LEADTEK

GPS

Global Positioning System

LR9101LP
GPS Module

www.leadtek.com

1. Introduction

The Leadtek GPS 9101LP module (LR9101LP) is a high sensitivity, high gain, low power and very compact Surface Mount Device (SMD). This 20-channel global positioning system (GPS) receiver is designed for a broad spectrum of OEM applications and is based on the fast and deep GPS signal search capabilities of SiRF StarIII™ single chip architecture. Leadtek GPS 9101LP is designed to allow quick and easy integration into GPS-related applications, especially for compact size devices, such as:

- PDA, Pocket PC and other computing devices
- Fleet Management / Asset Tracking
- AVL and Location-Based Services
- Hand-held Device for Personal Positioning and Navigation

1.1. Features

Hardware and Software

- Based on the high performance features of the SiRF Star III/LP single chip
- Built-in high gain amplifier and band pass filter
- RoHS compliant (lead-free)
- Compact module size for easy integration: 15x14x2.8 mm (590.6x551.2x110.2 mil).
- SMT pads allow for fully automatic assembly processes equipment and reflow soldering
- SiRFLocTM Client AGPS support

Performance

- Cold/Warm/Hot Start Time: 42 / 38 / 1 sec.
- Reacquisition Time: 0.1 second
- RF Metal Shield for best performance in noisy environments
- Multi-path Mitigation Hardware

Interface

- TTL level serial port for GPS communications interface

- Protocol: NMEA-0183/SiRF Binary (default NMEA)

- Baud Rate: 9600, 19200 bps (default 9600)

1.2. Advantages

- Ideal for compact size devices

- Data / Power / RF through surface mount pads

- Cost saving through elimination of RF and board to board digital connectors

- Flexible and cost effective hardware design for different application requirements

- Secure SMD PCB mounting method

2. Technical specifications

2.1. Module architecture
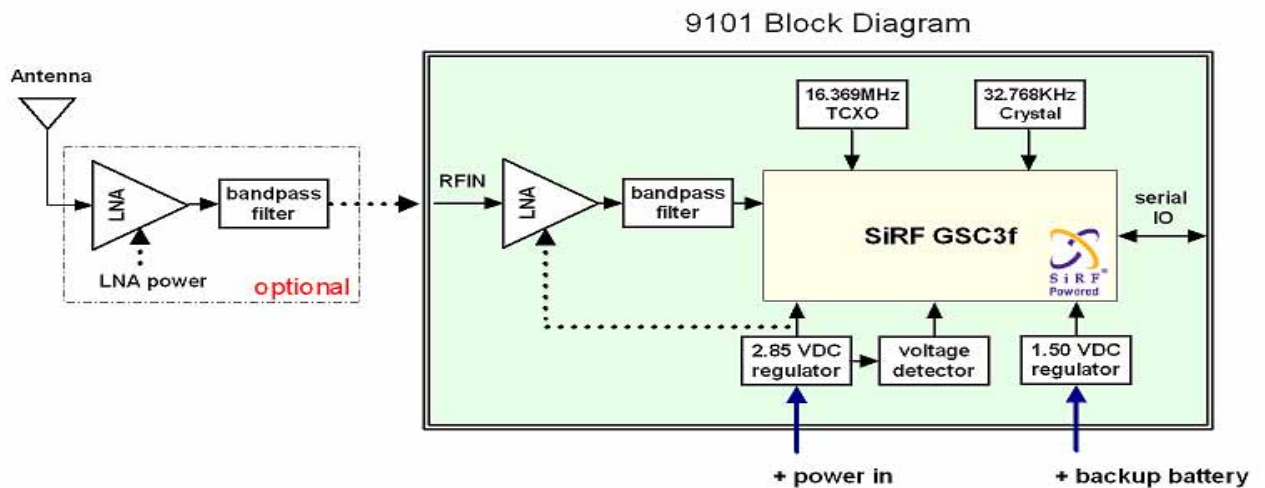
2.2. Hardware Features

- Based on the high performance features of the SiRF StarIII/LP single chip
- Built-in high gain amplifier and band pass filter
- Compact module size for easy integration: 15x14x2.8 mm (590.6x551.2x110.2 mil)
- SMT pads allow for fully automatic assembly processes equipment and reflow soldering
- RoHS compliant (lead-free)

2.3. Software Features

The firmware used on Leadtek 9101LP module is GSW3, the software for SiRF StarIII/LP receivers, and the default configuration is as following description:

Item	Description
Core of firmware	SiRF GSW3
Baud rate	9600, 19200 bps (default 9600)
Code type	NMEA-0183 ASCII
Datum	WGS-84
Protocol message	GGA, GSA, GSV, RMC,VTG
Output frequency	1 Hz

2.4. Mechanical specification

The Physical dimensions of the Leadtek 9101LP GPS Module are as follow:

Items	Description
Length	15.0 ± 0.1 mm (590.6 ± 4 mil)
Width	14.0 ± 0.1 mm (551.2 ± 4 mil)
Height	2.80 ± 0.3 mm (110.2 ± 12 mil)
Weight	1g

2.5. Recommended GPS Antenna Specification

This GPS 9101LP receiver is designed for use with passive antenna.

