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Product Name	Description	Version
LC20030-35AD	Dual-frequency multi-constellation GNSS smart antenna, USB	0.4
LC20031-35AD	Dual-frequency multi-constellation GNSS smart antenna, TTL	
LC20032-35AD	Dual-frequency multi-constellation GNSS smart antenna, RS232	

Antenna side

LC20030-35AD

LC20031-35AD

LC20032-35AD

1 Introduction

LC2003x-35AD series products are high-performance dual-band GNSS UDR (Untethered Dead Reckoning) smart antenna modules, including an embedded antenna and GNSS receiver circuits, designed for a broad spectrum of OEM system applications. The GNSS smart antenna will acquire both L1 and L5 signals at a time while providing the better standalone position accuracy and continue to work where GNSS signals are poor or not available. It can provide user with fast Time-To-First-Fix, superior sensitivity and low power consumption.

2 Features

- Concurrent reception of L1 and L5 band signals
- Support GPS, GLONASS, BEIDOU, GALILEO, QZSS
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN)
- GNSS module built-in TDK-42670-P 6-axis MEMS
- Support 135-channel GNSS
- Fast TTFF at low signal level
- Build-in gold capacitor to reserve system data for rapid satellite acquisition
- LED indicator for GNSS fix or not

3 Application

- Automotive navigation and fleet management
- Marine navigation

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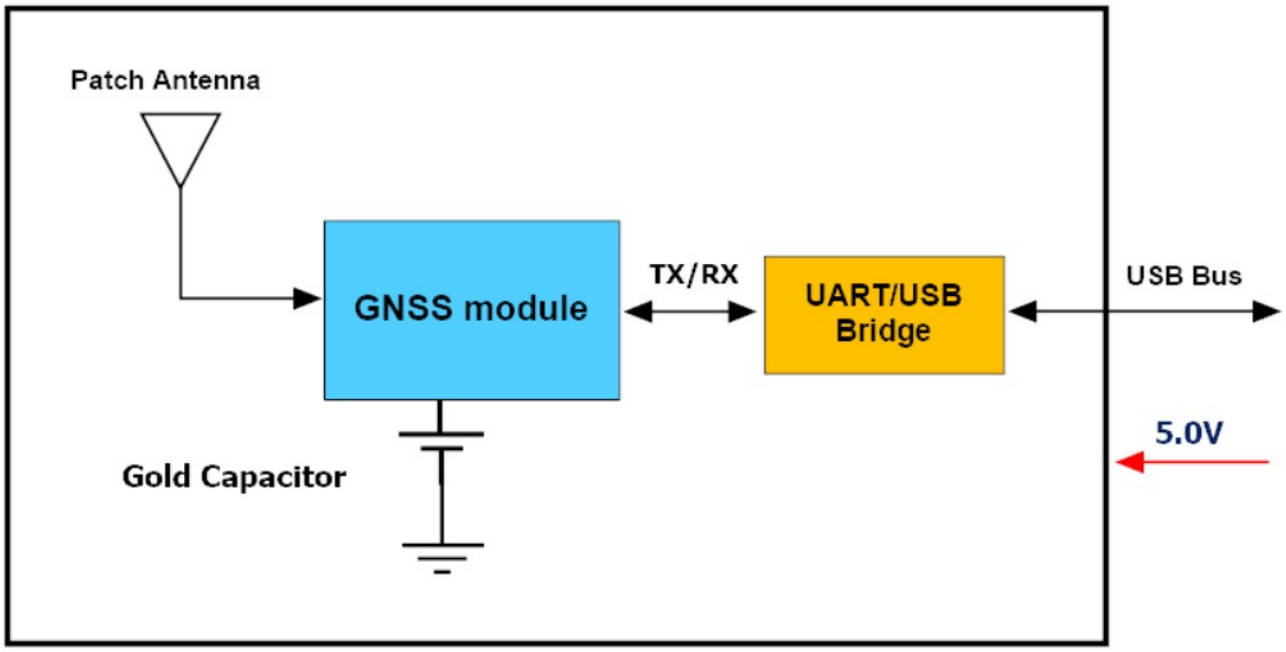

