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Product name	Description	Version
ST-1612i-UDG	Datasheet of ST-1612i-UDG multiple GNSS module with UDR	0.1

1 Introduction

LOCOSYS ST-1612i-UDG Dead Reckoning (DR) module is the perfect solution for automotive application. ST-1612i-UDG not only supports multi-constellation GNSS that includes GPS, GLONASS, GALILEO and QZSS, but also has inertial sensors (3-axis accelerometers and 3-axis gyros) to provide dead reckoning. Besides, no need of odometer connection and auto calibration function make it easy to use. With these features, ST-1612i-UDG can continue to work where GNSS signals are poor or not available and deliver seamless car navigation.

ST-1612i-UDG modules use AEC-Q100 qualified GNSS chips and are manufactured in IATF 16949 certified sites.

2 Features

- STMicroelectronics Teseo III high sensitivity solution
- AEC-Q100 qualified for automotive grade
- Support GPS, GLONASS, GALILEO and QZSS
- Capable of SBAS (WAAS, EGNOS, MSAS)
- Fast TTFF at low signal level
- Built-in Dead Reckoning (DR) software
- Built-in MEMS sensor (3-axis Gyroscope and 3-axis Accelerometer)
- Support SAE J2945/1 On-board system requirement for V2V safety communication
- IATF 16949 quality control
- Small form factor 16 x 12.2 x 2.3 mm
- SMD type, RoHS compliant

3 Application

- Autonomous Vehicle Guidance
- Autonomous Vehicle (ex: AVN/T-BOX/HUD)

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- Internet of Vehicles
- Unmanned Aerial Vehicles
- Precision Agriculture
- Hand-Held Device
- AGV Robotics
- V2V / V2X System
- Geographical measurement
- Geographical survey points
- Tracker

4 System Block Diagram

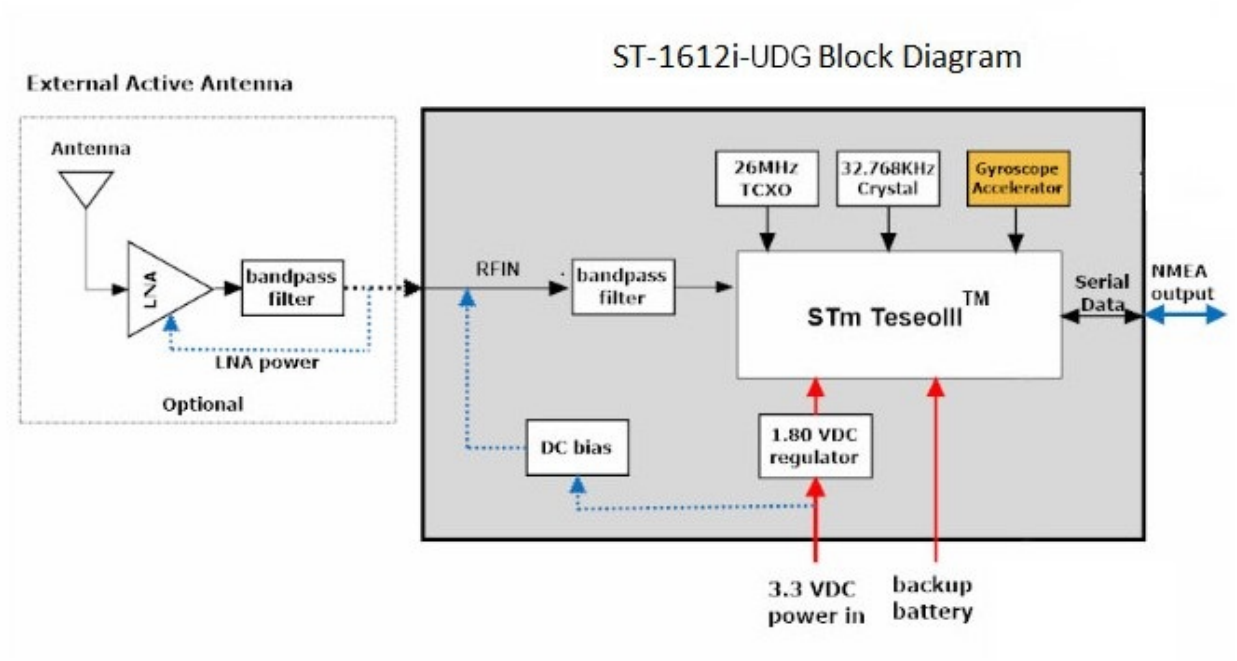

Fig 4-1 System block diagram.

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5 GNSS receiver

5.1 GNSS receiver

Chip	Teseo III Series	
Frequency	GPS, GALILEO, QZSS: L1 1575.42MHz, C/A code GLONASS: L1 1598.0625MHz ~ 1605.375MHz, C/A code	
Channels	Support 48 channels	
Update rate	1Hz default	
Sensitivity	Tracking(1)	-163dBm
	Cold start(2)	-147dBm
Acquisition Time	Cold Start (Open Sky)	32s (typical)
	Hot Start (Open Sky)	1s (typical)
Position Accuracy	Autonomous	1.8m CEP
	SBAS	1.5m (depends on accuracy of correction data)
	UDR Mode(3)	Avg 5.0 %(4)
Max. Altitude	< 18,000 m	
Max. Velocity	< 515 m/s	
Protocol Support	NMEA 0183 ver 3.01	115200 bps(5), 8 data bits, no parity, 1 stop bits (default) 1Hz(5): GGA, GLL, GSA, GSV, RMC, VTG, ZDA

Note1: For signal tracking sensitivity. With a good external LNA (Noise figure <=1.0dB, Gain>=13dB).
Note2: With a good external LNA (Noise figure <=1.0dB, Gain>=13dB).
Note3: Typical Error incurred without GNSS as a percentage of distance travelled.
Note4: Distance travelled (without GNSS)
Note5: Both baud rate and output message rate are configurable to be factory default. Please contact us for change.

5.2 MEMS Sensor

The ST-1612i-UDG receiver support Dead Reckoning (DR) function, it composed by a 3-axis Gyroscope and 3-axis Accelerometer. To provide optimal solution it needs to calibrate sensor parameters. The sensor parameters are initialized to default values allowing system to start up when no other better information is available, if system is started for the first time in an unknown vehicle gyroscope dedicated maneuvers are required and algorithms able to estimate these parameters.