Parameter	Specification
Antenna Type	Right-hand circular polarized passive antenna
Frequency Range	1575.42 ± 1.023 MHz

2.6. Environmental Specification

Item	Description
Operating temperature rang	-30 deg. C to +85 deg. C
Storage temperature range	-40 deg. C to +85 deg. C
Humidity	Up to 95% non-condensing or a wet bulb temperature of +35 deg. C
Altitude	18,000 meters (60,000 feet) max.
Velocity	515 meters/second (1000 knots) max.
Jerk	20 meters/second3, max.
Acceleration	4g, max.

2.7. Product compliance

◻ **RoHS**: Restriction of Hazardous Substances (RoHS) directive will come into force on 1st July 2006; all electronic products sold in the EU must be free of hazardous materials, such as lead. Leadtek is fully committed to being one of the first to introduce lead-free GPS products while maintaining backwards compatibility and focusing on a continuously high level of product and manufacturing quality.

Intertek Labtest

TEST REPORT   NUMBER : THJ0026117

申請商 APPLICANT: LEADTEK RESEARCH INC.   DATE   : JUL 21, 2006
                    4F NO 1 LANE 327 SEC 2
                    ZHONGSHAN RD ZHONGHE CITY
                    TAIPEI HSIEN TAIWAN

樣品敘述 SAMPLE DESCRIPTION:
    ONE (1) GROUP OF SUBMITTED SAMPLES SAID TO BE :
    SAMPLE DESCRIPTION   : GPS 9101
    樣品名稱
    ITEM NO.   GPS 9101
    型號
    DATE SAMPLE RECEIVED   : JUL 17, 2006
    收件日期
    DATE TEST STARTED   : JUL 18, 2006
    開始測試日期
    ****

測試執行 TEST CONDUCTED:
    依申請商之要求，細節請參考附頁.
    AS REQUESTED BY THE APPLICANT, FOR DETAILS PLEASE REFER TO ATTACHED PAGES.
    ****

AUTHORIZED BY:
ON BEHALF OF INTERTEK TESTING SERVICES
TAIWAN LIMITED

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▣ **FCC/CE:** The Federal Communications Commission (FCC) is an independent United States government agency, directly responsible to Congress. The FCC is charged with regulating interstate and international communications by radio, television, wire, satellite and cable. The FCC's jurisdiction covers the 50 states, the District of Columbia, and U.S. possessions.

FC

VERIFICATION OF COMPLIANCE

This Verification of Compliance is hereby issued to the below named company. The test results of this report relate only to the tested sample identified in this report.

Technical Standard: FCC Part 15 Class B (DoC)
IC ICES-003

(Operation Environment: For Home And Office Use)

General Information
Applicant: Leadtek Research Inc.
            18F, No. 166, Chien-Yi Rd., Chung-Ho,
            Taipei Hsien, Taiwan, (235) R.O.C.

Product Description
EUT Description: LR9101 GPS Module
Trade Name: LEADTEK
Model Number: LR9101

Measurement Facilities
Laboratory Name: *Compliance Certification Services Inc.*
            No. 165, Chung Sheng Road, Hsin Tien City, Taipei, Taiwan, R.O.C.
            Tel: +886-2-22170894 / Fax: +886-2-22171029
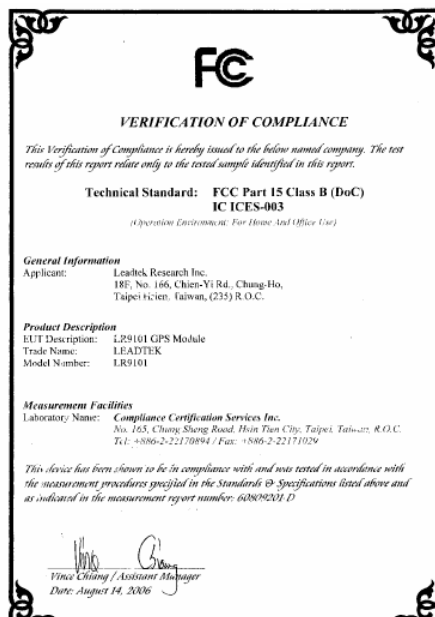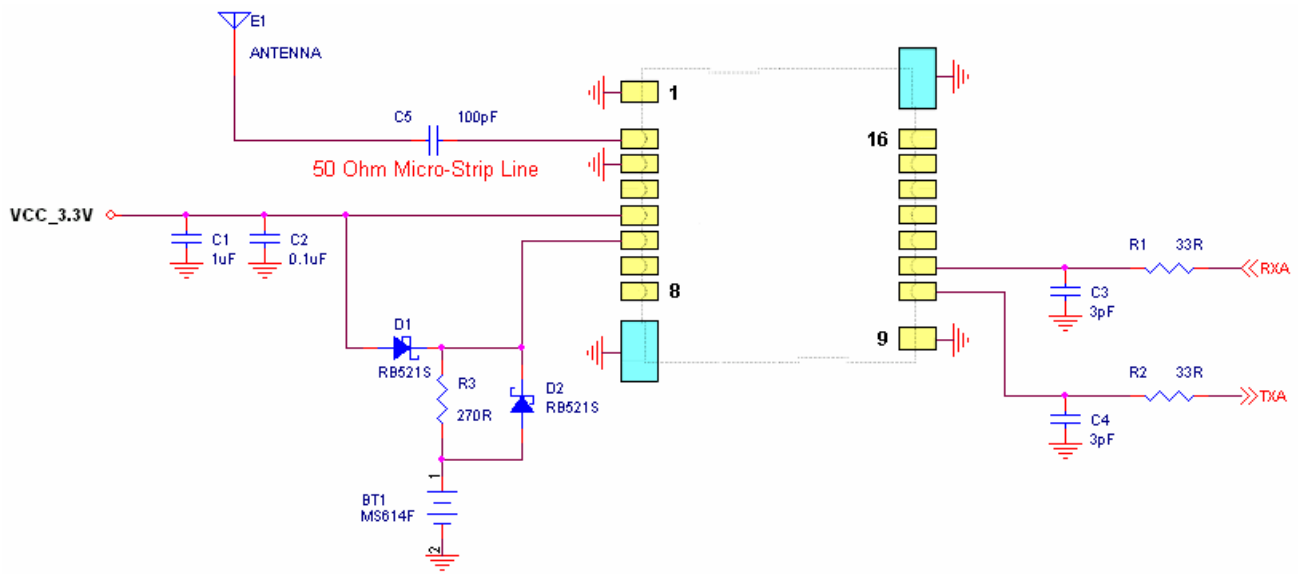
This device has been shown to be in compliance with and was tested in accordance with the measurement procedures specified in the Standards & Specifications listed above and as indicated in the measurement report number: 60809201-D

