

Product name	Description	Version
LS26030-15R	GNSS RTK module of PCIe Full-Mini card	0.3
LS26031-15R	GNSS RTK module of PCIe Half-Mini card	

**LS26030-15R****LS26031-15R**

## 1 Introduction

LS26030-15R and LS26031-15R are GNSS RTK modules incorporated into PCIe Full-Mini card and PCIe Half-Mini card, respectively. They support concurrent dual-frequency reception of GPS/QZSS, GLONASS, GALILEO and BEIDOU. They adopt advanced 12nm process and efficient power management architecture to perform low power consumption and high sensitivity. Besides, the USB interface makes these modules easy to integrate into the laptop that requires centimeter level RTK positioning.

## 2 Features

- USB interface
- Concurrent reception of L1 and L5 band signals
- Support GPS/QZSS, GLONASS, GALILEO and BEIDOU
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Support 135-channel GNSS
- Low power consumption
- Fast TTFF at low signal level
- Support PPS through USB
- Built-in micro battery to reserve system data for rapid satellite acquisition

### 3 Application

- Laptop with GNSS RTK function
- IPC with GNSS RTK function

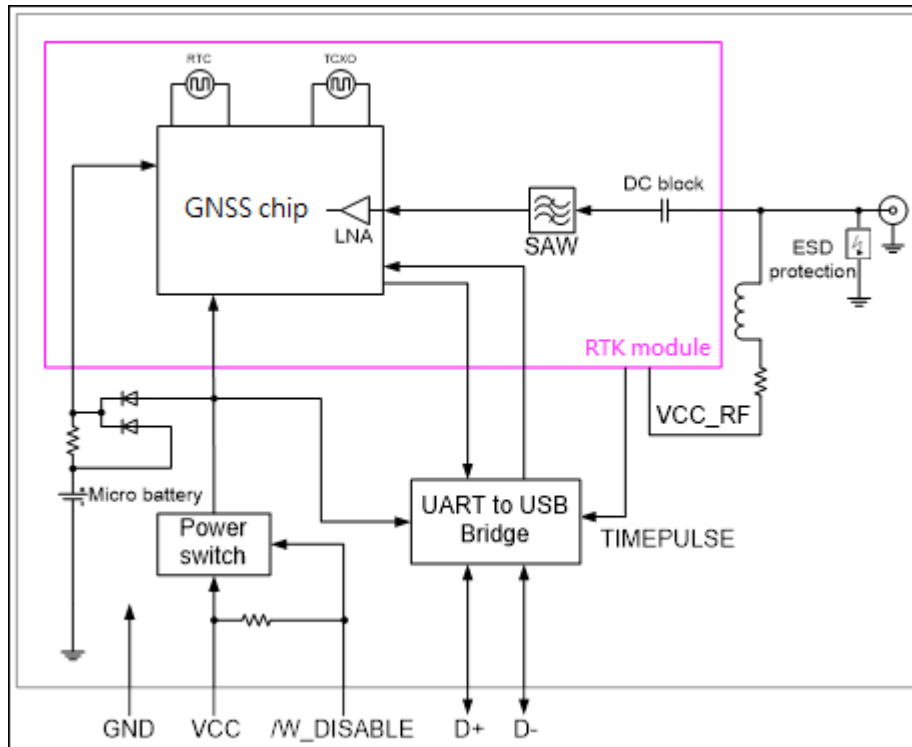


Fig 3-1 System block diagram.

## 4 GNSS receiver

Frequency	GPS/QZSS: L1 C/A, L5C GLONASS: L1OF GALILEO: E1, E5a BEIDOU: B1I, B2a	
Channels	Support 135 channels	
Update rate	1Hz, 5Hz or 10Hz	
Sensitivity	Tracking	Up to -165dBm (with external active antenna)
	Cold start	Up to -148dBm (with external active antenna)
Acquisition Time	Cold start	28s (typical)
	RTK convergence time	< 10s (typical, after 3D fix)
Position Accuracy	Autonomous	1.5m CEP
	RTK	1cm + 1ppm CEP (horizontal) 1.5cm + 1ppm CEP (vertical)
PPS signal accuracy	Typical ±1ms for PPS through USB <sup>(1)</sup>	
Max. Altitude	< 18,000 m	
Max. Velocity	< 500 m/s	
Protocol Support	NMEA 0183 ver. 4.1	115200 bps, 8 data bits, no parity, 1 stop bits (default) 1Hz: GGA, GLL, RMC 0.2Hz: GSV, GSA
	Raw data	RTCM3.3 Message type 1005, 1074, 1084, 1094, 1114, 1124

Note 1: The user can get PPS by checking DCD status. PPS accuracy is limited to USB poll interval.