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6 Pin assignment and descriptions

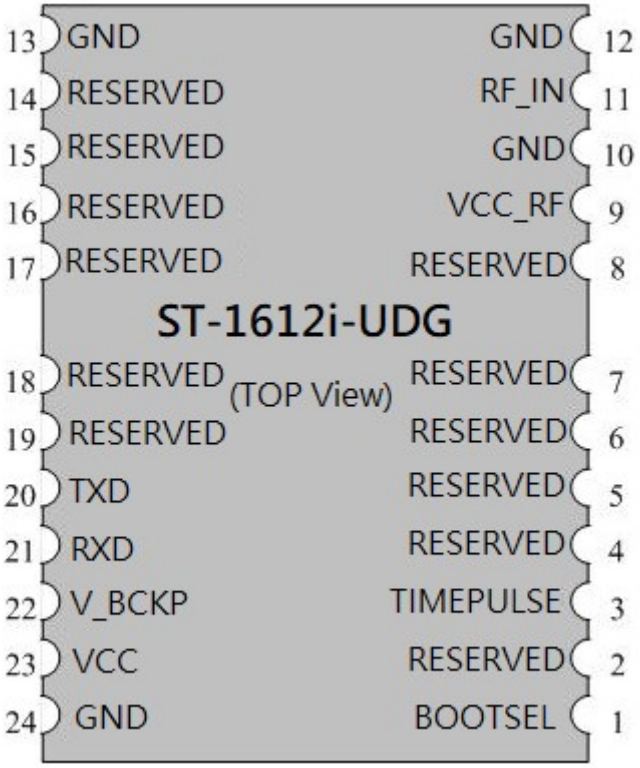

Table 6-1 Pin descriptions

Pin #	Name	Type	Description	Note
1	BOOTSEL		For firmware update use only, please keep floating	1
2	RESERVED		Reserved, keep floating	
3	TIMEPULSE	O	Time pulse (1PPS, default 500 ms pulse/sec, 3.3V Typical)	
4	RESERVED		Reserved, keep floating	
5	RESERVED		Reserved, keep floating	
6	RESERVED		Reserved, keep floating	
7	RESERVED		Reserved, keep floating	
8	RESERVED		Reserved, keep floating	
9	VCC_RF	O	Output voltage for active antenna	
10	GND	P	Ground	
11	RFIN	I	GNSS RF signal input	
12	GND	P	Ground	
13	GND	P	Ground	
14	RESERVED		Reserved, keep floating	
15	RESERVED		Reserved, keep floating	

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16	RESERVED		Reserved, keep floating	
17	RESERVED		Reserved, keep floating	
18	RESERVED		Reserved, keep floating	
19	RESERVED		Reserved, keep floating	
20	TXD	O	UART, asynchronous output (Default NMEA)	
21	RXD	I	UART, asynchronous input	
22	V_BCKP	P	Backup battery supply voltage	2
23	VCC	P	DC supply voltage	3
24	GND	P	Ground	

Note1: If needs update firmware, please pull high into boot mode, else keep floating.

Note2: In order to stabilize the V_BACKP power supply, placement of 10uF and 0.1uF capacitor is required to be close to the module.

Note3: The module is operated in fully functions, if customer want to turn module off for power saving reason, Please add a PMOS or LDO (with enable pin) to control the module on or off.

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7 DC & Temperature characteristics

7.1 Absolute maximum ratings

Parameter	Symbol	Ratings	Units
Input Voltage	VCC	3.6	V
Input Backup Battery Voltage	V_BCKP	3.6	V
Operating Temperature Range	Topr	-40 ~ 85	℃
Storage Temperature Range	Tstg	-40 ~ 85	℃

7.2 DC Electrical characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Voltage	VCC		3.0	3.3	3.6	V
Input Backup Battery Voltage	V_BCKP		1.8		3.6	V
VCC_RF Output Voltage	VCC_RF			VCC		V
Supply Current	Iss	VCC = 3.3V, w/o active antenna, Peak Acquisition Tracking		 71 68(1)	284	 mA mA mA
Backup Battery Current	Ibat	VCC = 0V		37		uA
VCC_RF Output Current	I_{out}	VIN = 3.3V			25	mA
High Level Input Voltage	V_{IH}		2.0		3.6	V
Low Level Input Voltage	V_{IL}		-0.3		0.8	V
High Level Output Voltage	V_{OH}		2.6			V
Low Level Output Voltage	V_{OL}				0.4	V

Note1: Measured when position fix (1Hz) is available and input voltage is 3.3V with UART interface.

7.3 Temperature characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units
Operating Temperature	Topr	-40	-	85	℃
Storage Temperature	Tstg	-40	25	85	℃

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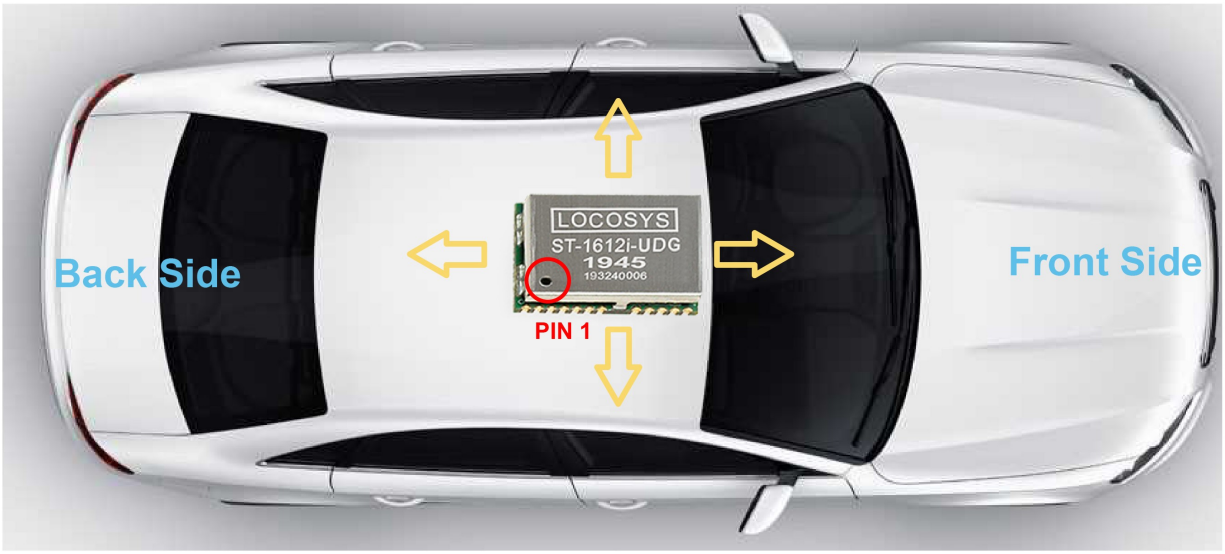
8 Installation

ST-1612i-UDG features an automatic alignment procedure appointed to estimate board orientation in respect to vehicle reference frame, and compensate such kind of misalignment. For this reason, there is no specific requirement for the orientation on the device in respect to vehicle travelling direction.



