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unicore UT986 GNSS All Constellation Multi Frequency High Precision Timing Module User Manual

Contents

unicore UT986 GNSS All Constellation Multi Frequency High Precision Timing Module

The UT986 is a new generation of GNSS high precision timing module that supports all constellations and multiple frequencies.
It is based on the RF-baseband integrated GNSS SoC — NebulasIVTM, and is mainly used in power grids and telecom base station timing.

Product Introduction

Overview

- 1408 super channels
- Supports BDS (including BDS-3 signals), GPS, GLONASS, and Galileo multi-system joint timing and single system standalone timing
- User-configurable flexible configurations
- Supports QZSS and DGPS function
- Integrates filters and linear amplifiers
- Optimized radio frequency structure and interference suppression capability
- Built-in JamShield adaptive anti-jamming technology and U-AutoAlign multi-path suppression technology
- Nanosecond-level PPS accuracy
- Supports fixed-location timing, optimized-location timing, and positioning timing
- Remains good timing accuracy even in complex signal environments

Installation and Operation

Target Readers

This manual applies to technicians who have certain knowledge in GNSS modules.

Installation for Test

Attentions

Before installation, please pay attention to the following:

- Make sure that the power supply voltage and current meet the requirements of the module.
- Ensure that the installation site has good ventilation and heat dissipation conditions.
- Do not exceed the maximum operating temperature and humidity of the module.
- Handle the module with care and avoid mechanical damage.

Installation

Follow the steps below to install the module:

1. Prepare the necessary tools and materials, including a soldering iron, flux, screwdriver, and cables.
2. Carefully remove the module from its packaging.
3. Position the module on the target board and align the pins with the corresponding pads.
4. Solder the module onto the board using a soldering iron and flux.
5. Connect cables as required.

Specifications

The electrical specifications of the UT986 module are provided in detail in the user manual. Please refer to the manual for more information.

Hardware

The hardware design of the UT986 module is provided in detail in the user manual. Please refer to the manual for more information.

Packaging

Product Label

The product label contains information about the product name, model, serial number, and production date.

Packaging Description

The module is packaged in a sealed anti-static bag to prevent damage from static electricity during transportation and storage.

Production and Maintenance

The user manual provides information on disassembly, cleaning, and reflow soldering of the UT986 module. Please refer to the manual for more information.

Revision History

Version	Revision History	Date
R1.0	First release	Aug., 2022

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Foreword
This document describes the information of the hardware, package, specification and the use of Unicode UM960L modules.

Target Readers
This document applies to technicians who possess the expertise on GNSS receivers.

Introduction

Overview
UT986 is a new generation of GNSS high precision timing module supporting all constellations and multiple frequencies. It is based on the RF-baseband integrated GNSS SoC — NebulasIVTM, and is mainly used in power grids and telecom base station timing.

UT986 has 1408 super channels, supporting BDS (including BDS-3 signals), GPS, GLONASS and Galileo multi-system joint timing and single system standalone timing, which users can flexibly configure. It also supports QZSS and DGPS function.

UT986 module integrates filters and linear amplifiers, and has optimized radio frequency structure and interference suppression capability. With the built-in JamShield adaptive anti-jamming technology and U-AutoAlign multi-path suppression technology, it can detect interference as well as spoofing, ensuring a good performance even in complex electromagnetic environments.

UT986 module can provide nanosecond-level PPS accuracy, support fixed-location timing, optimized-location

timing, and positioning timing, and remain good timing accuracy even in complex signal environments.