## 5 Software interface

### 5.1 NMEA output message

Table 5.1-1 NMEA output message

NMEA record	Description
GGA	Global positioning system fixed data
GLL	Geographic position - latitude/longitude
GSA	GNSS DOP and active satellites
GSV	GNSS satellites in view
RMC	Recommended minimum specific GNSS data
VTG	Course over ground and ground speed

- **GGA--- Global Positioning System Fixed Data**

Table 5.1-2 contains the values for the following example:

\$GNGGA,091250.000,2503.71250,N,12138.74514,E,1,32,0.55,119.0,M,17.2,M,,\*7E

Table 5.1- 2 GGA Data Format

Name	Example	Units	Description
Message ID	\$GNGGA		GGA protocol header
UTC Time	091250.000		hhmmss.sss
Latitude	2503.71250		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74514		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Table 5.1-3
Satellites Used	32		Number of satellites in view
HDOP	0.55		Horizontal Dilution of Precision (meters)
MSL Altitude	119.0	meters	Antenna Altitude above/below mean-sea-level (geoid) (in meters)
Units	M	meters	Units of antenna altitude, meters
Geoidal Separation	17.2	meters	
Units	M	meters	Units of geoidal separation, meters
Age of diff. GNSS data		second	Null fields when DGPS is not used
Diff. Ref. Station ID			Differential reference station ID, 0000-1023
Checksum	*7E		Checksum
<CR> <LF>			End of message termination

Table 5.1-3 Position Fix Indicators

Value	Description
0	No position fix
1	Autonomous GNSS fix
2	Differential GNSS fix
4	RTK fixed
5	RTK float
6	Estimated/Dead reckoning fix

● **GLL--- Geographic Position – Latitude/Longitude**

Table 5.1-4 contains the values for the following example:

\$GNGLL,2503.71193,N,12138.74582,E,094450.000,A,A\*47

Table 5.1-4 GLL Data Format

Name	Example	Units	Description
Message ID	\$GNGLL		GLL protocol header

Latitude	2503.71193		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74582		dddmm.mmmmm
E/W indicator	E		E=east or W=west
UTC Time	094450.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Mode	A		N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float E = Estimated/Dead reckoning fix
Checksum	*47		
<CR> <LF>			End of message termination

● **GSA---GNSS DOP and Active Satellites**

Table 5.1-5 contains the values for the following example:

- \$GNGSA,A,3,11,195,194,199,08,07,01,27,16,09,23,,1.19,0.64,1.00,1\*3F
- \$GNGSA,A,3,87,81,76,,,,,,,,,1.19,0.64,1.00,2\*0F
- \$GNGSA,A,3,,,,,,,,,1.19,0.64,1.00,3\*09
- \$GNGSA,A,3,34,24,12,07,11,10,08,38,25,09,13,16,1.19,0.64,1.00,4\*02

Table 5.1-5 GSA Data Format

Name	Example	Units	Description
Message ID	\$GNGSA		GSA protocol header
Mode 1	A		See Table 5.1-6
Mode 2	3		See Table 5.1-7
ID of satellite used	11		SV on Channel 1
ID of satellite used	195		SV on Channel 2
....			....
ID of satellite used			SV on Channel 12
PDOP	1.19		Position Dilution of Precision
HDOP	0.64		Horizontal Dilution of Precision
VDOP	1.00		Vertical Dilution of Precision
GNSS system ID	4		See Table 5.1-8
Checksum	*3F		
<CR> <LF>			End of message termination

Table 5.1-6 Mode 1

Value	Description
M	Manually set to operate in 2D or 3D mode
A	Automatically switching between 2D or 3D mode