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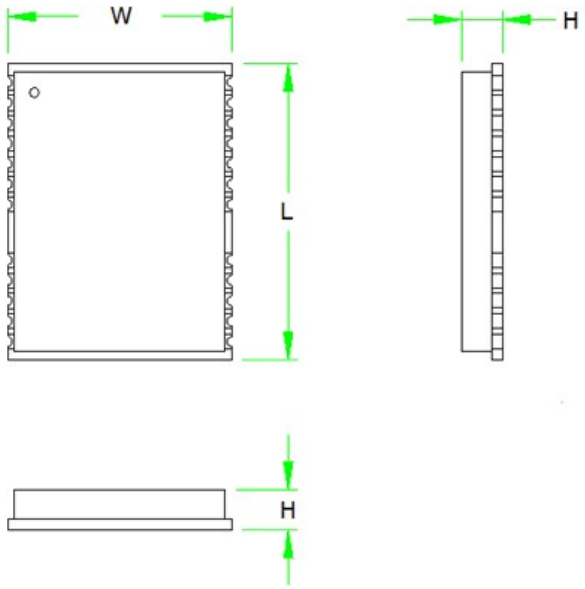
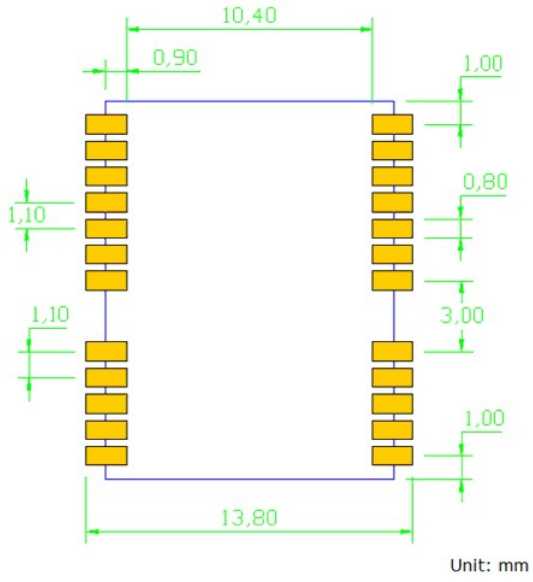
8.1 Outline dimensions



Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
W	12.1	12.2	12.3
L	15.7	16.0	16.4
H	2.1	2.3	2.5

8.2 Recommended land pattern dimensions



Note: The recommended land pattern dimensions are shown for reference only, as actual pad layouts may vary depending on application.

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9 Software interface

9.1 NMEA output message

Table 9.1-1 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
ZDA	UTC, day, month and year.

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

Table 9.1-2 contains the values for the following example:

*$GPGGA,083339.000,2503.71344,N,12138.74564,E,2,17,0.7,116.47,M,15.3,M,,*62*

Table 9.1- 2 GGA Data Format

Name	Example	Units	Description
Message ID	$GPGGA		GGA protocol header
UTC Time	083339.000		hhmmss.sss
Latitude	2503.71344		ddmm.mmmmm
N/S indicator	N		Latitude Direction: North or South
Longitude	12138.74564		dddmm.mmmmm
E/W Indicator	E		Longitude Direction: East or West
Position Fix Indicator	2		See Table 9.1-3
Satellites Used	17		Satellites in use
HDOP	0.7		Horizontal Dilution of Precision,max:99.0
MSL Altitude	116.47	meters	Height above mean sea level
Units	M	meters	Reference Unit for Altitude (“M” = meters)
Geoidal Separation	15.3	meters	Geoidal Separation measure in “M” = meters
Units	M	meters	Reference Unit for Geoidal Separation (“M” = meters)
DGPS Age			Not supported
DGPS Reference			Not supported
Checksum	*62		
<CR> <LF>			End of message termination

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Table 9.1-3 Position Fix Indicators

Value	Description
0	Fix not available or invalid
1	GNSS fix valid
2	Differential GNSS fix valid
3-5	Not supported
6	Estimated (Dead Reckoning) Mode

• GLL--- Geographic Position – Latitude/Longitude

Table 9.1-4 contains the values for the following example:

$GPGLL,2503.71344,N,12138.74564,E,083339.000,A,D*52

Table 9.1-4 GLL Data Format

Name	Example	Units	Description
Message ID	$GPGLL		GLL protocol header
Latitude	2503.71344		ddmm.mmmmm
N/S indicator	N		Latitude Direction: North or South
Longitude	12138.74564		dddmm.mmmmm
E/W indicator	E		Longitude Direction: East or West
UTC Time	083339.000		hhmmss.sss
Status	A		Validity of Data; A=data valid or V=data invalid
Mode	D		A = Autonomous mode, D = Differential mode, E = Estimated (Dead Reckoning) Mode, N=Data invalid,
Checksum	*52		
<CR> <LF>			End of message termination

• GSA---GNSS DOP and Active Satellites

Table 9.1-5 contains the values for the following example:

$GNGSA,A,3,25,22,20,31,14,10,26,29,32,16,,,1.2,0.7,1.0*23

$GNGSA,A,3,75,65,74,73,71,72,70,,,,,,1.2,0.7,1.0*2B

Table 9.1-5 GSA Data Format

Name	Example	Units	Description
Message ID	$GNGSA		GSA protocol header
Mode 1	A		See Table 9.1-6
Mode 2	3		See Table 9.1-7
ID of satellite used	25		Sv on Channel 1
ID of satellite used	22		Sv on Channel 2

….			….
ID of satellite used			Sv on Channel 12
PDOP	1.2		Position Dilution of Precision,max:99.0
HDOP	0.7		Horizontal Dilution of Precision, max:99.0
VDOP	1.0		Vertical Dilution of Precision, max:99.0
Checksum	*23		
<CR> <LF>			End of message termination

Table 9.1-6 Mode 1

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

Table 9.1-7 Mode 2

Value	**Description**
1	No Fix available
2	2D
3	3D

● GSV---GNSS Satellites in View

Table 9.1-8 contains the values for the following example:

$GPGSV,3,1,12,32,70,048,50,14,54,344,46,31,49,317,47,26,41,220,45*7B
$GPGSV,3,2,12,25,42,039,42,10,36,187,43,29,26,105,41,16,13,214,37*73
$GPGSV,3,3,12,22,13,314,38,20,11,169,36,42,50,134,37,50,50,134,40*7F
$GLGSV,2,1,07,71,76,155,44,72,48,331,40,73,38,016,42,74,28,254,37*6B
$GLGSV,2,2,07,70,23,153,32,75,22,249,39,65,05,332,28,,,,*5B

Table 9.1-8 GSV Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GPGSV		GSV protocol header
Total number of messages[1]	3		Range 1 to 8
Message number[1]	1		Range 1 to 8
Satellites in view	12		Total Number of Satellites in view
Satellite ID	32		Channel 1 (Range 01 to 330
Elevation	70	degrees	Channel 1 (Range 00 to 90)
Azimuth	048	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	50	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
…..			…..
Satellite ID	14		Channel 4 (Range 01 to 330

Elevation	54	degrees	Channel 4 (Range 00 to 90)
Azimuth	344	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	46	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Checksum	*7B		
<CR> <LF>			End of message termination

Note1: Depending on the number of satellites tracked multiple messages of GSV data may be required.