UT986 features a compact size of 17.0 mm × 22.4 mm × 2.4 mm. It adopts SMT pads, supports standard pick-and-place and fully automated integration of reflow soldering, and is compatible with previous generation of timing products as well as mainstream products on the market.
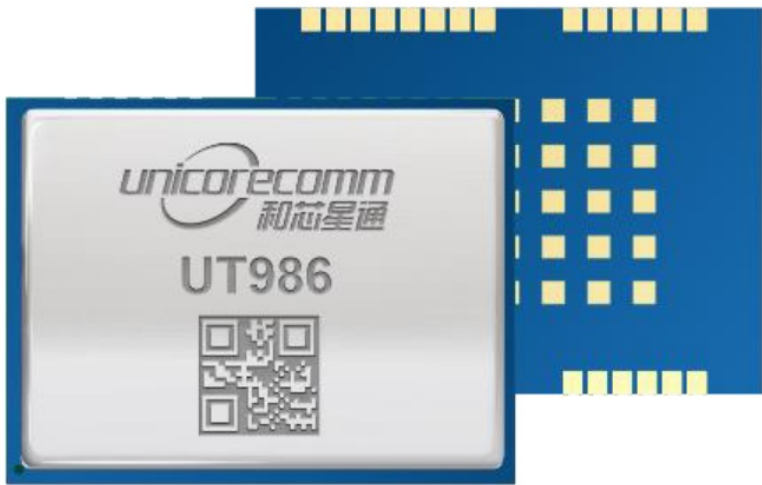
Figure 1-1 UT986 Module

Features

Table 1-1 Product Features

Model	Grade		Dimensions (mm)	GNSS				Power (V)	Interface			Function		
	Industrial Grade	Automotive Grade		GPS/QZSS	BDS	GLONASS	Galileo	3.0 to 3.6	UART 1	UART 2	1PPS	Built-in Flash	Data Update Rate	DGPS
UT986	●		17.0 × 22.4 × 2.4	●	●	●	●	●	●	●	●	●	1Hz	●

Block Diagram
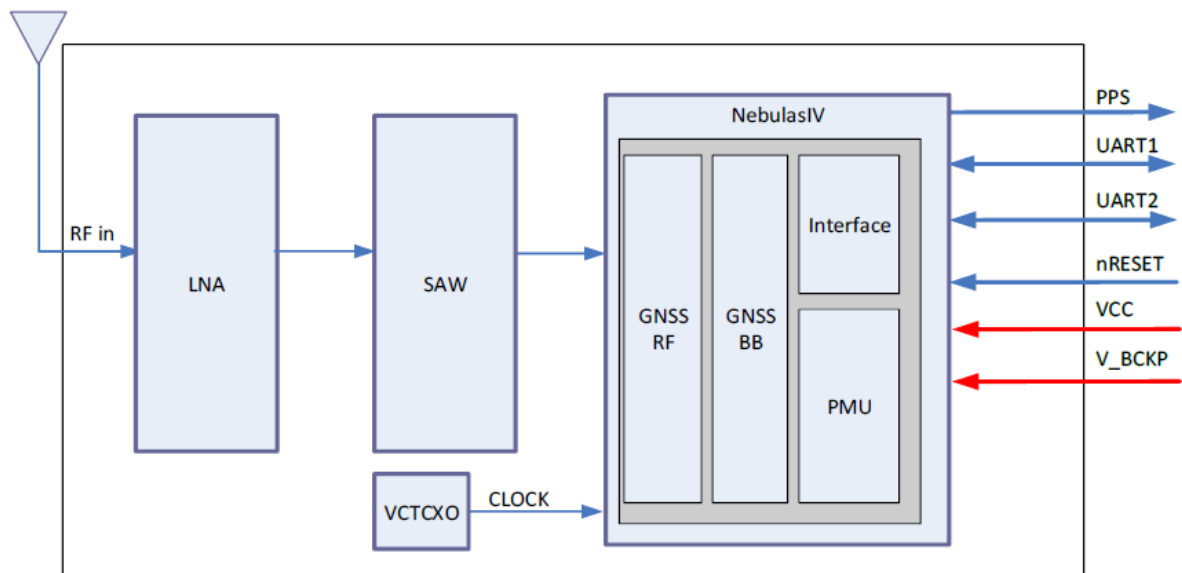
Figure 1-2 UT986 Block Diagram

Performance

Table 1-2 Key Performance/Specifications

Power					
Voltage	3.0 V to 3.6 V DC				
Power Consumption	700 mW				
RF Input					
VSWR	≤ 2.0				
Input Impedance	50 Ω				
Antenna Gain	5 dB to 35 dB				
Physical Characteristics					
Dimensions	17.0 mm × 22.4 mm × 2.4 mm				
Weight	1.9 g				
Environmental Specifications					
Operating Temperature	-40 °C to +85 °C				
Storage Temperature	-40 °C to +95 °C				
RoHS2.0	Compliant				