Vince Chiang / Assistant Manager
Date: August 14, 2006

CE

VERIFICATION OF COMPLIANCE

This Verification of Compliance is hereby issued to the below named company. The test results of this report relate only to the tested sample identified in this report.

Technical Standard: EMC DIRECTIVE 89/336/EEC
(EN55022 / EN55024)

(Operation Environment: Information Technology Equipment)

General Information
Applicant: Leadtek Research Inc.
            18F, No. 166, Chien-Yi Rd., Chung-Ho,
            Taipei Hsien, Taiwan, (235) R.O.C.

Product Description
EUT Description: LR9101 GPS Module
Trade Name: LEADTEK
Model Number: LR9101

Measurement Standard
EN 55022: 1998 + A1: 2000 + A2: 2003
EN 61000-3-2: 2000
EN 61000-3-3: 1995 + A1: 2001
EN 55024: 1998 + A1: 2001 + A2: 2003
    (IEC 61000-4-2: 1995 + A1: 1998 + A2: 2000; IEC 61000-4-3: 2002 + A1: 2002;
    IEC 61000-4-4: 1995 + A1: 2000 + A2: 2001; IEC 61000-4-5: 1995 + A1: 2000;
    IEC 61000-4-6: 1996 + A1: 2000; IEC 61000-4-8: 1993 + A1: 2000; IEC 61000-4-11: 1994 + A1: 2000)

Measurement Facilities
Laboratory Name: *Compliance Certification Services Inc.*
            No. 165, Chung Sheng Road, Hsin Tien City, Taipei, Taiwan, R.O.C.
            Tel: +886-2-22170894 / Fax: +886-2-22171029

This device has been shown to be in compliance with and was tested in accordance with the measurement procedures specified in the Standards & Specifications listed above and as indicated in the measurement report number: 60809201-E

Vince Chiang / Assistant Manager
Date: August 14, 2006

Please note that the compliances of this device are for this SMD module itself only. The complete system compliance must be examined and certified whenever you put this SMD inside.

2.8. Reference design

- All ground pads attach directly to ground plane by way of via.

- All components are reference only

3. Performance Characteristics

3.1. Position and velocity accuracy

Accuracy	Position	10 meters, 2D RMS 5 meters 2D RMS, WAAS corrected < 5meters (50%).
	Velocity	0.1 meters/second
	Time	1 microsecond synchronized to GPS time

3.2. Dynamic constrains

Dynamic Conditions	Altitude	18,000 meters (60,000 feet) max.
	Velocity	515 meters/second (1000 knots) max.
	Acceleration	4g, max.
	Jerk	20 meters/second^3, max.

3.3. Acquisition time [1]

Mode	Leadtek 9101LP GPS Module
TTFF Hot (valid almanac, position, time & ephemeris)	1 s
TTFF Warm (valid almanac, position, & time)	38 s
TTFF Cold (valid almanac)	42 s
re-acquisition (<10 s obstruction with valid almanac, position, time & ephemeris)	100 ms

Note 1: Open Sky and Stationary Environments.

3.4. Timing 1PPS output

The 1PPS pulse width is 1 μs, this 1PPS is NOT suited to steer various oscillators (timing receivers, telecommunications system, etc).

3.5. Sensitivity

Parameter	Description
Tracking Sensitivity	-159 dBm
Acquisition Sensitivity	-155 dBm

3.6. Battery backup (SRAM/RTC backup)

During 'Powered down' condition, the SRAM and RTC (Real Time Clock may be kept operation by supplying power from VBATT. The Leadtek 9101LP GPS module can accept slow VBATT supply rise time (unlike many other SiRF StarII based receivers) due to an on-board voltage detector.

3.7. Differential aiding

3.7.1. Differential GPS (DGPS): Option

DGPS specification improves the Leadtek 9101LP GPS Module horizontal position accuracy to less than 4M 2dRMS.

3.7.2. Satellite Based augmentation System (WASS/EGONS): Option

The Leadtek 9101LP GPS Module is capable of receive SBAS (WASS and EGONS) differential corrections. SBAS improves horizontal position accuracy by correcting GPS signal errors caused by ionosphere Disturbances, timing and satellite orbit errors.

Both SBAS and DGPS should improve position accuracy. However, other factors can affect accuracy, such as GDOP, multi-path, distance from DGPS reference station and latency of corrections.

