LOCOSYS

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Product name	Description	Version
ST-1612-DG	Datasheet of ST-1612-DG multiple GNSS module	0.2

1. Introduction

LOCOSYS ST-1612-DG module is using STMicroelectronics latest GNSS chip, Teseo III, to integrate on-board 3D gyroscope sensor, 3D accelerometer, and Odometer input deliver at a complete solution for road vehicle ADR (Automotive Dead Reckoning) applications. Dead reckoning can increase the accuracy in regions of adverse GNSS environment such as urban canyons, dense foliages, parking garages, tunnels, etc. Whenever GNSS position is missing or compromised, the ST-1612-DG module provided the application with accuracy estimation of vehicle's position and velocity by combined vehicle's speed and heading sensor data into STMicro solution. The ST-1612-DG module, with features high sensitivity, low power and ultra small form factor, can concurrently acquire and track multiple satellite constellations that include GPS, BEIDOU, GALILEO and QZSS at normal environment.

2. Features

- STMicroelectronics Teseo III high sensitivity solution
- Support GPS, GLONASS, GALILEO and QZSS
- Capable of SBAS (WAAS, EGNOS, MSAS)
- 48 tracking channels and 2 fast acquisition channels
- Fast TTFF at low signal level
- Dead Reckoning software
- 3-axis Gyroscope and 3-axis Accelerometer integrated
- Odometer wheel-tick input
- Forward / Reverse Direction (FWD) input
- Support UART or CAN Bus interface
- Support RTCM SC-104 Version-2.x data input
- Small form factor 16 x 12.2 x 2.2 mm
- SMD type, RoHS compliant
- Manufactured in ISO/TS 16949 certified sites.

3. Application

- Telematics market
- Automotive navigation
- Fleet tracking

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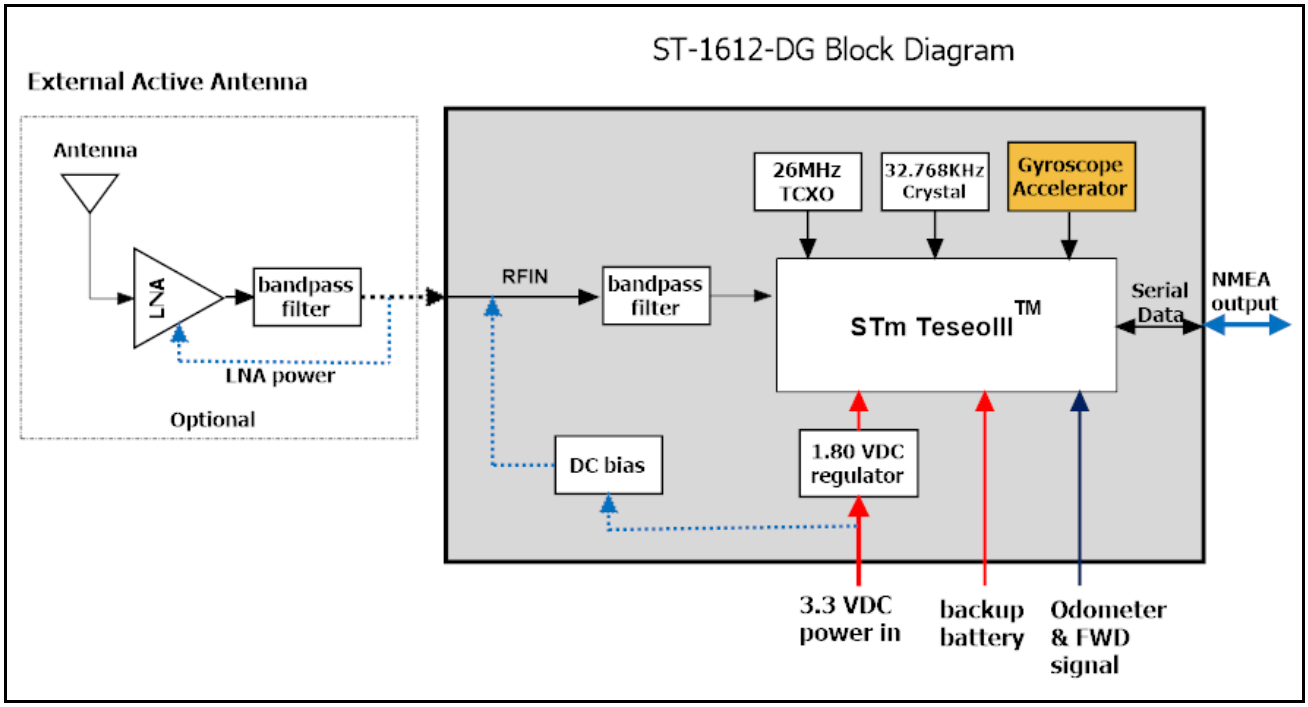
4. System Block Diagram