Table 5.1-7 Mode 2

Value	Description
1	No position fix
2	2D fix
3	3D fix

Table 5.1-8 GNSS system ID

Value	Description
1	GPS
2	GLONASS
3	GALILEO
4	BEIDOU
6	IRNSS

## ● GSV---GNSS Satellites in View

Table 5.1-9 contains the values for the following example:

```
$GPGSV,3,1,09,8,71,268,47,27,63,18,49,11,44,191,46,4,41,237,46,1*54
$GPGSV,3,2,09,16,38,42,42,9,32,279,39,26,22,70,38,31,15,131,36,1*56
$GPGSV,3,3,09,7,15,320,40,1*6B
$GPGSV,1,1,04,8,71,268,50,27,63,18,49,9,32,279,43,26,22,70,42,8*6C
$GLGSV,2,1,05,82,63,47,47,83,56,182,36,80,47,9,42,79,33,85,45,1*71
$GLGSV,2,2,05,81,15,27,37,1*71
$GAGSV,1,1,04,08,48,300,43,03,47,025,45,13,36,309,42,05,06,061,34,7*79
$GAGSV,1,1,04,08,48,300,43,03,47,025,47,13,36,309,43,05,06,061,33,1*7B
$GBGSV,5,1,17,12,80,182,47,24,64,5,51,7,58,355,44,3,57,205,45,1*7C
$GBGSV,5,2,17,1,54,141,44,34,52,211,49,9,48,230,45,10,47,316,42,1*79
$GBGSV,5,3,17,26,44,100,47,16,39,207,43,4,38,117,41,2,37,240,41,1*77
$GBGSV,5,4,17,39,37,210,43,6,36,198,41,38,27,173,41,25,18,317,42,1*4E
$GBGSV,5,5,17,35,16,39,40,1*7F
$GBGSV,1,1,02,24,64,5,50,26,44,100,43,4*77
```

Table 5.1-9 GSV Data Format

Name	Example	Units	Description
Message ID	\$GPGSV		GSV protocol header GP=GPS/QZSS, GL=GLONSS, GA=GALILEO,

			GB=BEIDOU, GI=IRNSS.
Total number of messages	3		Range 1 to 9
Message number	1		Range 1 to 9
Satellites in view	09		
Satellite ID	8		Channel 1
Elevation	71	degrees	Channel 1 (Range 00 to 90)
Azimuth	268	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	47	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
....			....
Satellite ID	4		Channel 4 (Range 01 to 196)
Elevation	41	degrees	Channel 4 (Range 00 to 90)
Azimuth	237	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	46	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Signal ID	1		GPS/QZSS: L1 C/A=1, L5Q=8 GLONASS: L1 C/A=1 GALILEO: E1=7, E5a=1 BEIDOU: B1=1, B2a=4 IRNSS: L6=1
Checksum	*54		
<CR> <LF>			End of message termination

● **RMC---Recommended Minimum Specific GNSS Data**

Table 5.1-10 contains the values for the following example:

\$GNRMC,070143.000,A,2503.71317,N,12138.74533,E,0.002,70.50,130220,,,A,V\*01

Table 5.1-10 RMC Data Format

Name	Example	Units	Description
Message ID	\$GNRMC		RMC protocol header
UTC Time	070143.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2503.7117		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.74533		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.002	knots	True
Course over ground	70.50	degrees	
Date	130220		ddmmyy
Magnetic variation		degrees	

Variation sense			E=east or W=west
Mode	A		N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float E = Estimated/Dead reckoning fix
Navigational status indicator	V		S = Safe C = Caution U = Unsafe V = Void
Checksum	*01		
<CR> <LF>			End of message termination

● **VTG---Course Over Ground and Ground Speed**

Table 5.1-11 contains the values for the following example:

\$GNVTG,0.00,T,,M,0.003,N,0.006,K,A\*26

Table 5.1-11 VTG Data Format

Name	Example	Units	Description
Message ID	\$GPVTG		VTG protocol header
Course over ground	0.00	degrees	Measured heading
Reference	T		True
Course over ground		degrees	Measured heading
Reference	M		Magnetic
Speed over ground	0.003	knots	Measured speed
Units	N		Knots
Speed over ground	0.006	km/hr	Measured speed
Units	K		Kilometer per hour
Mode	A		N = No position fix A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float E = Estimated/Dead reckoning fix
Checksum	*26		
<CR> <LF>			End of message termination