Fig 3-1 System block diagram of LC20030-35AD

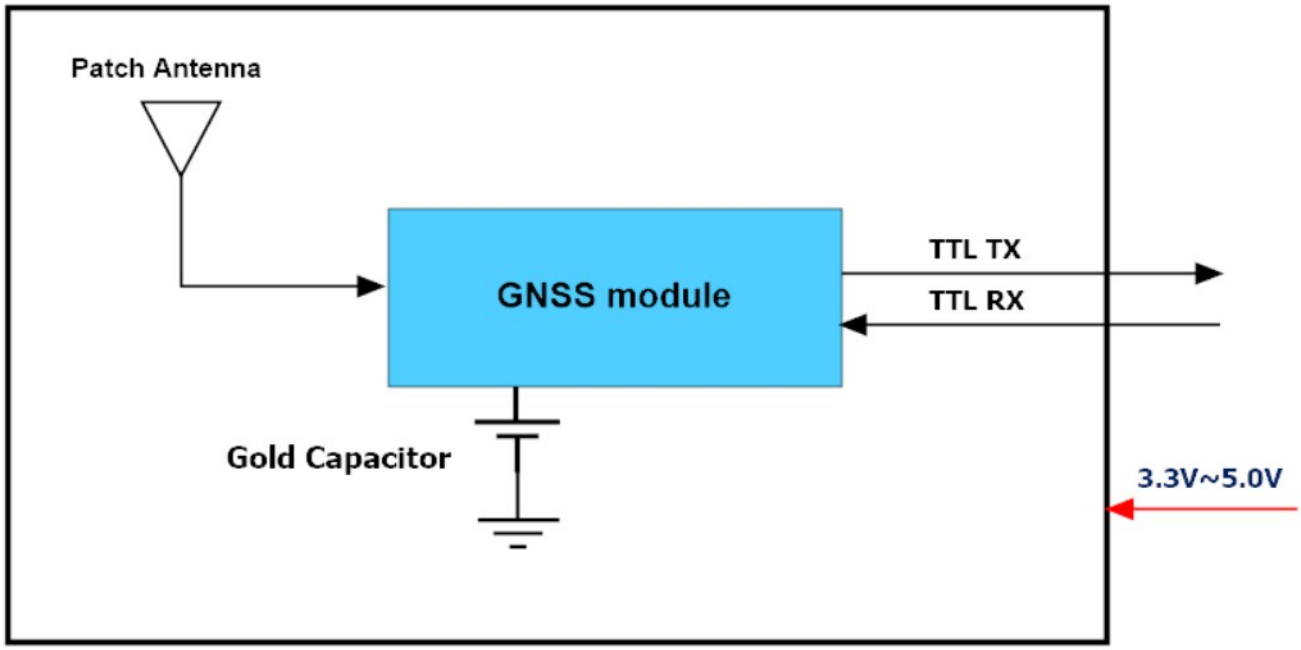

Fig 3-2 System block diagram of LC20031-35AD

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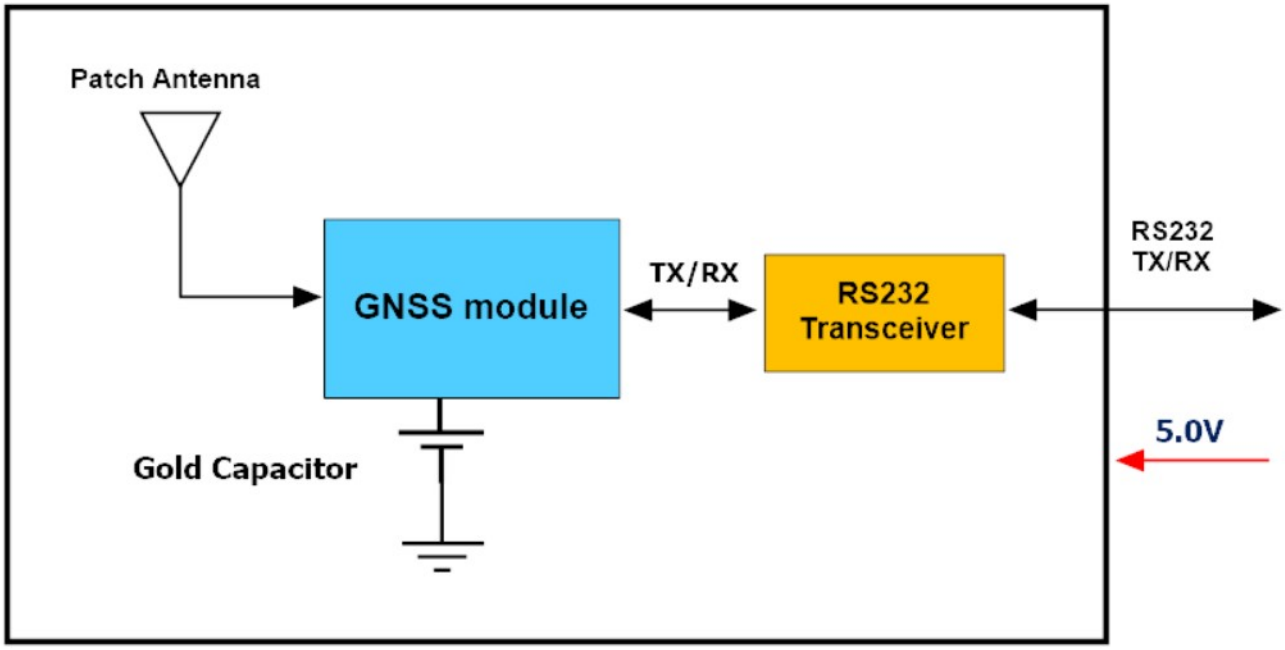

Fig 3-3 System block diagram of LC20032-35AD

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4 Recommended configuration

The LC2003x-35AD must be securely attached before power on, there is no requirements for installation orientation; do not move LC2003x-35AD after power on.

After power on, make vehicle keep static at least 5-10 seconds to complete the attitude initialization. It is necessary to keep the vehicle drive in an open sky area for several minutes for the DR algorithm convergence of integrated navigation system.

5 GNSS receiver

Frequency	GPS/QZSS: L1 C/A, L5C GLONASS: L1OF GALILEO: E1, E5a BEIDOU: B1I, B2a	
Channels	Support 135 channels	
Update rate	1Hz default	
Acquisition Time	Hot start (Open Sky)	1s (typical)
	Cold Start (Open Sky)	24s (typical) without AGPS
Position Accuracy	Autonomous	1.5m (CEP), 24hr, static at open sky
	UDR Mode	CEP ≤ 3% of distance travelled without GNSS
Datum	WGS-84 (default)	
Max. Altitude	< 18,000 m	
Max. Velocity	< 500 m/s	
Protocol Support	115200 bps , 8 data bits, no parity, 1 stop bits (default)	
	NMEA 0183 ver. 4.1	1Hz: GGA, GLL, GSA, GSV, RMC, VTG
	Proprietary message	1Hz: PLSATTIT

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6 Software interface

6.1 NMEA output message

Table 6.1-1 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 6.1-2 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 6.1-2 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 6.1-3
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

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Table 6.1-3 Position Fix Indicators

Value	Description
0	No position fix
1	Autonomous GNSS fix
2	Differential GNSS fix

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

Table 6.1-4 contains the values for the following example:

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

Table 6.1-4 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 E = Estimated/Dead reckoning fix
Checksum	*47		
<CR> <LF>			End of message termination

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

Table 6.1-5 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 6.1-5 GSA Data Format

Name	Example	Units	Description
Message ID	$GNGSA		GSA protocol header
Mode 1	A		See Table 6.1-6
Mode 2	3		See Table 6.1-7
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	1		See Table 6.1-8
Checksum	*3F		
<CR> <LF>			End of message termination

Table 6.1-6 Mode 1

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

Table 6.1-7 Mode 2

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

Table 6.1-8 GNSS system ID

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

- **GSV---GNSS Satellites in View**

Table 6.1-9 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

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$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 6.1-9 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 6.1-10 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 6.1-10 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	2503.71317		ddmm.mmmmm
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 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 6.1-11 contains the values for the following example:

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

Table 6.1-11 VTG Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNVTG		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

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			D = Differential GNSS fix E = Estimated/Dead reckoning fix
Checksum	*26		
<CR> <LF>			End of message termination

6.2 Proprietary output messages

- **PLSATTIT**

Table 6.2-1 contains the values for the following example:

$PLSATTIT,061030.000,120723,3,2,0,155.54,0.70,-0.41,25.0619348,121.6561793,30.39,-27.99,11.84,0.06,37.00,21. 66,0.0,0.0*2D

Table 6.2- 1 PLSATTIT Data Format

Name	**Example**	**Units**	**Description**
Message ID	$PLSATTIT		PLSATTIT protocol header
UTC Time	061030.000		hhmmss.sss
Date	120723		ddmmyy
DR_Stage	3		DR algorithm stage, 0: unknown, 1: initializing, 2: coarse, 3: stable.
Static_Status	2		User static status, 0: unknown, 1: static, 2: dynamic
Motion_Alarm	0		User motion detection alarm, 0: unknown 1: HARSH_ACCELERATION 2: HARSH_DECELERATION 4: HARSH_TURN 8: HARSH_LANE_CHANGE 16: HORIZONTAL_COLLISION 32: ROLLOVER 64: STABILITY_WARNING 128: EULER_ANOMALY
Vehicle_Heading	155.54	degree	0~360
Vehicle_Pitch	0.70	degree	-180~180
Vehicle_Roll	-0.41	degree	~180~180
Latitude	25.0619348	degree	dd.ddddddd, latitude in WGS84
Longitude	121.6561793	degree	dd.ddddddd, longitude in WGS84
Ground_Speed	30.39	km/hr	Speed over ground (2D)
Velocity_North	-27.99	km/hr	Velocity in north direction
Velocity_East	11.84	km/hr	Velocity in east direction

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Velocity_Down	0.06	km/hr	Velocity in down direction
Height_WGS84_Ellipsoid	37.00	meter	Altitude above WGS84 ellipsoid
Height_Mean_Sea_Level	21.66	meter	Altitude above mean sea level
Reserved1	0.0		
Reserved2	0.0		
Checksum	*2D		
<CR><LF>			

6.3 Proprietary commands

The commonly used commands are in the following.

6.3.1 ID: 004

[Description]

Hot Start. Use the available data in the NVRAM.

[Data Field]

$PAIR004*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

Send:

$PAIR004*3E\r\n

Response:

$PAIR001,004,0*3F\r\n ==> Success

6.3.2 ID: 005

[Description]

Warm Start. Not using Ephemeris data at the start.

[Data Field]

$PAIR005*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

Send:

$PAIR005*3F\r\n

Response:

$PAIR001,005,0*3E\r\n ==> Success

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6.3.3 ID: 006

[Description]

Cold Start. Not using the Position, Almanac and Ephemeris data at the start.

[Data Field]

$PAIR006*CS<CR><LF>

[Return]

PAIR_ACK for send result.

[Example]

Send:

$PAIR006*3C\r\n

Response:

$PAIR001,006,0*3D\r\n ==> Success

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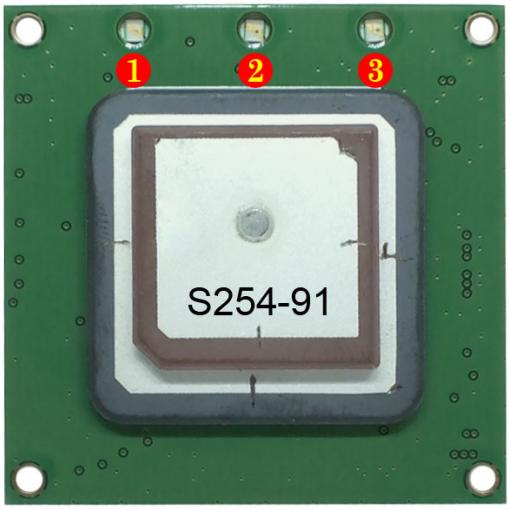
7 LED indicator