Note2: GPS ID: 01~32, SBAS ID: 33~51, QZSS ID: 183~197, GLONASS ID: 65~92, GALILEO ID: 301~330

● RMC---Recommended Minimum Specific GNSS Data

Table 9.1-9 contains the values for the following example:

$GPRMC,083339.000,A,2503.71344,N,12138.74564,E,0.0,0.0,031219,,,D*6D

Table 9.1-9 RMC Data Format

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Time	083339.000		hhmmss.sss
Status	A		A=data valid or V=data invalid
Latitude	2503.71344		ddmm.mmmmm
N/S Indicator	N		Latitude Direction: North or South
Longitude	12138.74564		dddmm.mmmmm
E/W Indicator	E		Longitude Direction: East or West
Speed over ground	0.0	knots	Speed over ground in knots
Course over ground	0.0	degrees	Course made good,max
Date	031219		ddmmyy
Magnetic variation		degrees	
Variation sense			Magnetic Variation Direction: East or West
Mode	D		A = Autonomous mode, D = Differential mode, E = Estimated (Dead Reckoning) mode, N=Data invalid
Checksum	*6D		
<CR> <LF>			End of message termination

● VTG---Course Over Ground and Ground Speed

Table 9.1-10 contains the values for the following example:

$GPVTG,0.0,T,,M,0.0,N,0.1,K,D*09

Table 9.1-10 VTG Data Format

Name	Example	Units	Description
Message ID	$GPVTG		VTG protocol header

Course over ground	0.0	degrees	Reference to “true” earth poles
Reference	T		Indicates “terrestrial”
Course over ground		degrees	Reference to “magnetic” earth poles
Reference	M		Indicates “Magnetic”
Speed over ground	0.0	knots	Speed over ground in knots
Units	N		Indicates “Knots”
Speed over ground	0.1	km/h	Speed over ground in kilometers per hour
Units	K		Indicates “Kilometers per hour”
Mode	D		A = Autonomous mode, D = Differential mode, E = Estimated (Dead Reckoning)mode
Checksum	*09		
<CR> <LF>			End of message termination

- **ZDA---UTC, day, month and year.**

Table 9.1-11 contains the values for the following example:

$GPZDA,083339.000,03,12,2019,00,00*5E

Table 9.1-11 ZDA Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GPZDA		ZDA protocol header
Timestamp	083339.000		hhmmss.sss
Day	03		Decimal, 2 digits Day of month (01 to 31)
Month	12		Decimal, 2 digits Month (01 to 12)
Year	2019		Decimal, 4 digits Year (1994 - …)
Local zone hour	00	hour	Local time zone offset from UTC (set to 00)
Local zone minutes	00	minute	Local time zone offset from UTC (set to 00)
Checksum	*5E		
<CR> <LF>			End of message termination

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9.2 Proprietary NMEA and DR input/output message

Table 9.2-1 DR output message

Software command	Command descriptions
$PSTMCOLD<CR><LF>	Perform a Cold start
$PSTMWARM<CR><LF>	Perform a Warm start
$PSTMHOT<CR><LF>	Perform a Hot start
$PSTMSRR <CR><LF>	Executes a system reset. The GNSS firmware is rebooted.
$PSTMRESTOREPAR<CR><LF>	Restore System Parameters (Factory Settings).
$PSTMSETPAR <CR><LF>	Set System Parameter in the configuration data block.
$PSTMSAVEPAR <CR><LF>	Save System Parameters in the GNSS backup memory
$PSTMNVMITEMINV<CR><LF>	Clear calibration status(1)

Note1: Optional Function

- **$PSTMCOLD**

Perform a COLD start.

Synopsis:

$PSTMCOLD,<Mask><CR><LF>

Table 9.2-2 $PSTMCOLD Data format

Parameter	Format	Description
Mask	Integer	Optional parameter to invalidate time, position, ephemeris and almanac: 0x1-clear almanac 0x2-clear ephemeris 0x4-clear position 0x8-clear time

Note: If Mask parameter is not used, default is 0xE (clear ephemeris, time and position).

Example:

$PSTMCOLD,6

- **$PSTMWARM**

Perform a WARM start.

Synopsis:

$PSTMWARM<CR><LF>

Example:

$PSTMWARM

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- **$PSTMHOT**

Perform a HOT start.

Synopsis:

$PSTMHOT<CR><LF>

Example:

$PSTMHOT

- **$PSTMSRR**

Executes a system reset. The GNSS firmware is rebooted.

Synopsis:

$PSTMSRR<CR><LF>

Arguments:

None.

Results:

The GNSS firmware reboots. No message will be sent as reply.

Example:

$PSTMSRR

- **$PSTMRESTOREPAR**

Restore the factory setting parameters. The configuration data block stored in NVM, if present, will be invalidated. Any changed parameter will be lost.

Synopsis:

$PSTMRESTOREPAR<CR><LF>

Results:

None.

Results:

The current configuration data block, including changed parameters, will be stored into the backup memory (NVM).

If there are no error the following message is returned.

$PSTMSAVEPAROK

In case of errors, the error message is returned

$PSTMSAVEPARERROR

Note the factory setting parameters can be restored using the $PSTMRESTOREPAR command.

Example:

$PSTMRESTOREPAR

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- **$PSTMSETPAR**

This command sets the defined parameter (indicated by "ID") to the value provided as "param value" in the commands parameter.

Synopsis:

$PSTMSETPAR,<ConfigBlock><ID>,<param_value>[,<mode>]<CR><LF>

Arguments:

Table 9.2-3 $PSTMSETPAR Data format

Parameter	Format	Description
ConfigBlock	Decima1,1 digit	Indicates one of configuration blocks 1 = Current Configuration, 2 = Default Configuration, 3 = NVM Stored configuration.
ID	Decimal, 3 digits	ID - Identifier
param_value	1 up to 80 bytes	Parameter to be set, see "Allowed values" as described in FW Configuration document.
mode	Decimal, 1 digit	This parameter is optional. It allows to perform bit-to-bit "OR" or "AND" operations between the selected parameter in the configuration block and the param_value in input. It has the following meaning: 0: the parameter in the configuration block is overwritten by the param_value. This is the default action as in the case mode is omitted. 1: the parameter in the configuration block is the result of bit-to-bit "OR" between old value and the param_value. This is useful for bit mask setting. 2: the parameter in the configuration block is the result of bit-to-bit "AND" between old value and NOT (param_value). This is useful for bit mask resetting.
<CR> <LF>		End of message termination

Results:

The parameter indicated by the ID value is set according to the parameters included in param_value.