5. GNSS receiver

5.1 GNSS receiver

Chip	STA8090FG 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, up to 10Hz.	
Sensitivity	Tracking	up to -161dBm (with external LNA)
	Cold start	up to -147dBm (with external LNA)
Acquisition Time	Cold Start (Open Sky)	37s (typical)
Position Accuracy	Autonomous	2m CEP
	SBAS	1.8m (depends on accuracy of correction data).
Max. Altitude	< 18,000 m	
Max. Velocity	< 515 m/s	
Protocol Support	NMEA 0183 ver 3.01	115200 bps(1), 8 data bits, no parity, 1 stop bits (default) 1Hz: GGA, GLL, GSA, GSV, RMC, VTG, ZDA
	Real-time Differential Correction	RTCM SC-104 v2.x message types 1 and 9

Note 1: Both baud rate and output message rate are configurable to be factory default.

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5.2 MEMS Sensor

The ST-1612-DG receiver support DR(Dead Reckoning) 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.

5.3 Sensor Data Input

The receiver needs two more sensor input, odometer and forward/reverse direction signal. There are three methods to feed data into receiver as below descriptions.

(1) Feed through CAN bus.

(2) Feed through vehicle physical signal.

(3) Feed through the UART port; please contact LOCOSYS for more details.

6. Pin assignment and descriptions

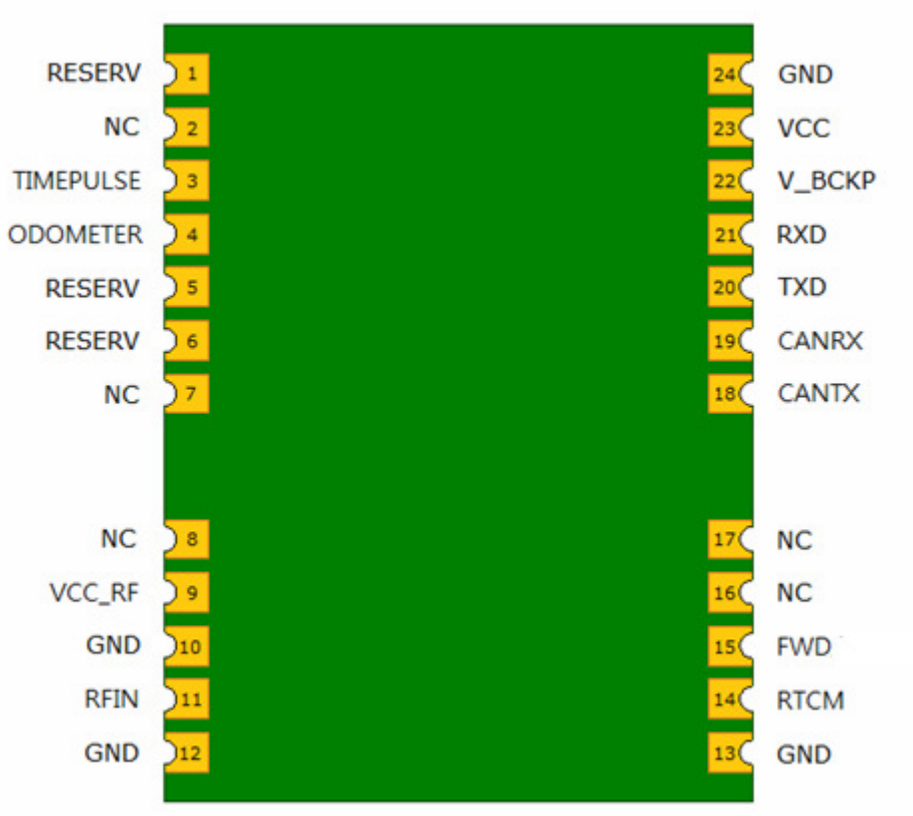

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Table 6-1 Pin descriptions

Pin #	Name	Type	Description	Note
1	RESERV		Reserved, keep floating	
2	NC		Not connected	
3	TIMEPULSE	O	Time pulse (1PPS, default 500 ms pulse/sec)	
4	ODOMETER	I	Odometer wheel-tick input	3
5	RESERV		Reserved, keep floating	
6	RESERV		Reserved, keep floating	
7	NC		Not connected	
8	NC		Not connected	
9	VCC_RF	O	Output voltage for active antenna	1
10	GND	P	Ground	
11	RFIN	I	GNSS RF signal input	