Input/output Data Interface					
UART x 2	LVTTL, Baud Rate: 9600 bps to 921600 bps				
GNSS Performance					
Frequencies	BDS: B1I, B1C, B2a GPS: L1C/A, L2C, L5 GLONASS: L1 Galileo: E1, E5a, E5b				
TTFF1	Cold Start: 30 s Reacquisition: 3 s				
Positioning Accuracy (CEP)	1.5 m (Dual-system horizontal, open sky) 3.0 m (Dual-system vertical, open sky)				
Velocity Accuracy (RMS)	0.03 m/s (Dual-system horizontal, open sky)				
		GPS	BDS	GLONASS	Galileo
Sensitivity2	Cold Start	-147 dBm	-145 dBm	-145 dBm	-145 dBm
	Tracking	-161 dBm	-160 dBm	-155 dBm	-155 dBm

1. All satellites C/N0 at 41dB
2. Tested with a good external LNA

1PPS Accuracy (RMS)3	2.5 ns
Data Update Rate	1 Hz
Data Format	NMEA 0183, Unicore Protocol, RTCM3.2

Precision Timing and Raw Data Output

UT986 supports fixed-location timing, optimized-location timing, and positioning timing. Switch or query the above timing modes through CFGTM command. The module can simultaneously track all the four GNSS systems including GPS, BDS, GLONASS and Galileo, and can be switched back and forth between these four systems using CFGGNSS command.

The default mode of UT986 module is optimized-location timing. It outputs information of the dynamic position and fixed position, which can be queried by TIMPOS command. Refer to UT986_Protocol Specification for more details.

Fixed-location Timing

Fixed-location timing mode only applies to static scenes. In this mode, users are required to input the exact position of the receiver's antenna center through the CFGTM command. UT986 uses this position to calculate the distance between the antenna and satellites, and calculate time to provide timing service.

Optimized-location Timing

Optimized-location timing mode also applies to static scenes. In this mode, the receiver collects a number of positioning points (within observation time) and calculates the exact position of the antenna. After that, the position is locked down, the timing mode is switched to fixed-location timing, and the receiver provides timing based on the locked position.

The observation time and accuracy are configured through CFGTM command. The fixed-location timing mode is activated only after both of them are configured. Query the observation status through TPFINFO command.

Using the CFGTM command, the calculated position of the antenna can be saved or not. For the former, the position estimation process only needs to be done once after UT986 is installed; and for the latter, the process does again after the restart. After the optimization of the position, the timing mode of the receiver automatically switches to the fixed-location timing mode.

If the position of UT986 antenna changes, the command CFGTM must be sent again to switch the timing mode back to the optimized-location timing mode to recalibrate the antenna position. Refer to UT986_ Protocol Specification for more details.

Positioning Timing

In the positioning timing mode, UT986 calculates the antenna position and time in real time. It is the only mode that supports dynamic timing, and the timing quality depends on the satellite environment, which makes it difficult to guarantee the timing accuracy.

Pulse per Second (1PPS)

UT986 provides one 1PPS signal output with adjustable pulse width and polarity, which can be configured and queried through the CFGTP command. TIMTP is used to describe the related 1PPS information including the corresponding time and time accuracy indicators.

Serial Port (UART)

The master serial port of UT986 is UART1, supporting data transmission and firmware upgrade, and the I/O signal type is LVTTL. The default baud rate is 460800 bps, and it can be configured by users. When designing products, please make sure that UART1 is connected to a PC or external processor to support firmware upgrade.
Serial port 2 only supports data transmission and is unavailable for firmware upgrade, only for backup.

Protocols

Table 1-3 Supported Interface Protocols

Protocol	Type
NMEA0183	I/O, ASCII, NMEA4.1, NMEA4.11(Default output)
Unicore Protocol	I/O, ASCII, Unicore Protocol
RTCM4	Input, RTCM3.2

Clock

The industrial VCTCXO is built in UT986 to ensure the stability of the clock system and the ability to capture signals quickly in weak signal environments.

Antenna

The filter and linear amplifier are built in the UT986 module. It is recommended to use an active antenna to provide better performance.