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4. Hardware Interface Power supply

Parameter	Leadtek 9101LP GPS Module
Input voltage	3.2 ~ 5.0 VDC
Current (typ.) at full power (3.3V)	49mA
Battery backup voltage	1.65~5.0 VDC

4.1. Specifications

4.1.1. Pin Positions
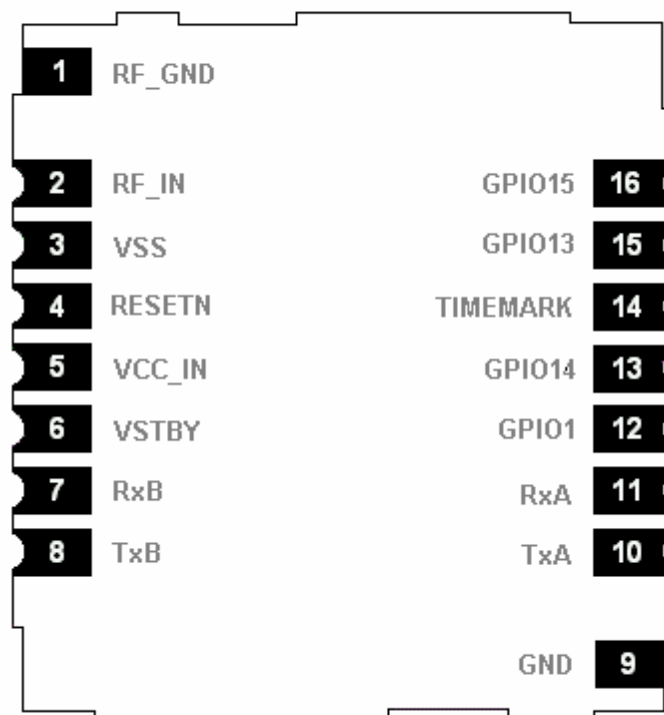
4.1.2. Pin Assignment

PIN	Name	Type	Description
1	RF GND	RF	RF Ground
2	RF IN	RF	RF input
3	VSS	PWR	Ground
4	RESETN	I	System reset (active low); In normal operation this pad should be left floating. Active pull-up is not recommended
5	VCC IN	PWR	3.2 ~ 5.0 VDC input
6	VSTBY	PWR	1.65 ~ 5.0 VDC RTC backup battery supply
7	RXB	I	TTL level asynchronous input for UART B
8	TXB	O	TTL level asynchronous output for UART B
9	GND [2]		Ground
10	TXA	O	TTL level asynchronous output for UART A
11	RXA	I	TTL level asynchronous input for UART A
12	GPIO1	I	Reserved, general purpose IO
13	GPIO14	I	Reserved, general purpose IO
14	TIMEMARK	O	1 PPS time mark output
15	GPIO13	I	Reserved, general purpose IO
16	GPIO15	I	Reserved, general purpose IO

Note 2: There are two more shielding case ground pads, please refer the recommended footprint.

5. Software interface

The host serial I/O port of the module's serial data interface supports full duplex communication between the module and the user. The default serials are shown in Table 5-1.

Port	Protocol	Description
Port A	NMEA 0183, 9600 bps	GGA, GSA, GSV, RMC, VTG
Port B	N/A	N/A

Table 5-1 Leadtek 9101LP GPS module default baud rates

5.1. NMEA output messages

The output NMEA (0183 v3.0) messages for the receiver are listed in Table 5-2. A complete description of each message is contained in the SiRF NMEA reference manual.
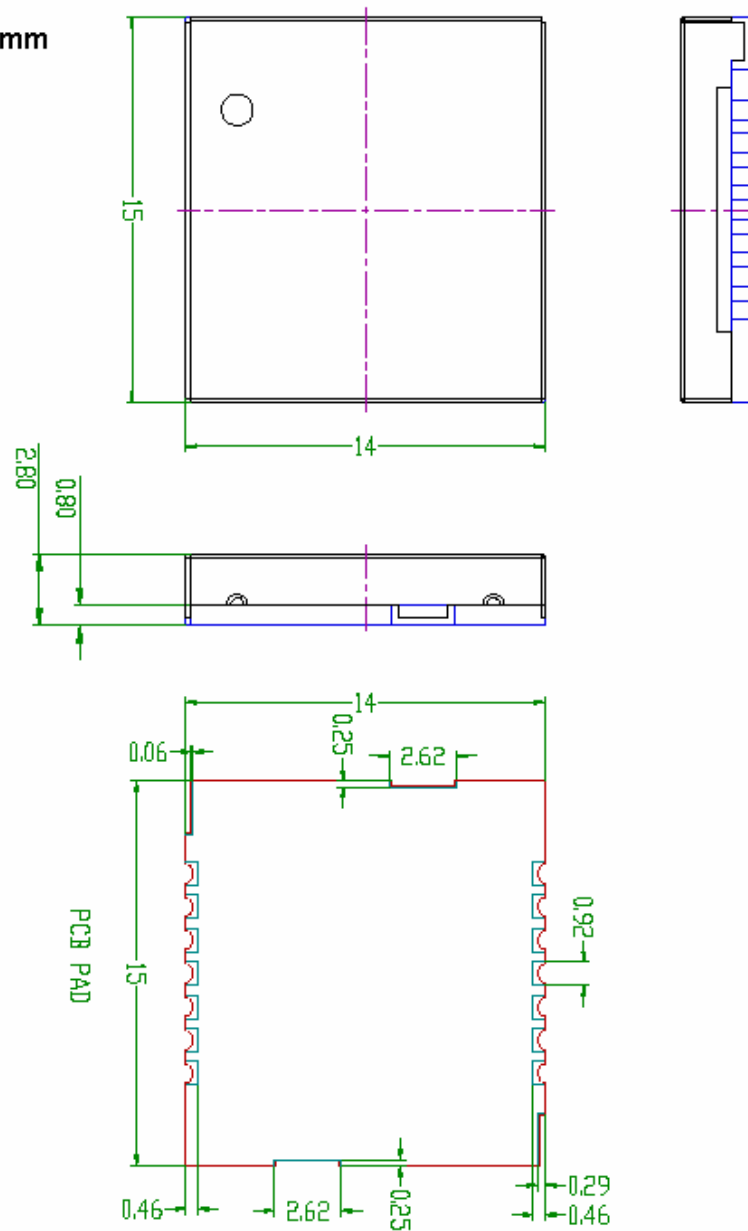
5.2. SiRF binary