12	GND	P	Ground	
13	GND	P	Ground	
14	RTCM	I	RTCM data input (TTL Level)	2
15	FWD	I	Forward/Reverse signal input	3
16	NC		Not connected	
17	NC		Not connected	
18	CANTX	O	CAN bus transmit data output	4
19	CANRX	I	CAN bus receive data input	4
20	TXD	O	UART, asynchronous output (Default NMEA)	
21	RXD	I	UART, asynchronous input	
22	V_BCKP	P	Backup battery supply voltage	
23	VCC	P	DC supply voltage	
24	GND	P	Ground	

Note

1. VCC_RF does not have short circuit protection.
2. It supports these RTCM message types: type 1 and 9.These four message types were all defined in RTCM SC-104 v2.3 spec, and also the same in v2.1, v2.2 and v2.3.
3. Pin4 and Pin15 needs external level shift circuits to meet DC electrical characteristics, please contact LOCOSYS for more information..
4. Need an external CAN bus driver IC (Maxim MAX3051 , STM L9616D…etc) and vehicle CAN bus protocol. The default firmware is used for UART only. Who needs firmware for CAN is different from default, please contact us.

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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,				
Backup Battery Current	Ibat	VCC = 0V		TBD		uA
VCC_RF Output Current	I_{out}	VIN = 3.3V			TBD	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

Note 1. 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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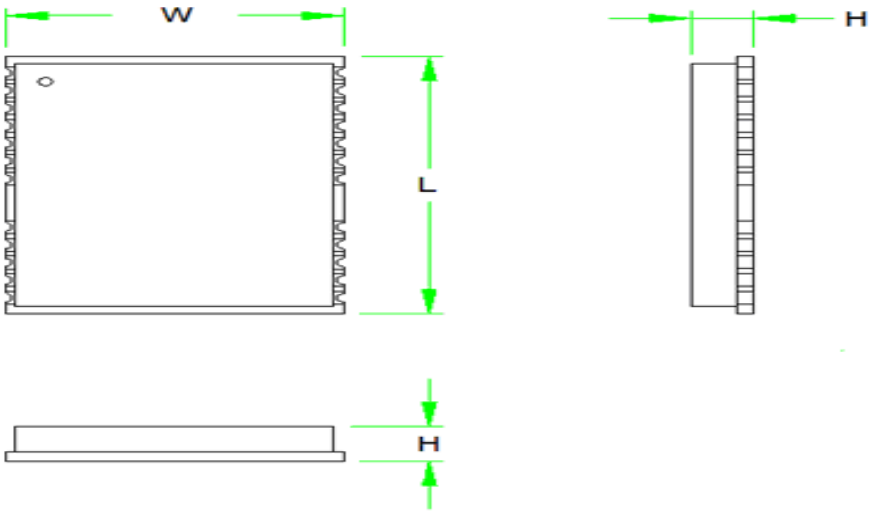
8. Mechanical specification

8.1 Recommended mounting direction

8.2 Outline dimensions



Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
W	12.10	12.18	12.30
L	15.75	16.06	16.25
H	2.05	2.22	2.35

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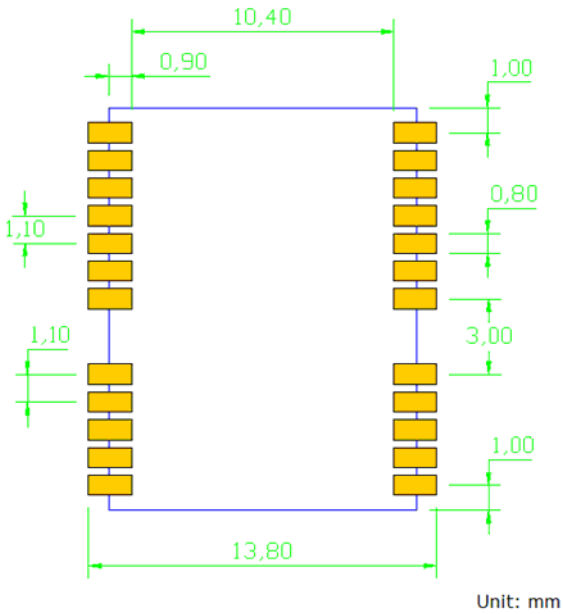
8.3 Recommended land pattern dimensions