The antenna should support signal frequencies ranging from 1160 MHz to 1230 MHz and 1555 MHz to 1610 MHz, support right-handed circular polarization, and the output VSWR should be ≤ 2.0, gain range should be within 5 dB to 35 dB, in-band flatness < 1.5, out-of-band suppression >50 dB @2G3G4G5G communication frequencies.

Installation

This section describes how to use the EVK to test and evaluate the performance of the UT986 module.

To ensure a successful installation, please prepare the following accessories in advance:

- UT986 EVK (including a power supply)
- Matching antenna
- Antenna cable
- Straight-through cable
- Desktop or laptop computer with serial port and UPrecise.

Please keep the packing box and antistatic box for storage and handling.

Attentions

Many components on the UT986 module are static sensitive devices (SSD). Therefore, it is necessary to provide ESD protection for IC circuits and other SSD. Please obey all the ESD precautions and procedures.

- Electrostatic discharge (ESD) may cause damage to the device. All operations mentioned in this chapter should be carried out on an antistatic workbench using an antistatic wrist strap and conductive foam pad. If there is no antistatic workbench, wear an antistatic wrist strap and connect the other end of the strap to the metal frame to avoid electrostatic damages.
- Hold the edge of the evaluation board, and do NOT touch the components directly.

Carefully check the board to make sure that there is no apparent loose or damaged components. If you have any questions, please contact Unicore or the local distributors.

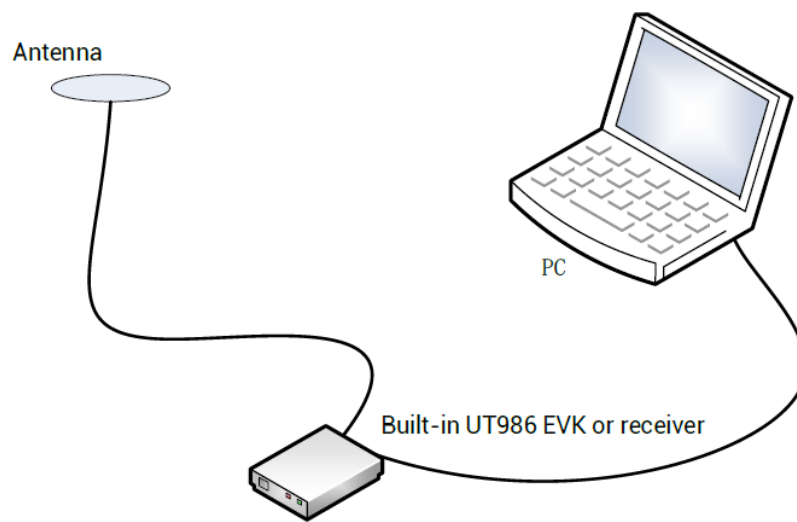**Figure 2-1 shows the typical installation of UT986 EVK.**

Figure 2-1 Typical Installation of UT986

Installation

After the above preparation, please follow the steps below to install.

- Step1. Ensure adequate antistatic measures, such as wearing a grounded antistatic wrist strap, using a grounded workbench, etc.
- Step2. Open UT986 EVK and take out the evaluation board.
- Step3. Select the GNSS antenna with appropriate gain (the system frequency supported by the antenna should be consistent with the module), fix it in a nonoccluded area, and use the appropriate cable to connect the antenna with the UT986 evaluation board.
- Step4. Connect PC to COM1 or COM2 of the evaluation board with a straight-through cable.
- Step5. Power on the evaluation board and initialize UT986.
- Step6. Open the UPrecise software.
- Step7. Control the receiver via UPrecise to display constellations view, messages, the receiver's status, etc.