A complete description of each binary message is contained in the Leadtek SiRF Binary Protocol reference manual.

6. Mechanical drawing and footprint

6.1. Outline Drawing

Items	Description
Length	15.0 ± 0.1 mm (590.6 ± 4 mil)
Width	14.0 ± 0.1 mm (551.2 ± 4 mil)
Height	2.80 ± 0.3 mm (110.2 ± 12 mil)

Unit: mm

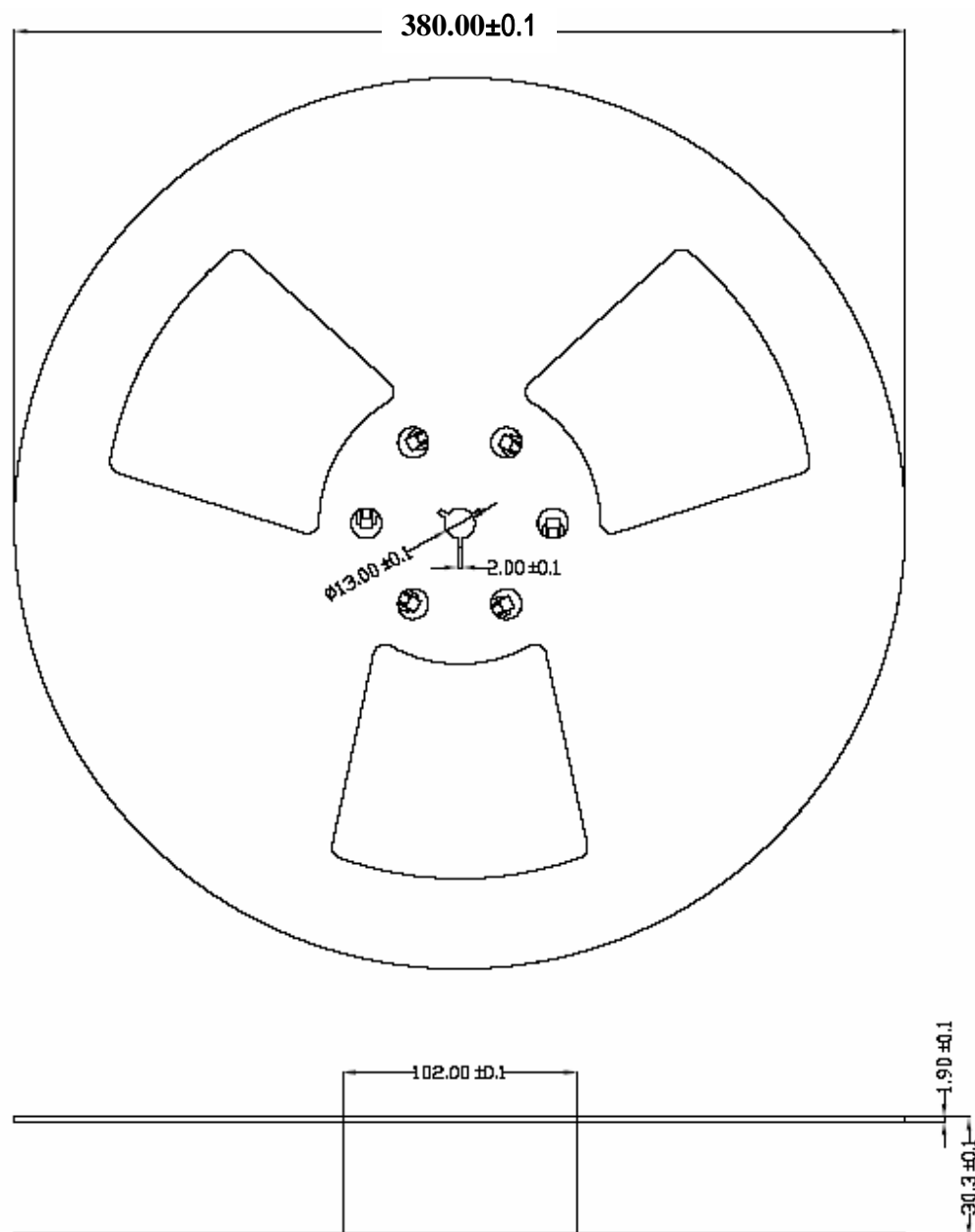## 6.2. Recommended footprint (Bottom view)
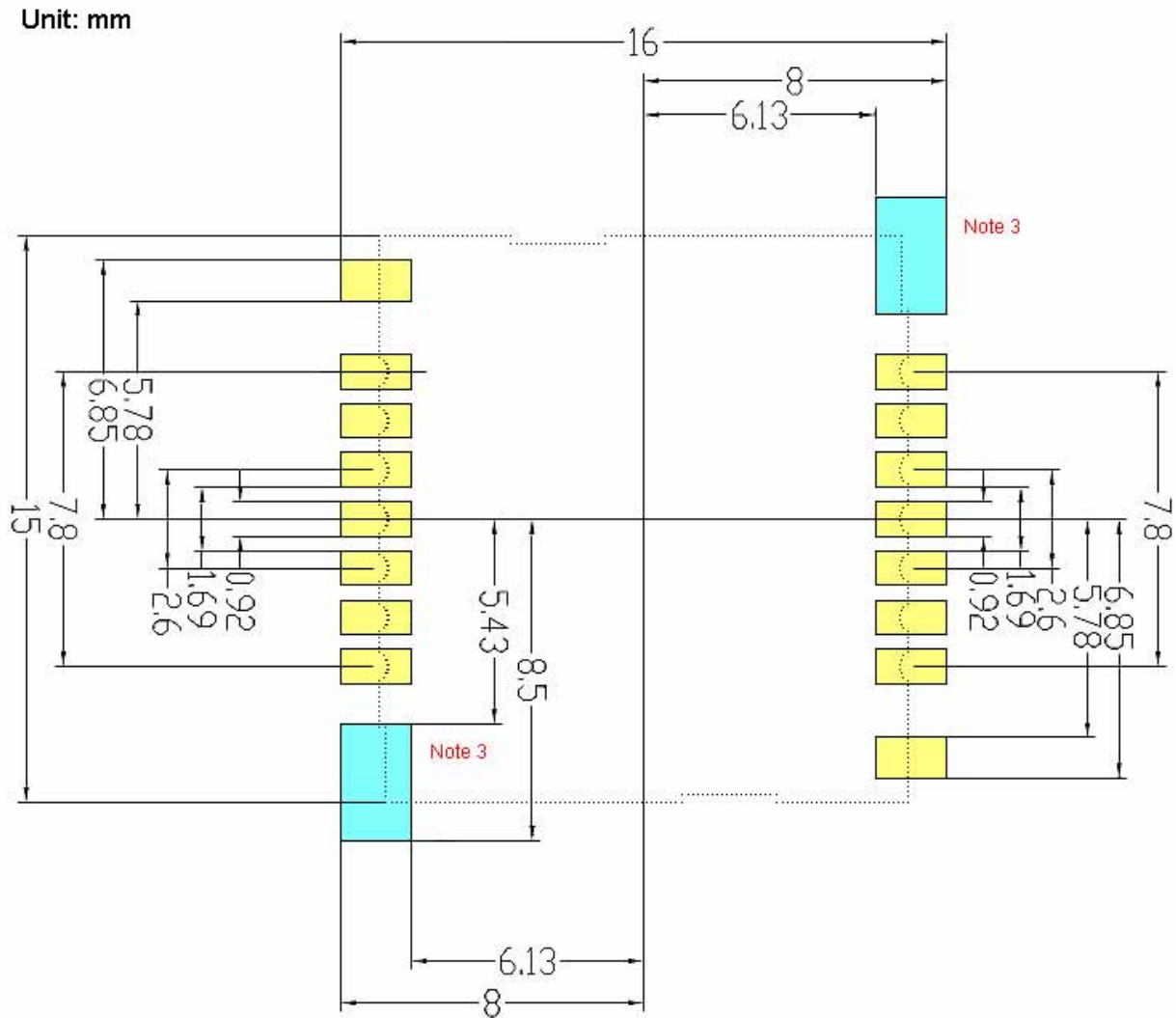
Note 3: These two shielding case ground pads should attach directly to a ground plane.