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:

$GNGGA,220355.000,0000.08730,N,15000.25512,W,1,05,1.6,087.30,M,13.0,M,,*66

Table 9.1- 2 GGA Data Format

Name	Example	Units	Description
Message ID	$GNGGA		GGA protocol header
UTC Time	220355.000		hhmmss.sss
Latitude	0000.08730		ddmm.mmmm
N/S indicator	N		Latitude Direction: North or South
Longitude	15000.25512		dddmm.mmmm
E/W Indicator	W		Longitude Direction: East or West
Position Fix Indicator	1		See Table 9.1-3
Satellites Used	05		Satellites in use
HDOP	1.6		Horizontal Dilution of Precision
MSL Altitude	087.30	meters	Height above mean sea level
Units	M	meters	Reference Unit for Altitude (M = meters)
Geoidal Separation	13.0	meters	Geoidal Separation measure
Units	M	meters	Reference Unit for Geoidal Separation (M = meters)
DGPS Age			Not supported
DGPS Reference			Not supported
Checksum	*66		
<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	Dead Reckoning Mode, fix valid

● GLL--- Geographic Position – Latitude/Longitude

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

$GNGLL,0000.08730,N,15000.25512,W,220355.000,A,A*5F

Table 9.1-4 GLL Data Format

Name	Example	Units	Description
Message ID	$GNGLL		GLL protocol header
Latitude	0000.08730		ddmm.mmmm
N/S indicator	N		Latitude Direction: North or South
Longitude	15000.25512		dddmm.mmmm
E/W indicator	W		Longitude Direction: East or West
UTC Time	220355.000		hhmmss.sss
Status	A		Validity of Data; A=data valid or V=data invalid
Mode	A		A = Autonomous mode, D = Differential mode, E = Estimated mode, N=Data invalid,
Checksum	*5F		
<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,3,30,03,31,16,11,,,,,,,,2.4,1.6,1.8*21

$GNGSA,A,3,,,,,,,,,,,,,2.4,1.6,1.8*24

$GNGSA,A,3,,,,,,,,,,,,,2.4,1.6,1.8*24

$GNGSA,A,3,,,,,,,,,,,,,2.4,1.6,1.8*24

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	30		Sv on Channel 1

ID of satellite used	03		Sv on Channel 2
….			….
ID of satellite used			Sv on Channel 12
PDOP	2.4		Position Dilution of Precision
HDOP	1.6		Horizontal Dilution of Precision
VDOP	1.8		Vertical Dilution of Precision
Checksum	*21		
<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	Fix not available
2	2D
3	3D

● GSV---GNSS Satellites in View

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

$GNGSV,6,1,24,03,71,305,46,05,51,197,,11,08,327,45,15,18,289,*68

$GNGSV,6,2,24,16,35,215,45,18,68,103,,19,32,133,,25,23,012,*6B

$GNGSV,6,3,24,30,25,179,45,31,30,139,46,32,34,290,,74,17,006,44*68

$GNGSV,6,4,24,65,41,320,45,76,41,320,45,76,38,265,,75,45,311,*6A

$GNGSV,6,5,24,69,41,320,,70,24,142,,86,09,193,,80,41,320,*6F

$GNGSV,6,6,24,70,08,144,,85,11,142,44,71,56,108,44,72,47,004,43*6C

Table 9.1-8 GSV Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNGSV		GSV protocol header
Total number of messages1	6		Range 1 to 8
Message number1	1		Range 1 to 8
Satellites in view	24		
Satellite ID	03		Channel 1 (Range 01 to 196)
Elevation	71	degrees	Channel 1 (Range 00 to 90)
Azimuth	305	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	46	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
…..			…..

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Satellite ID	15		Channel 4 (Range 01 to 32)
Elevation	18	degrees	Channel 4 (Range 00 to 90)
Azimuth	289	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)		dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Checksum	*68		
<CR> <LF>			End of message termination

Note 1. Depending on the number of satellites tracked multiple messages of GSV data may be required.