In case of no errors, the following message is returned

$PSTMSETPAROK ,<ConfigBlock><ID>*<Checksum><CR><LF>

In case of errors, the error message is returned

$PSTMSETPARERROR*<Checksum><CR><LF>

Table 9.2-4 $PSTMSETPAROK Data format

Parameter	Format	Description
ConfigBlock	Decima1,1 digit	Indicates one of configuration blocks 1 = Current Configuration, 2 = Default Configuration,

		3 = NVM Stored configuration.
ID	Decimal, 3 digits	ID - Identifier
Checksum	Hexadecimal, 2 digits	
<CR> <LF>		End of message termination

Note 1: The configuration block parameter is ignored by the “SET” command because only the current configuration, stored in the RAM memory, can be written. It is used only to keep same syntax as for the “GET” command. The configuration block stored in NVM will be overwritten by current configuration after the $PSTMSAVEPAR command.

Note 2: There is no comma and no space between ConfigBlock and ID parameters.

Note 3: The input param_value must be expressed in hexadecimal format without “0x” prefix for any integer value except DOP configuration. It must be decimal for any not integer value and DOP setting.

Example:

Issuing the command:

$PSTMSETPAR,1121,10

You could have this answer:

$PSTMSETPAROK,1121*30

- **$PSTMSAVEPAR**

Save current configuration data block into the backup memory.

Synopsis:

$PSTMSAVEPAR<CR><LF>

Arguments:

None.

Results:

The current configuration data block, including changed parameters, will be stored into the backup memory (NVM).

If there are no error the following message is returned.

If there are no error the following message is returned

$PSTMSAVEPAROK

In case of errors, the error message is returned

$PSTMSAVEPARERROR

Note: the factory setting parameters can be restored using the $PSTMRESTOREPAR command.

Example:

$PSTMSAVEPAR

- **$PSTMNVMITEMINV (Optional Function)**

Clear calibration status

Synopsis:

$PSTMNVMITEMINV<ConfigBlock>,<ID>< CR><LF>

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Arguments:

None.

Example:

$PSTMNVMITEMINV 80,1

9.3 Dead Reckoning (DR) output message

Table 9.3-1 DR output message

DR record	Description
$PSTMDRSENMSG <CR><LF>	Format: for Msg ID =24、30、31
$PSTMDROL<CR><LF>	Reports the calibration status of the DR calibration parameters.

- **$PSTMDRSENMSG,24**

Example:

$PSTMDRSENMSG,24,1174901488,5184,1*3D

Table 9.3-2 $PSTMDRSENMSG,24 Data Format

Name	Example	Description
Message	$PSTMDRSENMSG	Reports DR sensor message data, which is specific to the message id for each specific DR sensor configuration.
Message ID	24	Gyroscope sensor temperature
cpu timestamp	1174901488	microseconds
temperature	5184	Gyro sensor temperature
validity	1	
Checksum	*3D	
<CR> <LF>		End of message termination

- **$PSTMDRSENMSG,30**

Example:

$PSTMDRSENMSG,30,2827546184,407,-125,16522*3D

Table 9.3-3 $PSTMDRSENMSG,30 Data Format

Name	Example	Description
Message	$PSTMDRSENMSG	Reports DR sensor message data, which is specific to the message id for each specific DR sensor configuration.
Message ID	30	3D accelerometer
cpu timestamp	2827546184	microseconds
raw_x	407	407mg /LSB*0.061 = 24.827mg*0.0098 m/s^2 = 0.2433046 m/s^2
raw_y	-125	-125mg /LSB*0.061 = -7.625mg*0.0098 m/s^2 = -0.074725 m/s^2
raw_z	16522	16522mg /LSB*0.061 = 1007.842mg*0.0098 m/s^2 = 9.8768516 m/s^2
Checksum	*3D	

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<CR> <LF>		End of message termination

Note: for unit mg/LSB*0.061 ,1g=1000mg ; 1g= 9.8 m/s^2 ; 1mg = 0.0098 m/s^2

- **$PSTMDRSENMSG,31**

Example:

$PSTMDRSENMSG,31,2827547603,360,-807,-526*17

Table 9.3-4 $PSTMDRSENMSG,31 Data Format

Name	Example	Description
Message	$PSTMDRSENMSG	Reports DR sensor message data, which is specific to the message id for each specific DR sensor configuration.
Message ID	31	3D gyroscope
cpu timestamp	2827547603	microseconds
raw_x	360	360 mdps *4.375 = 1575 mdps = 1.575 dps = 1.575 degree/s
raw_y	-807	-807 mdps *4.375 = 3530.625 mdps = 3.530625 dps = 3.530625 degree/s
raw_z	-526	-526 mdps *4.375 = 2301.25 mdps = 2.30125 dps = 2.30125 degree/s
Checksum	*17	
<CR> <LF>		End of message termination

Note: for unit mdps*4.375,1dps = 1000mdps = 1000m degree/s

- **$ PSTMDROL**

Example:

$PSTMDROL,0.000000,0.000000,0.000000,6.573551,4.090758,1.000000,0.019760,-0.217429,0.236543,0.000000,0.000000,0.000000,NC,AA,1,0,0,1.20,-4.15*1B

Table 9.3-5 $PSTMDROL Data Format

Name	Example	Description
Message ID	$PSTMDROL	Reports the calibration status of the DR calibration parameters.
M pitch	0.000000	Misalignment sensor vs. vehicle frame saved in memory – Pitch angle [deg]
M roll	0.000000	Misalignment sensor vs. vehicle frame saved in memory – Roll angle [deg]
M yaw	0.000000	Misalignment sensor vs. vehicle frame saved in memory – yaw angle [deg]
A pitch	6.573551	Vehicle pitch angle measured by accelerometer [deg]
A roll	4.090758	Vehicle roll angle measured by accelerometer [deg]
gsz	1.000000	Gyro z axis sensitivity [adimensional]
gbx	0.019760	Gyro x axis bias [dps]
gby	-0.217429	Gyro y axis bias [dps]
gbz	0.236543	Gyro z axis bias [dps]
abx	0.00000	Accelerometer x axis bias [m/s^2]
aby	0.00000	Accelerometer y axis bias [m/s^2]
abz	0.00000	Accelerometer z axis bias [m/s^2]

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IMU cal	NC	6-axes IMU calibration status. char #1: accelerometer char #2: gyroscope A: Not Available (sensor not supported) N: Not calibrated C: Calibrated
AS cal	AA	Additional sensors calibration status. A: Not Available (sensor not supported) N: Not calibrated C: Calibrated
Motion status	1	Motion status indicator. 0: Unclassified 1: Stopped 2: Straight 3: No straight no turn 4: Turning 5: Accelerating 6: Braking 7: Reverse
Err code	0	FW error code. 00: No Error 01: Gyro Failure 02: Accelerometer Failure 03: GNSS Failure 04: Pressure Sensor Failure 05: Magnetometer Failure 06: Misalignment Failure 07: Acc KF Failure 08: Gyro KF Failure 09: Generic SW Failure
sr	0	System Ready Flag. 0: System not ready (GNSS-only PVT out) 1: System ready (PVT is GNSS sensors fusion)
Reserved1	1.20	Reserved
Reserved2	-4.15	Reserved
Checksum	*1B	
<CR> <LF>		End of message termination