7. Automated manufacturing components

7.1. Reel and taping specifications

(Unit: mm)

7.2. Polystyrene Alloy Taping Specifications

- 10 sprocket hole pitch cumulative tolerance ±0.20mm
- Carrier camber is within 1mm in 100mm
- A0 and B0 measured on a plane 0.3mm above the bottom of the pocket
- K0 measured from a plane on the inside bottom of the pocket to the top surface of the carrier
- All dimensions meet EIA-481-2 requirements
- 22" 1R= 63M 3000PCS 13"21M 1000PCS

7.3. Polystyrene Alloy Taping Drawing

DEVICE TYPE:LR9101-G
CUSTOMER   :
DWG NO   :
MATERIAL :P.S0.5黑色
DATE   : 95.06.02

ITEM	W	A0	B0	K0	K1	P	E	F	D	D1	P0	P2
DIM	24 $^{+0.3}_{-0.3}$	14.5 $^{+0.1}_{-0.1}$	15.5 $^{+0.1}_{-0.1}$	3.1 $^{+0.1}_{-0.1}$	0 $^{+0.1}_{-0.1}$	20 $^{+0.1}_{-0.1}$	1.75 $^{+0.1}_{-0.1}$	11.5 $^{+0.1}_{-0.1}$	1.5 $^{+0.1}_{-0.0}$	1.5 $^{+0.25}_{-0.0}$	4.0 $^{+0.1}_{-0.1}$	2.0 $^{+0.1}_{-0.1}$
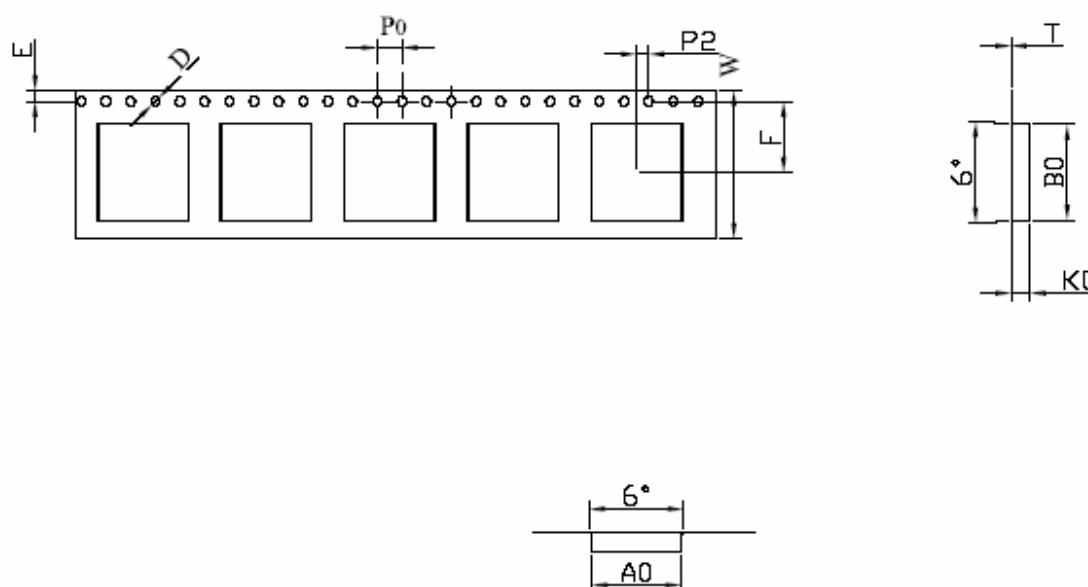
8. RoHS compliant information

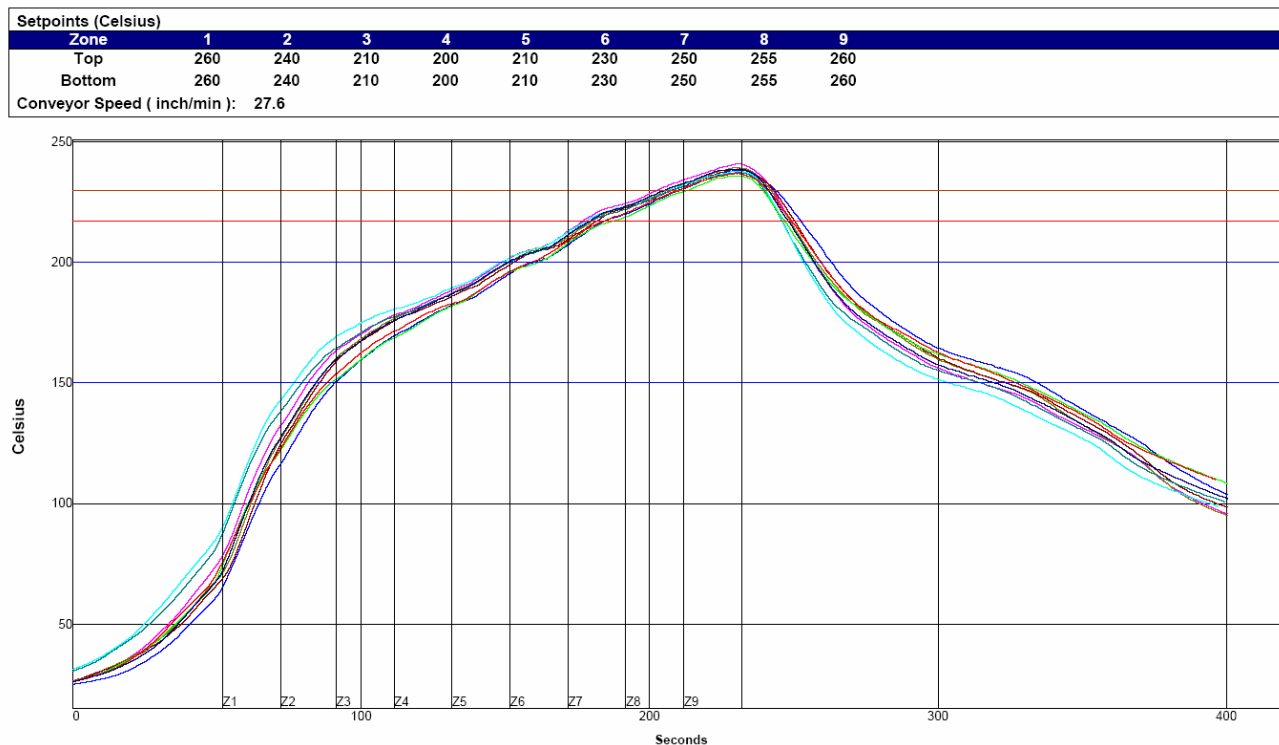By July 1, 2006, all electronic products sold in the EU must be free of hazardous materials, such as lead. Leadtek is filly committed to being one of the first to introduce lead-free GPS Products while maintaining backwards compatibility and focusing on a continuously high level of product and manufacturing quality.