LED	Color	Descriptions
1	Blue	PPS Indicator
2	Red	Power Indicator
3	Green	TX Indicator

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8 Pin assignment and descriptions

- **LC20030-35AD**

Pin #	Name	Type	Description
1	VCC	I	DC supply input.
2	USB_DM		USB D-
3	USB_DP		USB D+
4	TIMEPULSE*	O	PPS, default 100ms pulse/sec when 3D fix is available
5	GND	P	Ground
6	GND	P	Ground
7	GND	P	Ground
8	GND	P	Ground
9	GND	P	Ground

Note: The Timepulse(PPS) signal also connect to DCD(Data Carrier Detect) pin.

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- **LC20031-35AD**

Pin #	Name	Type	Description
1	VCC	I	DC supply input.
2	RXD	I	UART, asynchronous input, TTL level
3	TXD	O	UART, asynchronous output, TTL level
4	TIMEPULSE	O	PPS, default 100ms pulse/sec when 3D fix is available
5	GND	P	Ground
6	GND	P	Ground
7	GND	P	Ground
8	GND	P	Ground
9	GND	P	Ground

- **LC20032-35AD**

Pin #	Name	Type	Description
1	VCC	I	DC supply input.
2	RXD	I	UART, asynchronous input, RS232 level
3	TXD	O	UART, asynchronous output, RS232 level
4	TIMEPULSE	O	PPS, default 100ms pulse/sec when 3D fix is available
5	GND	P	Ground
6	GND	P	Ground
7	GND	P	Ground
8	GND	P	Ground
9	GND	P	Ground

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9 DC & Temperature characteristics

9.1 DC Electrical characteristics

Parameter	Symbol	Product	Min.	Typ.	Max.	Units
Input voltage	VCC	LC20030-35AD LC20031-35AD LC20032-35AD	4.75 3.30 4.75	5.0 3.3 5.0	5.25 5.25 5.25	V
Input current	Icc	LC20030-35AD LC20031-35AD LC20032-35AD		62(1) 65(1)/60(2) 66(1)		mA
High Level Input Voltage	V_{IH}	LC20031-35AD	0.7*VCC		VCC	V
Low Level Input Voltage	V_{IL}	LC20031-35AD	0		0.2*VCC	V
High Level Output Voltage	V_{OH}	LC20031-35AD	VCC-0.4			V
Low Level Output Voltage	V_{OL}	LC20031-35AD			0.4	V
High Level Output Current	I_{OH}	LC20031-35AD		4		mA
Low Level Output Current	I_{OL}	LC20031-35AD		4		mA

Note 1: Measured at VCC = 5.0V when position fix (1Hz) is available.

Note 2: Measured at VCC = 3.3V when position fix (1Hz) is available.

9.2 Temperature characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units
Operating Temperature	Topr	-10	-	60	℃
Storage Temperature	Tstg	-10	25	60	℃