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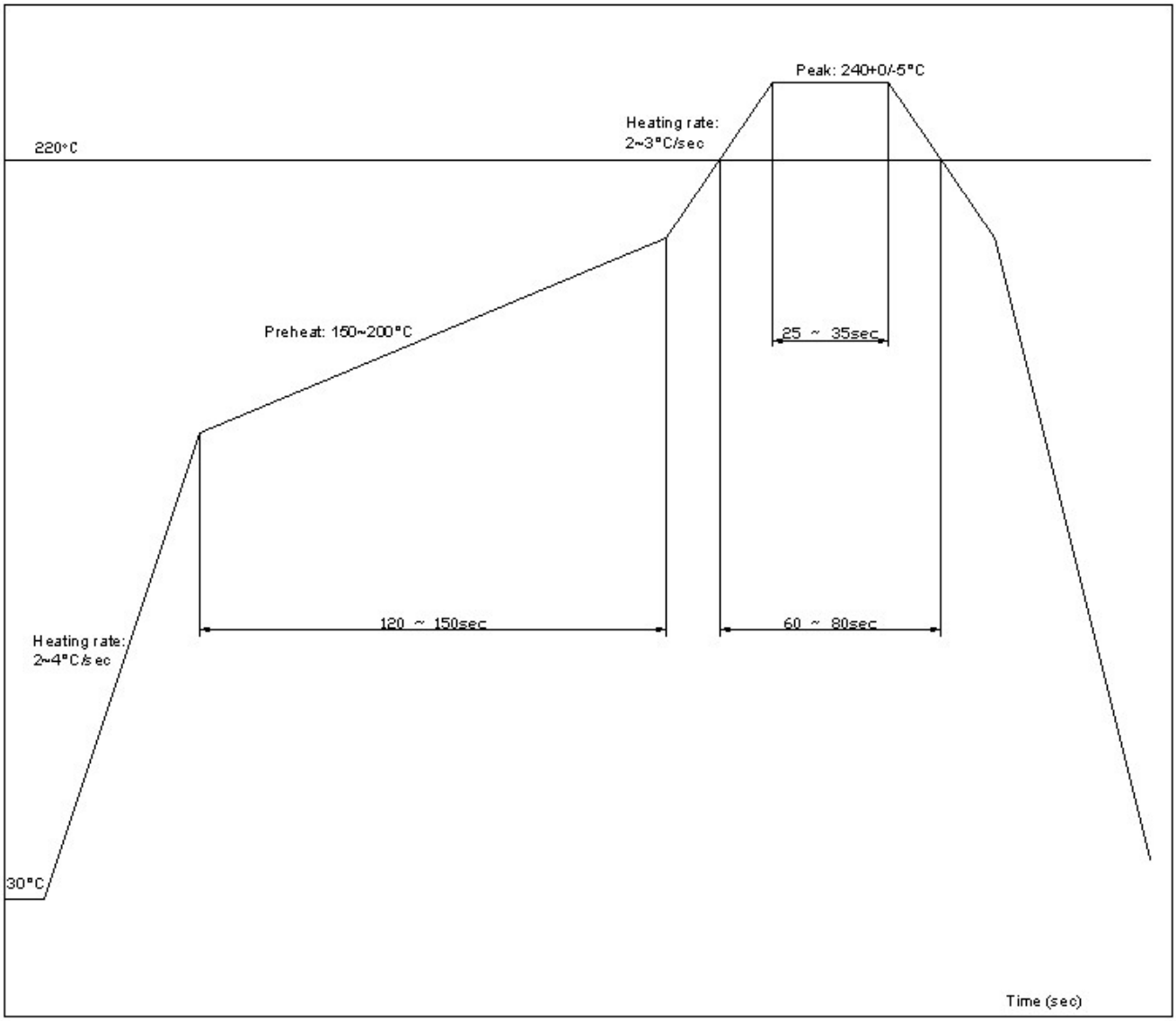
10 Recommended soldering reflow profile

The module belongs to RoHS device. The maximum of reflow temperature, real on top of PCB, is not over 240 Celsius.

Lead-free Processes



Lead –Free Solder Paste (Sn 96.5-Ag 3.0-Cu 0.5) Cycle Interval: 300 sec

Note: The ST-1612i-UDG module should be soldered on the topside in the soldering process to prevent from falling down.

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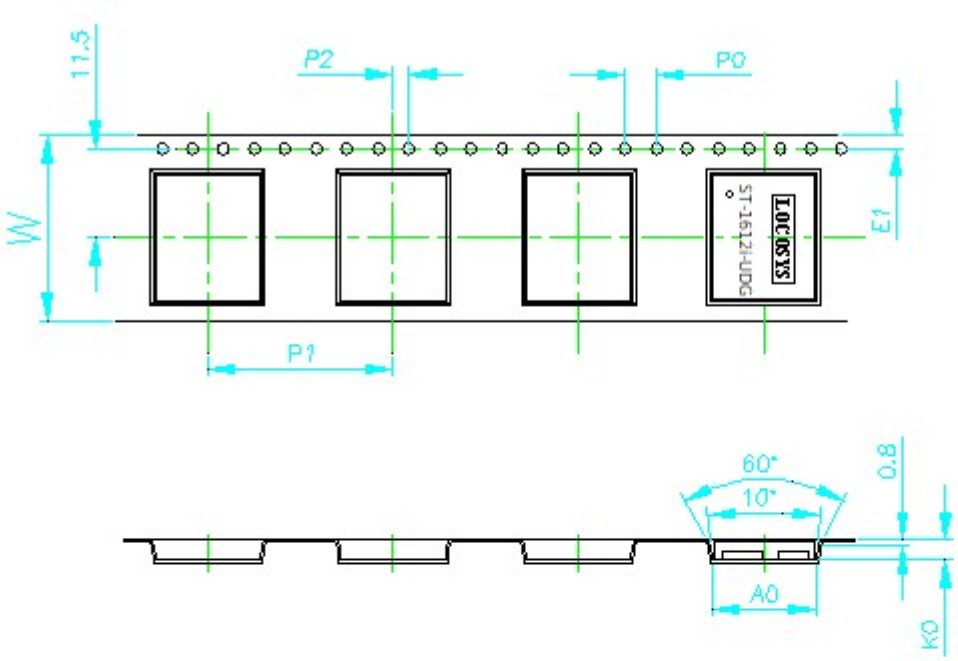
11 Reel Packing information



A0	13.50 ±0.1
B0	16.40 ±0.1
D0	ø1.5
E1	1.75 ±0.1
K0	2.70 ±0.1
P0	4.0 ±0.1
P1	24.00 ±0.1
P2	2.0 ±0.10
T	0.3 ±0.10
W	24.0 ±0.30