## 5.2 Proprietary NMEA input/output message

### 5.2.1 Query firmware version

**Synopsis:**

```
$PLSC,VER*CK<CR><LF>
```

**Response:**

```
$PLSR,<VER>*CK<CR><LF>
```

**Examples:**

```
$PLSC,VER*61<CR><LF>
```

### 5.2.2 Set the module as a reference station or a rover

**Synopsis:**

```
$PLSC,MCBASE,<MODE>*CK<CR><LF>
```

**Response:**

```
$PLSR,MCBASE,<MODE>*CK<CR><LF>
```

Parameter	Format	Description
MODE	Decimal	0: set up the board as a rover(default) 1: set up the board as a reference station (Output RTCM3.3 1005, 1074, 1084, 1094, 1124 messages)

**Examples:**

```
$PLSC,MCBASE,1*26<CR><LF>
```

### 5.2.3 Set the location of the base station

**Synopsis:**

```
$PLSC,SETBASEXYZ,<X>,<Y>,<Z>*CK<CR><LF>
```

**Response:**

```
$PLSR,BASEXYZ,<X>,<Y>,<Z>*CK<CR><LF>
```

Parameter	Format	Description
X	DDDDDDDD.DDD	WGS-84 ECEF X-axis coordinate (in meters)
Y	DDDDDDDD.DDD	WGS-84 ECEF Y-axis coordinate (in meters)
Z	DDDDDDDD.DDD	WGS-84 ECEF Z-axis coordinate (in meters)

**Examples:**

```
$PLSC,SETBASEXYZ,-3028442.081,4923062.884,2687870.875*03<CR><LF>
```

### 5.2.4 Set the fix rate

**Synopsis:**

```
$PLSC, FIXRATE,<FIXRATE>*CK<CR><LF>
```

**Response:**

```
$PLSR, FIXRATE,<FIXRATE>*CK<CR><LF>
```

Parameter	Format	Description
FIXRATE	Decimal	1: the fix rate is 1Hz (default) 5: the fix rate is 5Hz

**Examples:**

```
$PLSC, FIXRATE, 5*6C <CR><LF>
```

### 5.2.5 GST message output

**Synopsis:**

```
$PAIR062, 8, <OUTPUT_MODE>*CS<CR><LF>  
$PAIR513*CS<CR><LF>
```

Parameter	Format	Description
OUTPUT_MODE	Decimal	0: disable \$GNGST output (default) 1: enable \$GNGST output

**Examples:**

```
$PAIR062, 8, 1*37 <CR><LF>
```

Note: Changing fix rate from 1Hz to 5Hz will reset the settings to factory default.

### 5.2.6 PLSV message output

**Synopsis:**

```
$PAIR100, 1, <OUTPUT_MODE>*CS<CR><LF>  
$PAIR513*CS<CR><LF>
```

Parameter	Format	Description
OUTPUT_MODE	Decimal	0: disable \$PLSV output (default) 1: enable \$PLSV output

**Examples:**

```
$PAIR100, 1, 1*3B <CR><LF>
```

Note: Changing fix rate from 1Hz to 5Hz will reset the settings to factory default.

## 6 How to make sure PPS through USB is working on Linux Ubuntu?

GPSD is a daemon used to handle NMEA and PPS information on Linux system. GPSD client application called "gpsmon" could be used to check if PPS is working on Linux Ubuntu. "gpsmon" is a monitor that watches packets coming from a GPS receiver and displays them along with diagnostic information. Here provides steps for GPSD installation and PPS performance on Linux system.

The user can check if a GPSD program has been installed by using the following command.

**\$ps ax | grep gps**

```
cloud@CloudxUBT: ~
cloud@CloudxUBT:~$ ps ax | grep gps
19446 ?        S<sl    0:00  /usr/sbin/gpsd -N -n /dev/ttyUSB0
19482 pts/4    S+      0:00  gpsmon
19504 pts/17   S+      0:00  grep --color=auto gps
```

The user can install GPSD package by the following commands if it is not yet installed.