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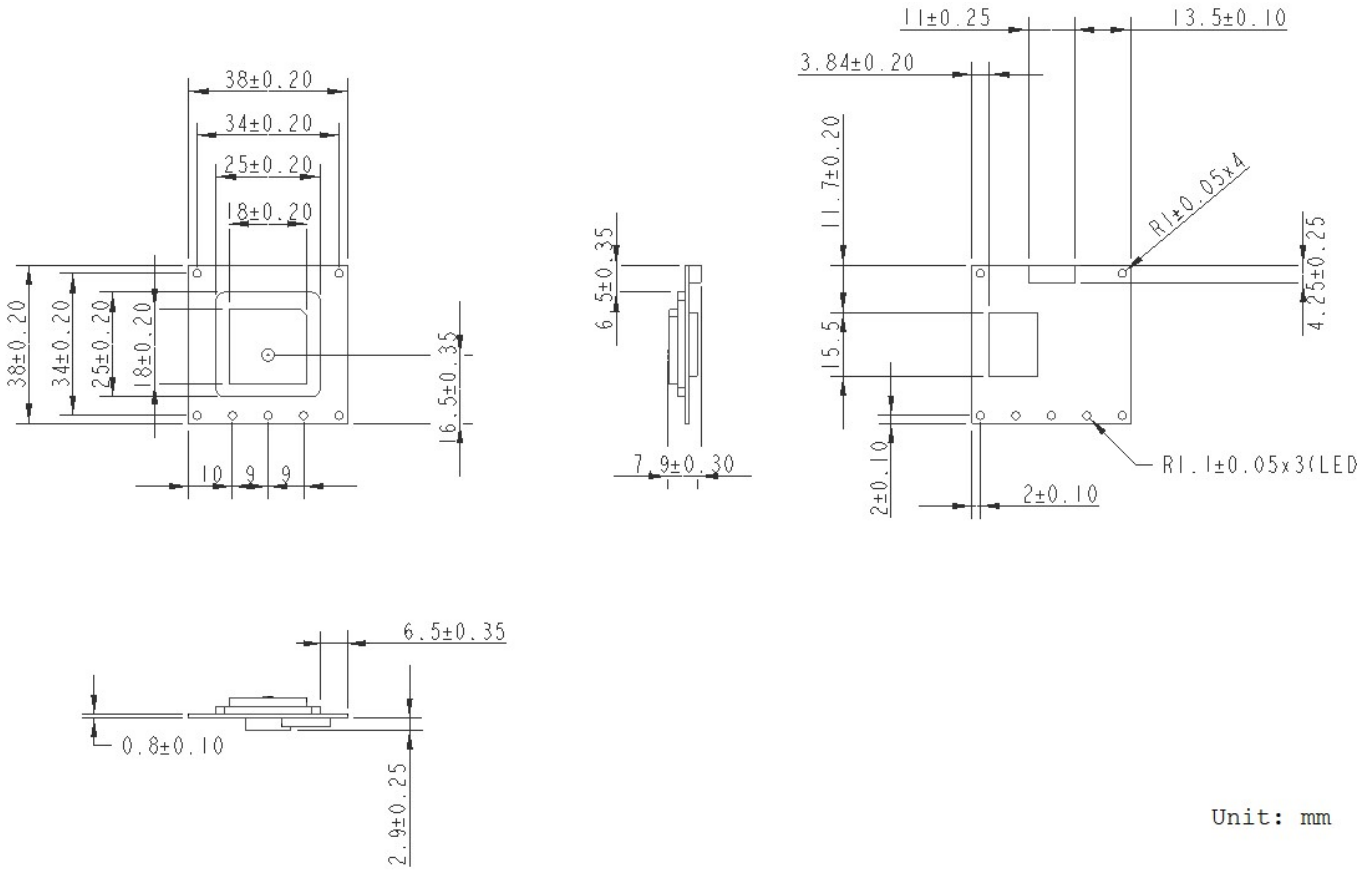
10 Mechanical specification