Electrical Specifications

Absolute Maximum Ratings

Table 3-1 Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Condition
Power Supply Voltage	VCC	-0.5	3.6	V	
Backup Power Supply Voltage	V_BCKP	-0.5	3.6	V	
Input Pin Voltage	Vin	-0.5	VCC + 0.2	V	
Storage Temperature	Tstg	-40	95	°C	
Maximum ESD Stress	VESD (HBM)		2000	V	All pins

Operational Conditions

Table 3-2 Operational Conditions

Parameter	Symbol	Min.	Typical	Max.	Unit	Condition
Power Supply Voltage	VCC	3.0	3.3	3.6	V	
VCC Maximum Ripple	Vrpp	0		50	mV	
Peak Current	Iccp			600	mA	VCC = 3.3 V
Backup Power Supply Voltage	V_BCKP	2.0		3.6	V	
Operating Temperature	Topr	-40		85	°C	

IO Threshold Values

Table 3-3 IO Threshold Values

Parameter	Symbol	Min.	Typical	Max.	Unit	Condition
Low Level Input Voltage	Vin_low	0		VCC × 0.2	V	
High Level Input Voltage	Vin_high	VCC × 0.7		VCC + 0.2	V	
Low Level Output Voltage	Vout_low	0		0.45	V	Iout = 4 mA
High Level Output Voltage	Vout_high	VCC − 0.45		VCC	V	Iout = 4 mA
nRESET Low Level Voltage	Vnrst_low	0		0.3	V	

Antenna Characteristics

Table 3-4 Antenna Characteristics

Parameter	Symbol	Min.	Typical	Max.	Unit	Condition
Antenna Gain	Gant	5		35	dB	

Mechanical Specifications

Table 3-5 Dimensions

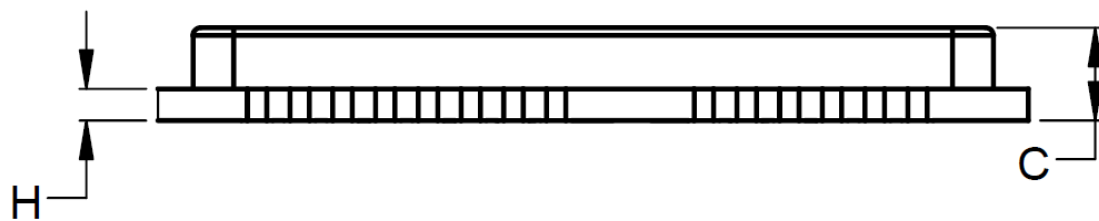| Parameter	Min. (mm)	Typical (mm)	Max. (mm)
A	22.20	22.40	22.90
B	16.80	17.00	17.50
C	2.2	2.4	2.6
D	2.75	2.85	2.95
E	1.00	1.10	1.20
F	3.70	3.80	3.90
G	2.45	2.55	2.65
H	0.72	0.82	0.92
J	1.90	2.00	2.10
K (Outer edge of the stamp hole)	0.70	0.80	0.90
M	0.90	1.00	1.10
N (Inner edge of the stamp hole)	Φ0.40	Φ0.50	Φ0.60
P	5.10	5.20	5.30
R	4.40	4.50	4.60
X	0.90	1.00	1.10
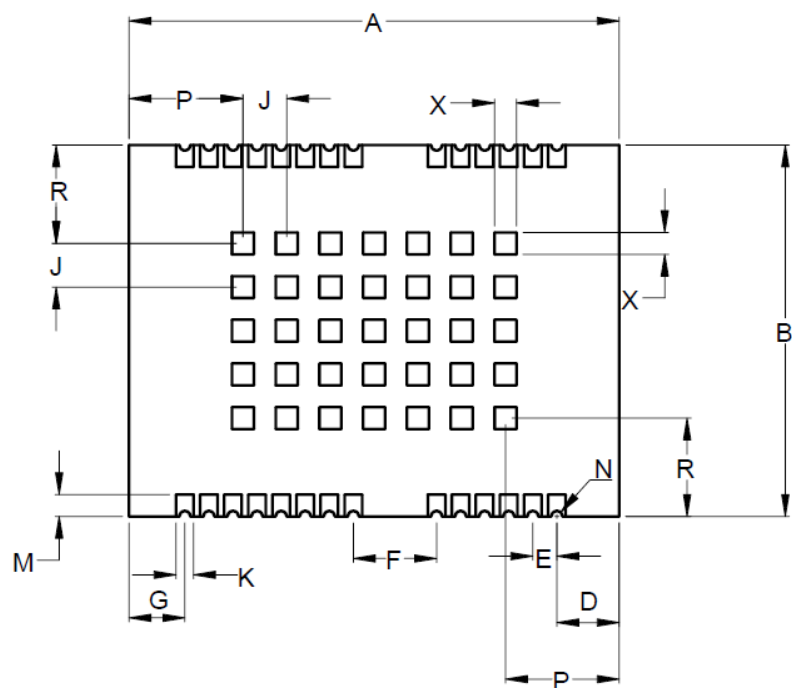
Figure 3-1 Mechanical Layout