**\$sudo apt-get update**

**\$sudo apt-get install gpsd-clients gpsd**

```
cloud@CloudxUBT:~$ sudo apt-get update
Hit:1 http://tw.archive.ubuntu.com/ubuntu xenial InRelease
Hit:2 http://tw.archive.ubuntu.com/ubuntu xenial-updates InRelease
Hit:3 http://tw.archive.ubuntu.com/ubuntu xenial-backports InRelease
Hit:4 http://security.ubuntu.com/ubuntu xenial-security InRelease
Reading package lists... Done
cloud@CloudxUBT:~$ sudo apt-get install gpsd-clients gpsd
Reading package lists... Done
Building dependency tree
Reading state information... Done
```

Before starting GPSD, the user should connect GNSS module to USB port. Linux system normally enumerates a USB device such as "/dev/ttyUSB0" in this case. The user can use the following command to check if GNSS module is connected.

**\$ls /dev/ttyU\***

```
cloud@CloudxUBT:~$ ls /dev/ttyU*
/dev/ttyUSB0
```

Now the user gets the device name as "/dev/ttyUSB0". Using the following command to configure GPSD file.

**\$sudo gedit /etc/default/gpsd**

```
cloud@CloudxUBT: ~
cloud@CloudxUBT:~$ sudo gedit /etc/default/gpsd
[sudo] password for cloud:
```

Please set the device name as **DEVICE="/dev/ttyUSB0"** and GPSD options with no wait parameter as **GPSD\_OPTIONS="-n"**.

```
gpsd (/etc/default) - gedit
# Default settings for the gpsd init script and the hotplug wrapper.

# Start the gpsd daemon automatically at boot time
START_DAEMON="true"

# Use USB hotplugging to add new USB devices automatically to the daemon
USB_AUTO="true"

# Devices gpsd should collect to at boot time.
# They need to be read/writeable, either by user gpsd or the group dialout.
DEVICES="/dev/ttyUSB0"

# Other options you want to pass to gpsd
GPSD_OPTIONS="-n"
```

Then restart GPSD service by the following command.

### \$sudo service gpsd restart

```
cloud@CloudxUBT:~$ sudo service gpsd restart
[sudo] password for cloud:
```

Using the following command to check if GPSD is working as expected. (“-n” and “/dev/ttyUSB0” parameters)

### \$ps aux | grep gpsd

```
cloud@CloudxUBT:~$ ps aux | grep gpsd
gpsd      2786  0.1  0.2 115980 4104 ?        S<sL 10:04   0:12 /usr/sbin/gpsd -N -n /dev/ttyUSB0
cloud    3412  0.0  0.0  21572  1084 pts/17   S+   13:37   0:00 grep --color=auto gpsd
```

Execute the GPSD client program.

### \$gpsmon

```
cloud@CloudxUBT: ~
/dev/ttyUSB0 u-blox>
Ch PRN Az EL S/N Flag U
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
NAV_SVINFO
00000000000100000000000000006900ff0cff000000f722
(26) b5620104120010144d0c750069003300440050000f270f27a510
(24) b5620120100010144d0c90c40500cb07120700000000f208
```

ECEF Pos: -3033216.97m +4921615.83m +2685348.87m  
 ECEF Vel: +0.00m/s +0.00m/s +0.01m/s

LTP Pos: 25.061926663° 121.645740207° 121.75m  
 LTP Vel: 0.01m/s 0.0° 0.00m/s

Time: 23 21:16:20.00  
 Time GPS: 1995+206378.000 Day: 2

Est Pos Err 2.58m Est Vel Err 0.00m/s  
 PRNs: 12 PDOP: 1.1 Fix 0x03 Flags 0x0f  
 NAV\_SOL

DOP [H] 0.8 [V] 0.7 [P] 1.1 [T] 0.5 [G] 1.2  
 NAV\_DOP

TOFF: 0.236903389 PPS: 0.009320523

As shown above, PPS is detected with delay of 0.009320523 seconds to the local clock while delay of GPS is 0.236903389 seconds (shown by TOFF)

7 Pin assignment and descriptions

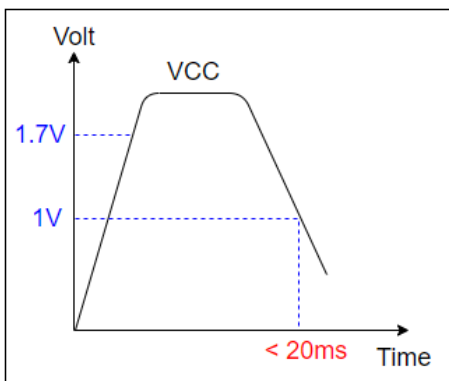
Table 6-1 Pin descriptions of PCIe Mini card