Unit: mm

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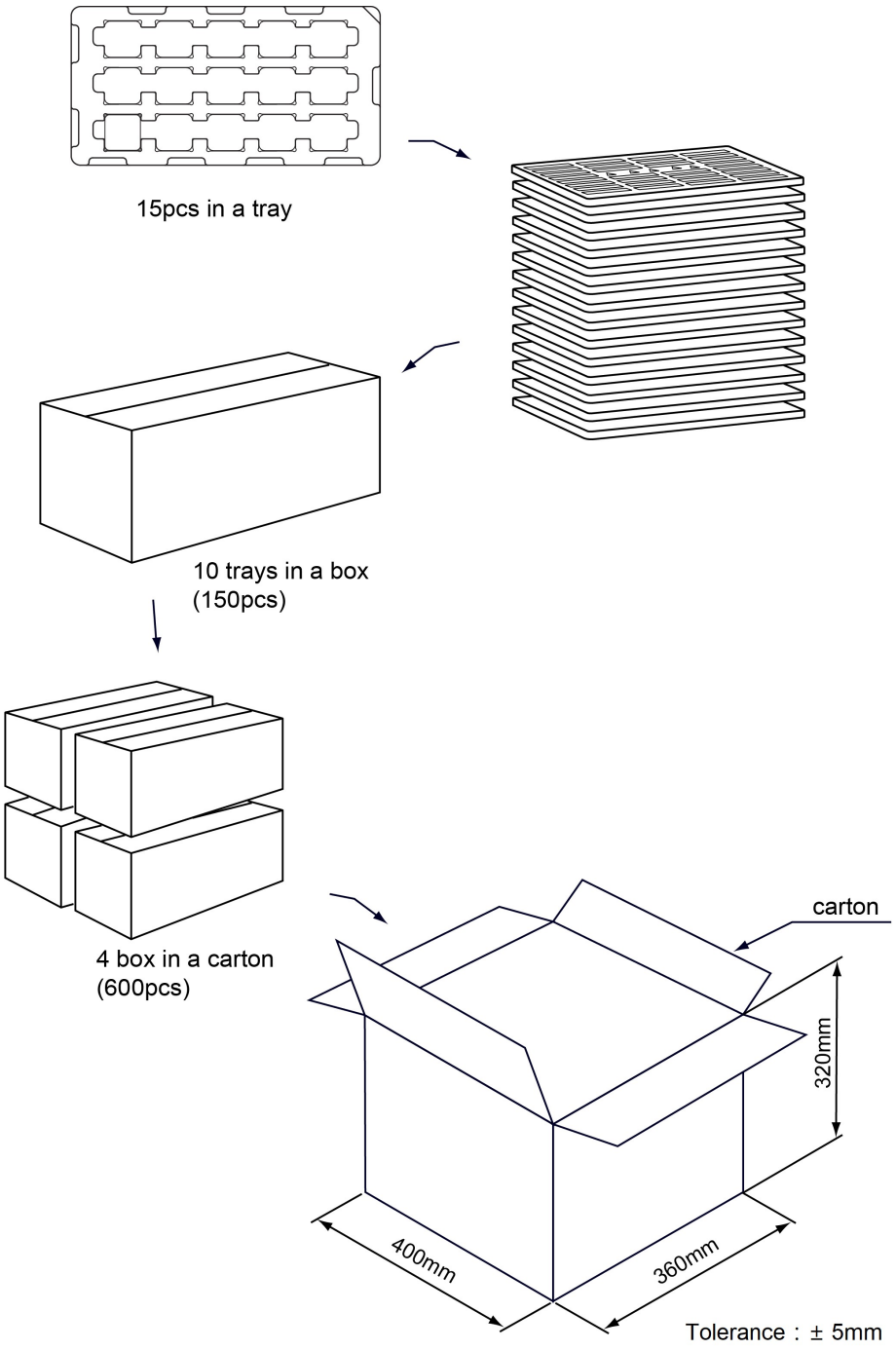
11 Product handling

11.1 ESD precaution

GNSS modules are electrostatic sensitive devices. Handling the modules without proper ESD protection may result in severe damage to them. ESD protection must be implemented throughout the processing, handling and even when the modules are being returned for repair.

11.2 Packaging



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12 Ordering information

Product name	Description	Remark
LC20030-35AD	Dual-frequency multi-constellation GNSS smart antenna, USB	GPS/QZSS: L1 C/A, L5C GLONASS: L1OF GALILEO: E1, E5a BEIDOU: B1I, B2a
LC20031-35AD	Dual-frequency multi-constellation GNSS smart antenna, TTL	
LC20032-35AD	Dual-frequency multi-constellation GNSS smart antenna, RS232	

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Document change list

Revision 0.1

- Draft release on May 3, 2023.

Revision 0.2 (June 2, 2023)

- Changed pin 5、6、7、8 from NC to GND in section 8.
- Changed the operating and storage temperature (Min.) from -20℃ to -10 ℃ in section 9.2.
- Revised the mechanical specification in section 10.

Revision 0.3 (August 10, 2023)

- Add the PLSATTIT output in the section 5.
- Removed the PAIRMSG in the section 5.
- Removed the PAIRMSG,90 and PAIRMSG,91 in section 6.2.
- Add the PLSATTIT in section 6.2.

Revision 0.4 (December 19, 2023)

- Removed the storage the section 11.3.