Note 2. GPS ID: 01~32, SBAS ID: 33~51, QZSS ID: 193~197, GLONASS ID: 65~96

● RMC---Recommended Minimum Specific GNSS Data

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

$GNRMC,220359.000,A,0000.10755,N,15000.24720,W,020,024,170815,,,A*62

Table 9.1-9 RMC Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNRMC		RMC protocol header
UTC Time	220359.000		hhmmss.sss
Status	A		A=data valid or V=data invalid
Latitude	0000.10755		ddmm.mmmm
N/S Indicator	N		Latitude Direction: North or South
Longitude	15000.24720		dddmm.mmmm
E/W Indicator	W		Longitude Direction: East or West
Speed over ground	020	knots	True
Course over ground	024	degrees	
Date	170815		ddmmyy
Magnetic variation		degrees	
Variation sense			Magnetic Variation Direction: East or West
Mode	A		A = Autonomous mode, D = Differential mode, E = Estimated mode, N=Data invalid
Checksum	*62		
<CR> <LF>			End of message termination

● VTG---Course Over Ground and Ground Speed

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

$GNVTG,024,T,,M,020,N,036,K,A*0C

Table 9.1-10 VTG Data Format

Name	**Example**	**Units**	**Description**

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Message ID	$GNVTG		VTG protocol header
Course over ground	024	degrees	Reference to “true” earth poles
Reference	T		True heading
Course over ground		degrees	Reference to “magnetic” earth poles
Reference	M		Magnetic heading
Speed over ground	020	knots	Measured speed
Units	N		Knots
Speed over ground	036	km/hr	Measured speed
Units	K		Kilometer per hour
Mode	A		A = Autonomous mode, D = Differential mode, E = Estimated mode, N=Data invalid
Checksum	*0C		
<CR> <LF>			End of message termination

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

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

$GNZDA,220358.00,17,08,2015,00,00*7E

Table 9.1-11 ZDA Data Format

Name	Example	Units	Description
Message ID	$GNZDA		ZDA protocol header
Timestamp	220358.00		hhmmss.ss
Day	17		Decimal, 2 digits Day of month (01 to 31)
Month	08		Decimal, 2 digits Month (01 to 12)
Year	2015		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	*7E		
<CR> <LF>			End of message termination

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9.2 Proprietary NMEA input/output message

The table below summarizes the most common set of receiver's proprietary commands. Detailed input/output command sets, please refer to ST proprietary command sets.

Table 9.2-1 The table below summarizes the most common of ST-1612-DG proprietary command sets

Command descriptions	Software command
Perform a Cold start	$PSTMCOLD<CR><LF>
Perform a Warm start	$PSTMWARM<CR><LF>
Perform a Hot start	$PSTMHOT<CR><LF>
Perform a Factory reset :	$PSTMSRR<CR><LF>
System Reset	$PSTMSRR<CR><LF>
Restore System Parameters (Factory Settings)	$PSTMRESTOREPAR<CR><LF>