Pin #	Name	Type	Description	Note
1	NC			
2	NC			
3	NC			
4	GND	P	Ground	
5	NC			
6	NC			
7	NC			
8	NC			
9	GND	P	Ground	
10	NC			
11	NC			
12	NC			
13	NC			
14	NC			
15	GND	P	Ground	
16	NC			
17	NC			
18	GND	P	Ground	
19	NC			
20	/W_DISABLE	I	Power control input pin. Internal pull-up resistor. High: power on; Low: power off	
21	GND	P	Ground	
22	NC			
23	NC			
24	NC			
25	NC			
26	GND	P	Ground	
27	GND	P	Ground	
28	NC			
29	GND	P	Ground	
30	NC			
31	NC			
32	NC			
33	NC			

34	GND	P	Ground	
35	GND	P	Ground	
36	USB_D-		USB D- line	
37	GND	P	Ground	
38	USB_D+		USB D+ line	
39	NC			
40	GND	P	Ground	
41	NC			
42	NC			
43	GND	P	Ground	
44	NC			
45	NC			
46	NC			
47	NC			
48	NC			
49	NC			
50	GND	P	Ground	
51	NC			
52	VCC	P	DC supply input. Must be clean and stable.	1

<Note>

1. If an abnormal input voltage as shown in the figure below is input, even if the correct voltage is input again later, the module may not work until the built-in micro battery is exhausted.



## 8 DC & Temperature characteristics

### 8.1 DC Electrical characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Voltage	VCC		3.0		3.6	V
Supply Current	I <sub>SS</sub>	VCC = 3.3V, Peak Tracking Power off		80 <sup>(2)</sup> < 1 <sup>(3)</sup>	150 <sup>(1)</sup>	mA mA uA
High Level Input Voltage	V <sub>IH</sub>	/W_DISABLE pin	1.3		VCC	V
Low Level Input Voltage	V <sub>IL</sub>	/W_DISABLE pin			0.25	V

<Note>

1. Measured with 1MHz sampling rate.
2. Measured when position fix (1Hz) is available and input voltage is 3.3V.
3. Measured when /W\_DISABLE pin is at low level.