1. 10 sprocket hole pitch cumulative tolerance ±0.2
2. Camber not to exceed 1mm in 100mm
3. A0 and B0 measured on a plane 0.3mm above the bottom of the pocket
4. K0 measured from a plane on the inside bottom of the pocket to the top surface of the carrier .
5. pocket position relative to sprocket hole measured as true position of pocket,not pocket hole.
6. Component load per 13"reel: 1000 pcs
7. Packimg length per 22"reel: 75 M

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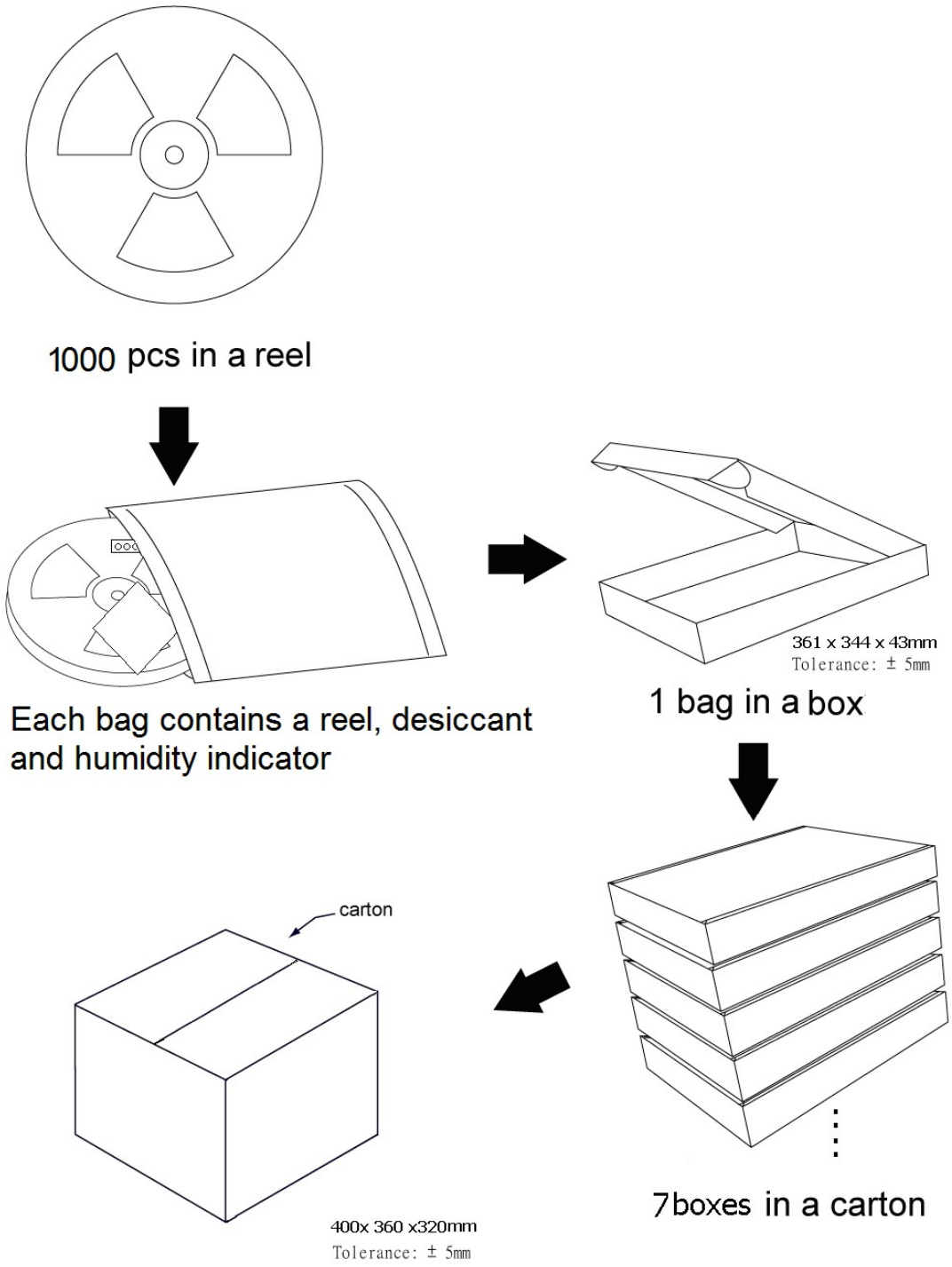
12 Packing and Handling

GNSS modules, like any other SMD devices, are sensitive to moisture, electrostatic discharge, and temperature. By following the description sketched in the document for LOCOSYS GNSS module storage and handling, it is possible to reduce the chances of them being damaged during production.

12.1 Packing



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12.2 Moisture Sensitivity

The module belongs to moisture sensitive device (IPC/JEDEC J-STD-020C Level III). If it is not used by then, we strong recommended storing the GNSS modules in dry places such as dry cabinet. The approximate shelf life for LOCOSYS GNSS modules packages is 6 months from the bag seal date, when store in a non-condensing storage environment (<30°C/60% RH)

12.3 ESD Handling

Please carefully follow the following precautions to prevent severe damage to GNSS modules.

LOCOSYS GNSS modules are sensitive to electrostatic discharges, and thus are Electrostatic Sensitive Devices (ESD). Careful handling of the GNSS modules and in particular RFIN pin must follow the standard ESD safety protections:

- Unless there is a galvanic coupling between the local GND and the PCB GND, then the first point of contact when handling the PCB shall always be between the local GND and PCB GND.
- Before working with RFIN pin, please make sure the GND is connected.
- When working with RFIN pin, do not contact any charges capacitors or materials that can easily develop or store charges such as patch antenna, coax cable, soldering iron.
- When soldering RFIN pin, please make sure to use an ESD safe soldering iron (tip).