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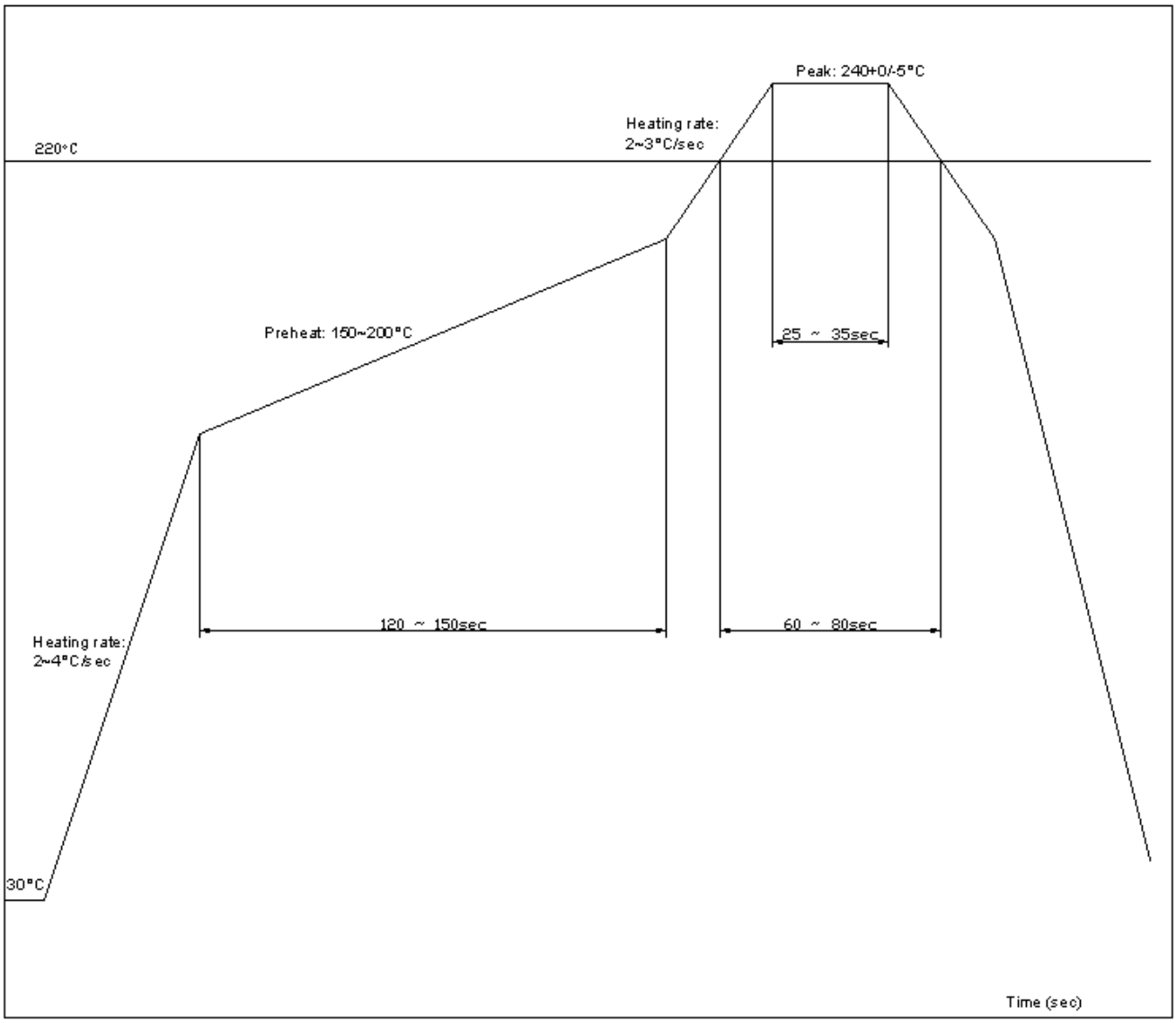
10. Recommended soldering reflow profile

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-1612-DG module should be soldered on the topside in the soldering process to prevent from falling down

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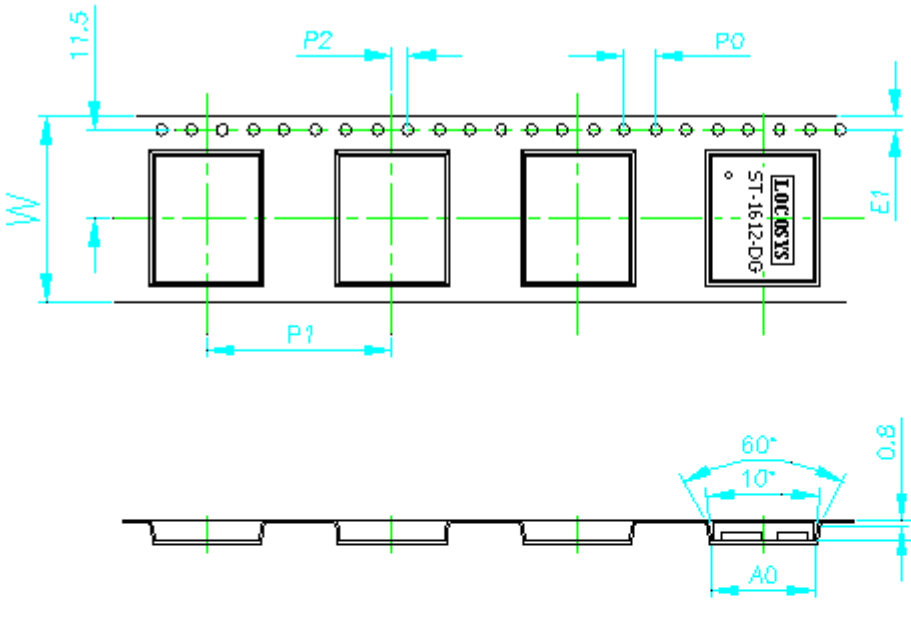
11. Reel Packing information