### 8.2 Temperature characteristics

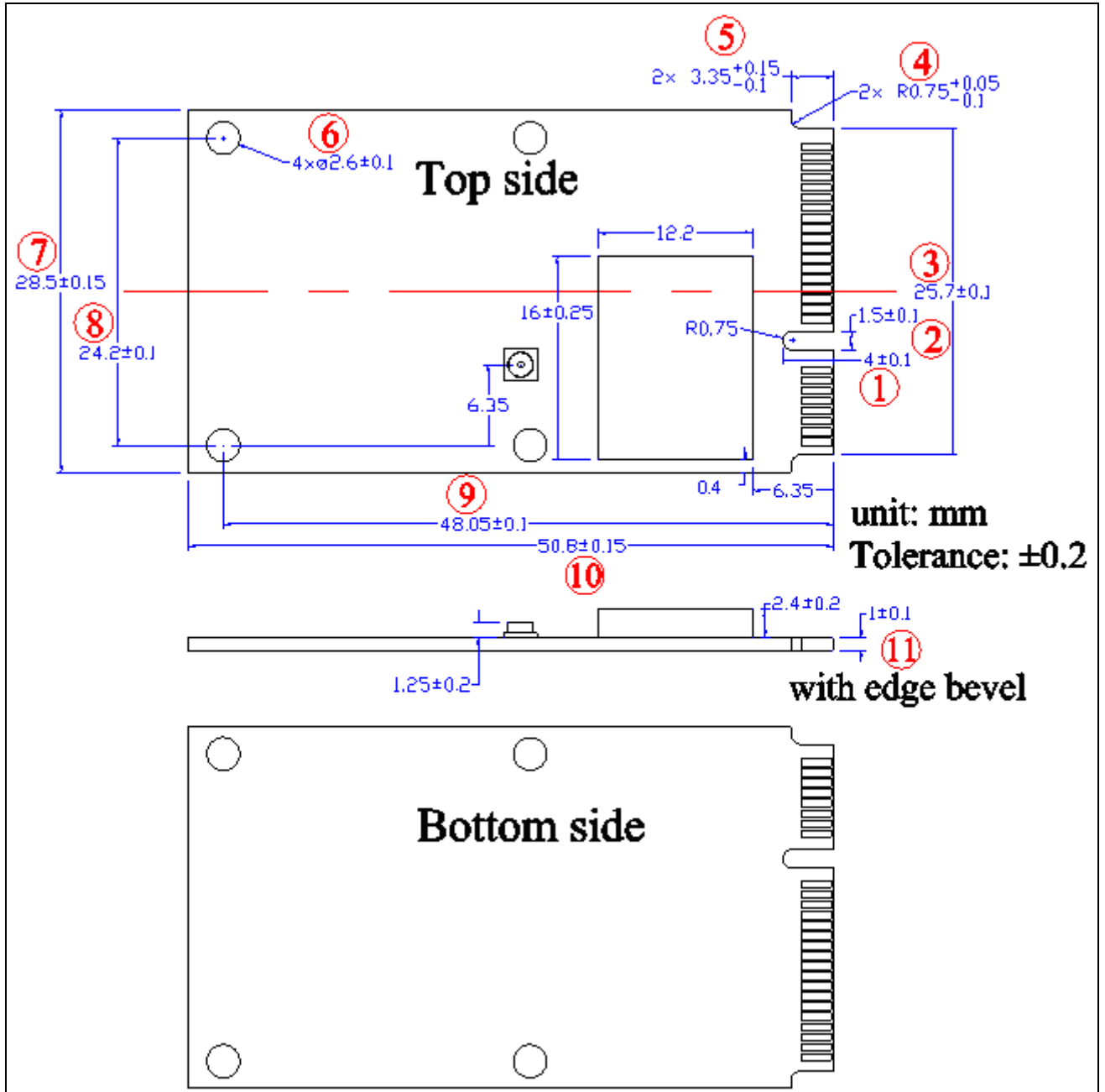
Parameter	Symbol	Min.	Typ.	Max.	Units
Operating Temperature	T <sub>opr</sub>	-40	-	85	°C
Storage Temperature	T <sub>stg</sub>	-40	25	85	°C

Note the operating and storage temperature of the built-in micro battery are -20 ~ +60 °C and -40 ~ +60 °C respectively. The module will still work even the battery is broken or short due to temperature or other issues.