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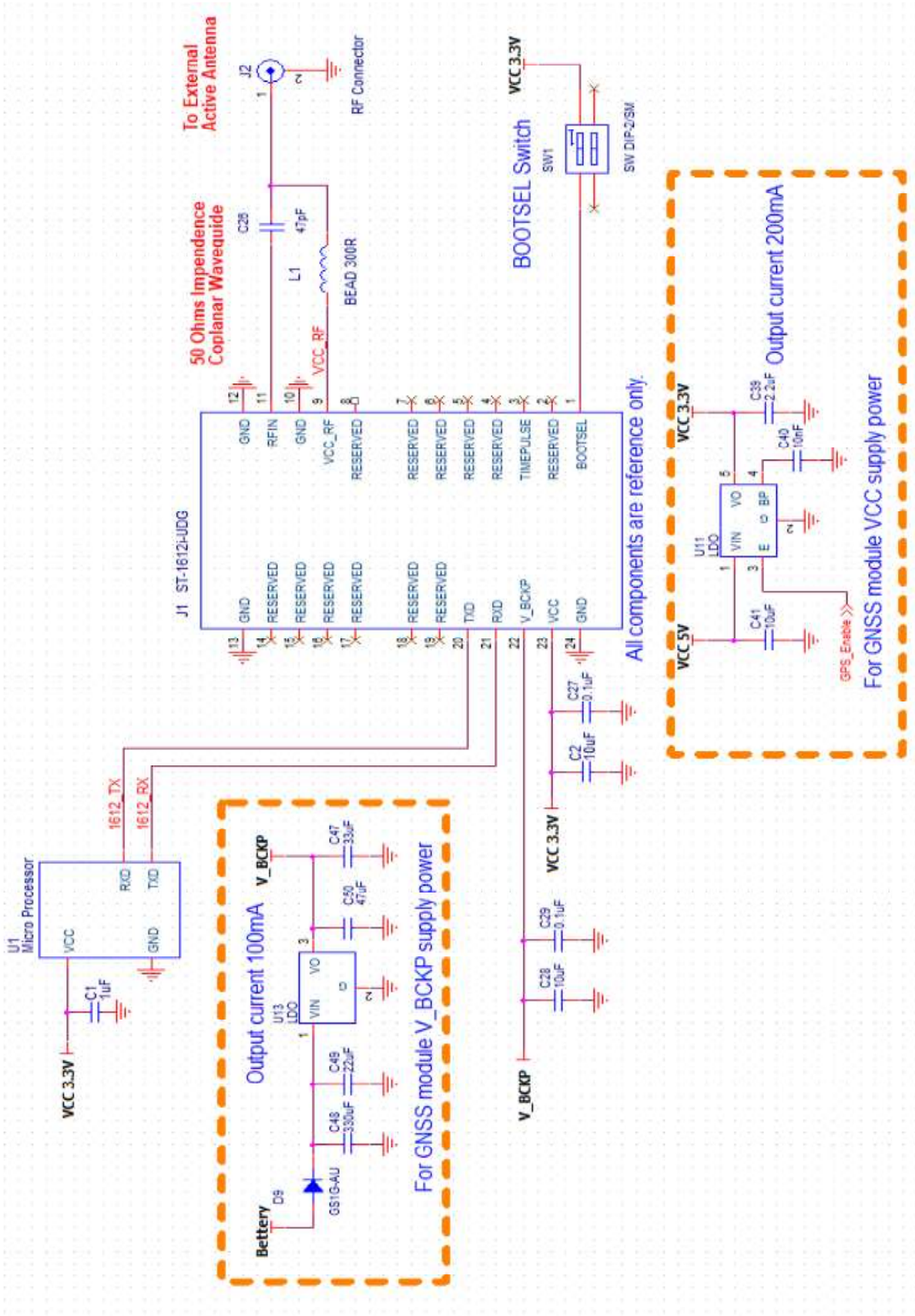
13 Reference Circuit

13.1 Active Antenna



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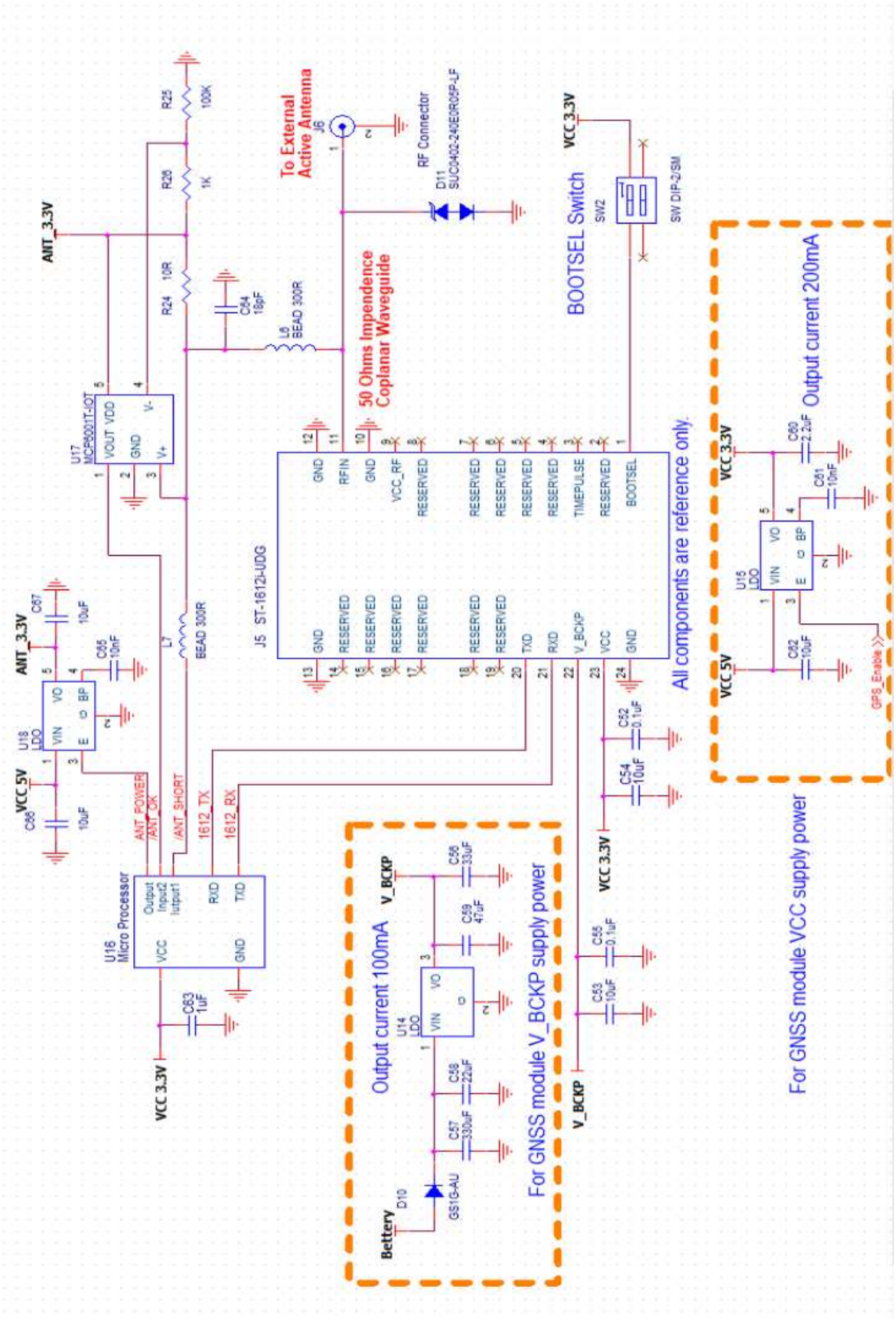
13.2 External Active Antenna



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13.2.1 External Active Antenna Logic Table

Logic table			
/ANT_SHORT	/ANT_OK	Staus of the external GNSS active antenna	Description
LOW	X	SHORT	Antenna is short.
HIGH	LOW	OK	Antenna is properly connected.
HIGH	HIGH	OPEN	Antenna is not connected.

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Document change list

Revision 0.1

- Draft release on Dec.03, 2019