8.1. RoHS soldering profile

Reflow Profile

High quality, low defect soldering requires identifying the optimum temperature profile for reflowing the solder paste. To have the correct profile assures components, boards, and solder joints are not damaged and reliable solder connection is achievable. Profiles are essential for establishing and maintaining processes. You must be able to repeat the profile to achieve process consistency. The heating and cooling rise rates must be compatible with the solder paste and components. The amount of time that the assembly is exposed to certain temperatures must first be defined and then maintained. The following is an example of a typical thermal profile.

Setpoints (Celsius)

Zone	1	2	3	4	5	6	7	8	9
Top	260	240	210	200	210	230	250	255	260
Bottom	260	240	210	200	210	230	250	255	260

Conveyor Speed (inch/min): 27.6

Glossary

A-GPS

Assisted GPS or AGPS is a technology that uses an assistance server to cut down the time needed to find the location. Although GPS provides excellent position accuracy, position fixes require lines of sight to the satellites. In regular GPS networks there are only GPS satellites and GPS receivers. In A-GPS networks, the receiver, being limited in processing power and normally under less than ideal locations for position fixing, communicates with the assistance server that has high processing power and access to a reference network. Although dependent on cellular coverage, AGPS processing is quicker and more efficient than regular GPS.

API

An application programming interface is a set of definitions of the way one piece of computer software communicates with another. One of the primary purposes of an API is to provide a set of commonly used functions, such as to draw windows or icons on the screen. Programmers can then take advantage of the API by making use of its functionality, saving them the task of programming everything from scratch.

Baud Rate

Is a measure of the signaling rate, which is the number of changes to the transmission media per second in a modulated signal.
For Example: 250 baud means that 250 signals are transmitted in one second. If each signal carries 4 bits of information then in each second 1000 bits are transmitted. This is abbreviated as 1000 bit/s.

Dead Reckoning

The process of estimating your position by advancing a known position using course, speed, time and distance to be traveled. It is figuring out where you will be at a certain time if you hold the speed, time and course you plan to travel.

Differential GPS (DGPS)

An extension of the GPS system that uses land-based radio beacons to transmit position corrections to GPS receivers. DGPS reduces the effect of selective availability, propagation delay, etc. and can improve position accuracy to better than 10 meters.

EGNOS

A satellite navigation system being developed by the European Space Agency, the European Commission, and EUROCONTROL. It is intended to supplement the GPS and GLONASS systems by reporting on the reliability and accuracy of the signals. According to specifications, horizontal position accuracy should be better than 7 meters. In practice, the horizontal position accuracy is at the meter level. It will consist of three geostationary satellites and a network of ground stations.
Similar service is provided in America by the WAAS system. See WAAS.

European Geostationary Navigation Overlay System

See EGNOS.

LNA

A special type of electronic amplifier or amplifier used in communication systems to amplify very weak signals captured by an antenna. It is usually located at the antenna and is a key component, which is placed at the front-end of a receiver system.

Low Noise Amplifier

See LNA.

Multi-path mitigation

Anticipating errors caused when a satellite signal reaches the GPS receiver antenna by more than one path. Usually caused by one or more paths being bounced or reflected off of structures near the antenna and occurs to some extent everywhere. The signal which traverses a longer path will yield a larger pseudo range estimate and increase the error.

NMEA

An U.S. standards committee that defines data message structure, contents, and protocols to allow the GPS receiver to communicate with other pieces of electronic equipment.

National Marine Electronics Association

See NMEA.

1PPS

Pulse which is generated once per second. GPS and some radio clocks and related timekeeping gear have a pulse-per-second or PPS signal that is needed for high accuracy time synchronization. The PPS signal can be connected in either of two ways, either through the data leads of a serial port or through the modem control leads. Either way requires conversion of the PPS signal,
Most GPS devices emit an rs-232 serial stream with some kind of timestamp format. Many GPS devices are small realtime systems with the satellite tracking done at high priority, positioning done at medium priority, and time output done at low priority. The timestamps often have +- 200 ms of jitter (variance in delay), and output a PPS signal on the exact second.

SMD

Electronic device components that are mounted directly onto the surface of printed circuit boards (PCBs). In the industry it has largely replaced the previous construction method of fitting components with wire leads into holes in the circuit board (also called through-hole technology).

Surface Mount Device

See SMD.

TCXO

An electronic device that uses the mechanical resonance of a physical crystal to create an electrical signal with a very precise frequency and can be embedded in integrated circuits. TCXO reduces the environmental changes of temperature, humidity, and vibration, to keep a stable output frequency.

Temperature Controlled Crystal Oscillator

See TCXO.

Time To First Fix (TTFF)

The time it takes a GPS receiver to find satellites after you first turn it on, when the GPS receiver has lost memory, or has been moved over 300 miles from its last location. Standard TTFF Timing consists of:

Mode	Requires	Timing
Snap Start	Hot + Clock + Sat Pos	3 minutes off
Hot Start	Warm + Ephemeris	30 minutes off
Warm Start	Position Accuracy	<500 KM
	Time Accuracy	<2 hours
	Almanac	<1 year
Cold Start	Nothing	N/A

Specifications are typical times assuming good satellite visibility and above threshold signal strengths.

WAAS

A system of satellites and ground stations that provide GPS signal corrections for better position accuracy. A WAAS-capable receiver can give you a position accuracy of better than three meters, 95 percent of the time. (At this time, the system is still in the development stage and is not fully operational.) WAAS consists of approximately 25 ground reference stations positioned across the United States that monitor GPS satellite data. Two master stations, located on either coast, collect data from the reference stations and create a GPS correction message.

Wide Area Augmentation System

See WAAS.

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