9 Mechanical specification

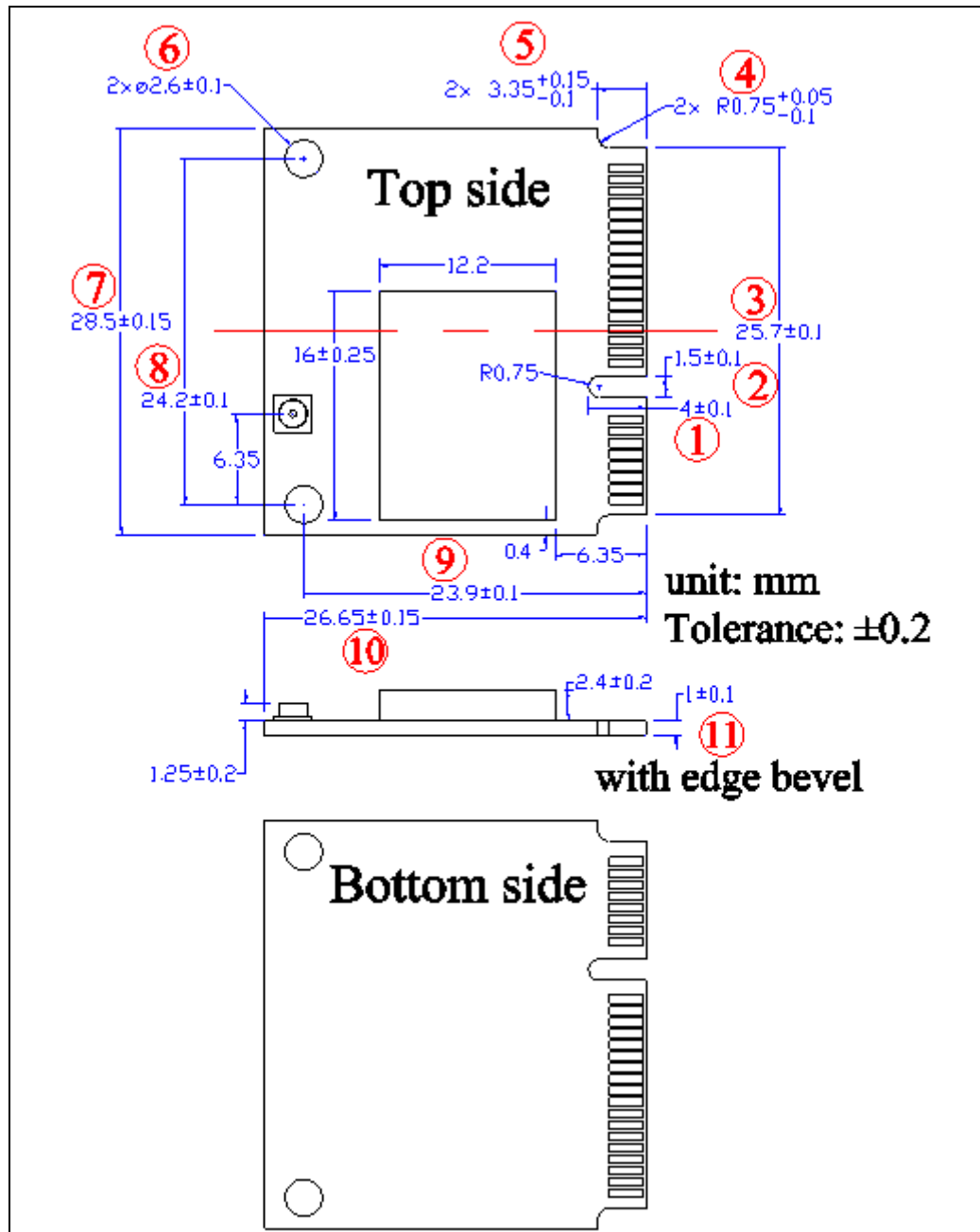
The dimension and pin definition are compliant with PCI Express Mini Card Revision 1.2.

9.1 Outline dimensions of LS26030-15R





9.2 Outline dimensions of LS26031-15R

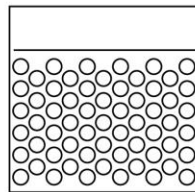


### 10 Packing information

Both LS26030-15R and LS26031-15R use the same package.

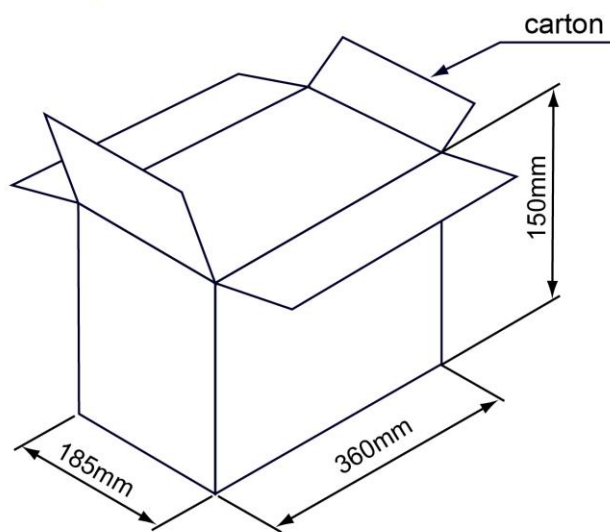


1pcs in an antistatic bag



6pcs in a bubble bag

30 bubble bags in a carton  
(180pcs)



Tolerance:  $\pm 10$  mm

## Document change list

### Revision 0.1

- Draft release on July 6, 2021.

### Revision 0.2 (November 17, 2021)

- Added “Support PPS through USB” in section 2 and 4.
- Changed Fig 3-1
- Added 5Hz, 10Hz update rate in section 4.
- Changed default NMEA sentences in section 4.
- Added section 6.
- Changed 49<sup>th</sup> pin from TIMEMARK to NC in section 7. Removed the corresponding function.

### Revision 0.3 (December 22, 2021)

- Changed the packaging in section 10.