Pin Definition
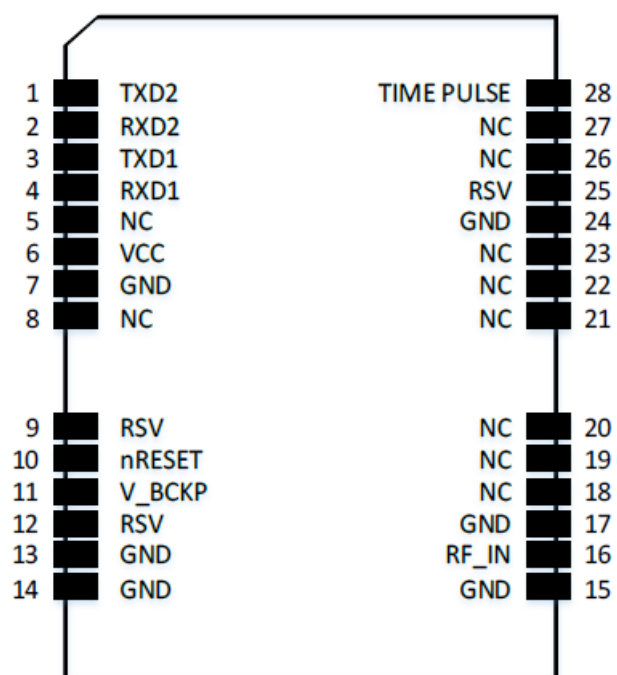
Figure 3-2 UT986 Pin Assignment

Table 3-6 Pin Definition

No.	Name	I/O	Electrical Level	Description
1	TXD2	O	LVTTL	COM2 for data transmission. Firmware upgrade is not supported. Leave this pin floating if idle.
2	RXD2	I	LVTTL	COM2 for data reception. Firmware upgrade is not supported. Leave this pin floating if idle.
3	TXD1	O	LVTTL	COM1 for data transmission. Firmware upgrade is supported.
4	RXD1	I	LVTTL	COM1 for data reception. Firmware upgrade is supported.
5	NC			No connection inside
6	VCC	I	3.0 V to 3.6 V	Power supply
7	GND	—		Ground
8	NC			No connection inside
9	RSV			Reserved (recommended to be floating)
10	nRESET	I	LVTTL	External reset pin, active low

No.	Name	I/O	Electrical Level	Description
11	V_BCKP5	I	2.0 V to 3.6 V	When the main power supply VCC is cut off, V_BCKP supplies power to RTC and SRAM. The level requirement is 2.0 V to 3.6 V. The working current of V_BCKP is about 20 µA at 25 °C when VCC is cut off. Leave this pin floating when hot start function is disabled.
12	RSV			Reserved (recommended to be floating)
13	GND	—		Ground
14	GND	—		Ground
15	GND	—		Ground
16	RF_IN	I		GNSS signal input
17	GND	—		Ground
18	NC			No connection inside
19	NC			No connection inside
20	NC			No connection inside
21	NC			No connection inside
22	NC			No connection inside
23	NC			No connection inside
24	GND	—		Ground
25	RSV			Reserved (recommended to be floating)
26	NC			No connection inside
27	NC			No connection inside
28	TIME PULSE	O	LVTTL	1PPS (Leave this pin floating if idle.)

It is not supported by Firmware V1.0; future versions will support.

Hardware Design

Hardware Reference Design

UT986 just supports feeding the antenna from the outside of the module rather than from the inside. It is recommended to use devices with high power and that can withstand high voltage. Gas discharge tube, varistor, TVS tube and other high-power protective devices may also be used in the power supply circuit to further protect the module from lightning strike and surge.

