not Used)
Speed over ground	0.13	Knots	Nautical Miles per Hour
Units	N		Knots
Speed over ground	0.24	Km/hr	in Kilometers per Hour
Units	K		Kilometer per hour
Mode	A		A=Autonomous, N=No fix, D=DGPS, E=DR
Checksum	*23		
EOL	<CR> <LF>		End of message termination

ZDA-Date and Time

This sentence contains UTC date & time, and local time zone offset information.

\$GNZDA,023345.000,10,04,2010,,*4D

Table 8: ZDA Data Format

Name	Example	Units	Description
Message ID	\$GPZDA		ZDA protocol header
UTC Time	023345.000		hhmmss.sss
Day	10		UTC time: day (01 ... 31) dd
Month	04		UTC time: month (01 ... 12) mm

Year	2010		UTC time: year (4 digit year) yyyy
local zone hours	<null>		Local Time Zone Offset Hours (Null fields when it is not Used)
local zone minutes	<null>		Local Time Zone Offset Minutes (Null fields when it is not Used)
Checksum	*4D		
EOL	<CR> <LF>		End of message termination

16. 联系信息/ Contact Information

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