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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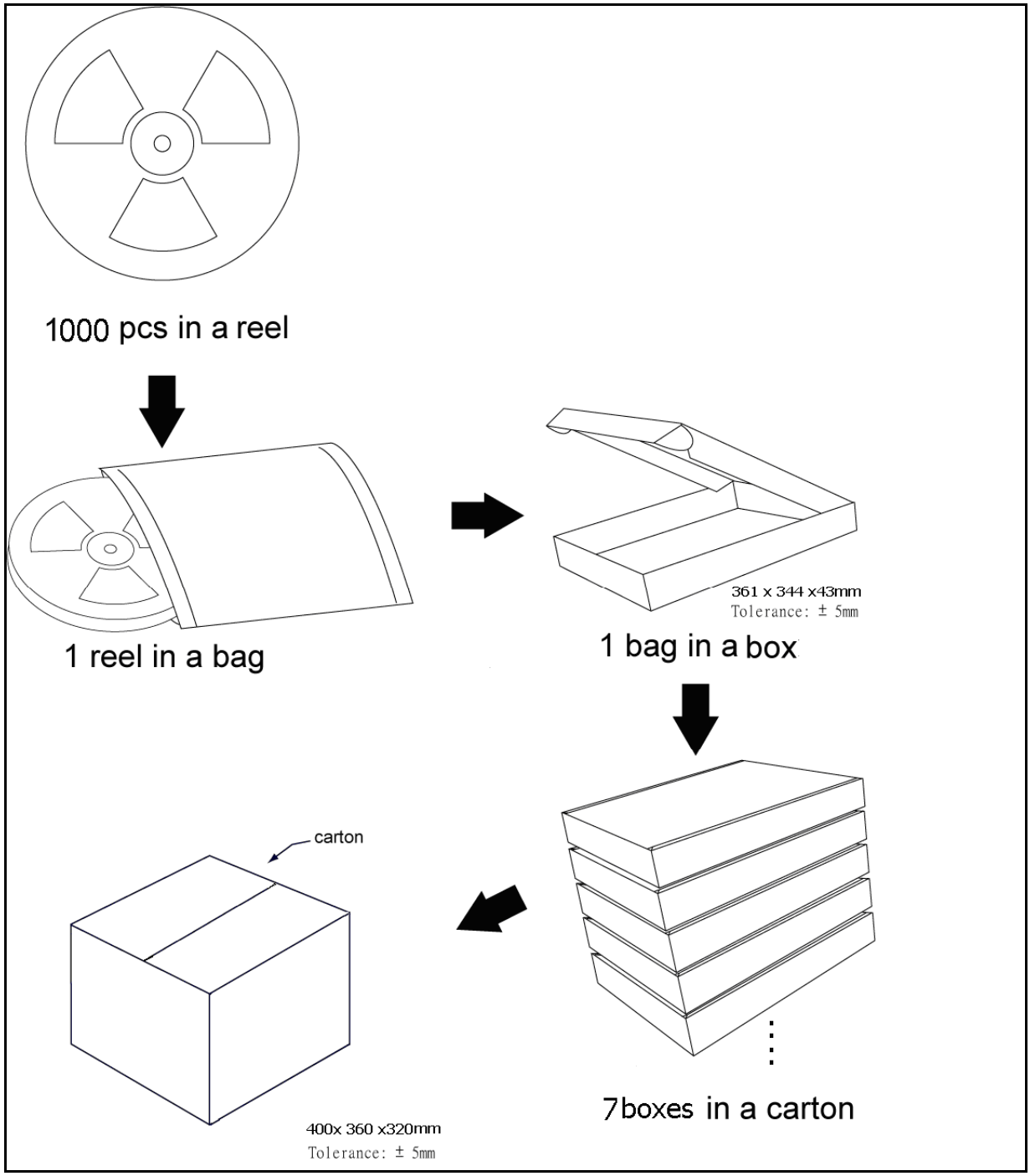
12. Packing and Handling

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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Document change list

Revision 0.2

- First release on May. 04, 2016.