Figure 4-1 UT986 Reference Circuit

Remarks:

- L1: feed inductor, 68 nH RF inductor in 0603 package is recommended. The rated current of the L1 inductor should be larger than the operating current of the selected antenna, and leave enough design margin
- C1: decoupling capacitor, recommended to connect two capacitors of 100 nF/100 pF in parallel
- C3: DC blocking capacitor, recommended 100 pF capacitor
- D1: ESD diode, choose the ESD protection device that supports high frequency signals (above 1000 MHz)
- D2: TVS diode, choose the TVS diode with appropriate clamping specification according to the requirement of feed voltage and antenna voltage
- RF_IN does not feed the antenna. You need to design the antenna feed circuit according to the antenna you choose.

Power Supply VCC

In order to guarantee the module works normally, the initial voltage level of VCC should be less than 0.4 V when powered on, and it should be monotonic. The undershoot and ringing should be within 5% of VCC. As far as the power-on waveform, the rise time from 10% to 90% should be within 1 ms to 10 ms. And the time interval between the last power-off (after VCC < 0.4 V) to the next power-on should be more than 500 ms.

It is recommended to use the same power supply for the VCC of UT986 and the IO of Host, so as to avoid abnormal startup caused by the IO leakage between UT986 and Host. The power supply of UT986 VCC ranges from 3.0 V to 3.6 V, and the input decoupling capacitor C2 needs to be more than 10 µF. Other capacitors, such as 1 µF/ 100 nF/ 100 pF, can be connected in parallel.

Serial Port

The two serial ports of UT986 are LVTTL, which need to be converted through RS232 level if connected to a PC. The TXD1 and RXD1 of UT986 are necessary ports which need to be connected to the corresponding UART of Host.

The TXD2 and RXD2 of UT986 are optional ports which can be connected or unconnected depending on the situation.

It is recommended to reserve a test point for serial port 2 as the debug port.

f there is data input at the digital 10 (including RXD1, TXD1, RXD2, TXD2, TIME PULSE, and nRESET) when the module is not powered on, it will form a leakage on the VCC. And if the leakage voltage is higher than 0.4 V, it may cause a start failure when the module is powered on. Therefore, in order to prevent the leakage, ensure that the 10 ports connected to the module are in high impedance or low level before the module is powered on.

nRESET Timing Requirement

The module's reset pin nRESET and power supply VCC should meet the following requirement of time sequence when powering up.

During its normal operation, pulling down the nRESET pin for more than 2.5 ms can also reset the UT986 module. The reset pin nRESET is effective when lower than 0.3 V.
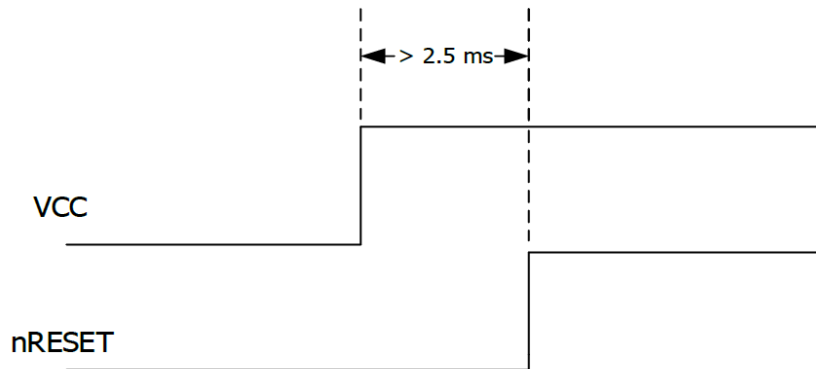
Figure 4-2 UT986 Reset Signal

TIME PULSE Output

The TIME PULSE of UT986 is the output of time signals, which are important functional signals, and needs to be connected to the time scale input IO of Host. The period of TIME PULSE output a signal is 1 s, and the default duty cycle is 10%.

Layout Recommendation

- Power supply: Stable and low ripple power is necessary for good performance. Make sure the peak-to-peak ripple voltage does not exceed 50 mV.
    - Use LDO to ensure the purity of power supply
    - Place LDO as close to the module as possible in layout
    - Widen the power circuit wiring or use split copper surface to transmit current
    - Keep away from any high power or high inductance devices such as a magnetic coil.
- Antenna link: The antenna link requires 50 Ω impedance matching. The RF routing connecting RF_IN and the antenna should have 50 Ω impedance, as short and smooth as possible, and avoid acute angles.
- Antenna location: In order to obtain a good signal-to-noise ratio, ensure that the antenna is well isolated from electromagnetic radiation sources, especially electromagnetic radiation in the frequency range of 1100 MHz to 1610 MHz.
- Try to avoid circuits below UT986 module.
- UT986 is a temperature sensitive device and rapid temperature changes can result in reduced performance. Keep it away as far as possible from any high-temperature air and high-power heating devices.
- Connect all the GND pins of UT986 to the ground.
- All the RSV pins are reserved and it is recommended to keep them floating.

- The thermal pad of UT986 must be connected to a large area of grounding copper to effectively dissipate heat.
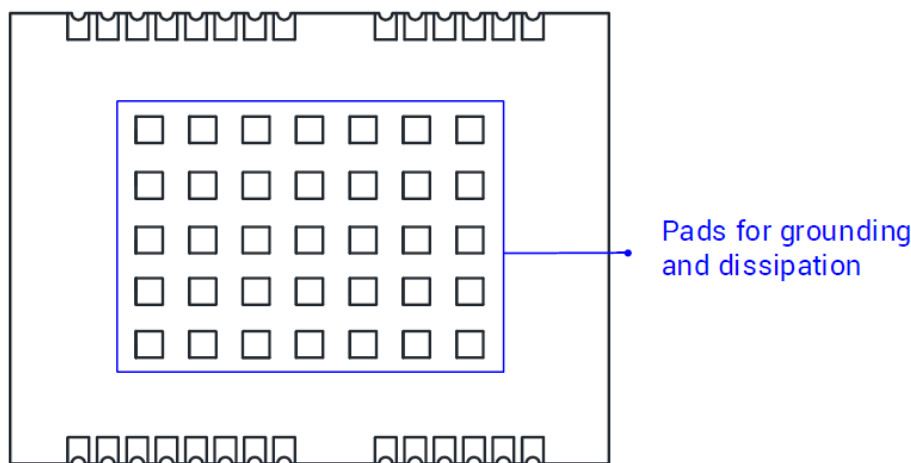
Grounding and Heat Dissipation

Figure 4-3 Pads for grounding and dissipation

There are 35 pads in the middle rectangle area of UT986 module, which are used for grounding and heat dissipation. When designing PCB, connect the pads to a large size of ground to facilitate heat dissipation.

Packaging
Product Label

Figure 5-1 Product Label

Packaging Description
UT986 module uses carrier tape and reel (suitable for mainstream surface mount devices), packaged in vacuum-sealed aluminum foil antistatic bags, with a desiccant inside to prevent moisture. When using reflow welding process to weld modules, please strictly comply with IPC standard to conduct humidity control on the modules. As packaging materials such as carrier tape can only withstand the temperature of 55 °C, modules should be removed from the package during baking.
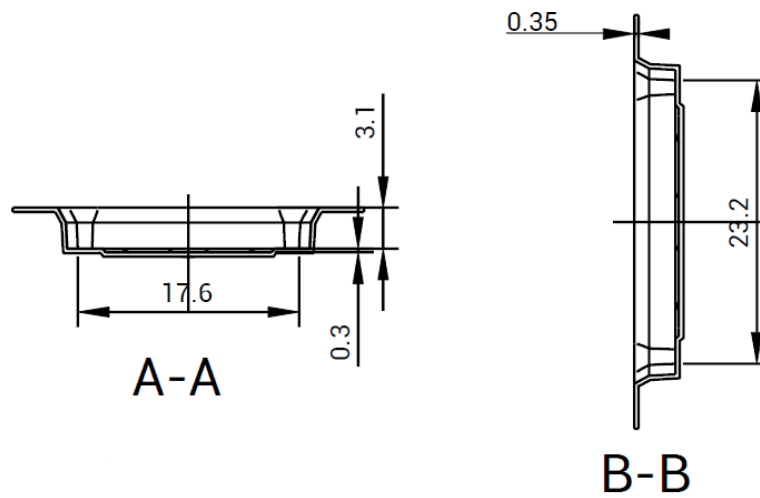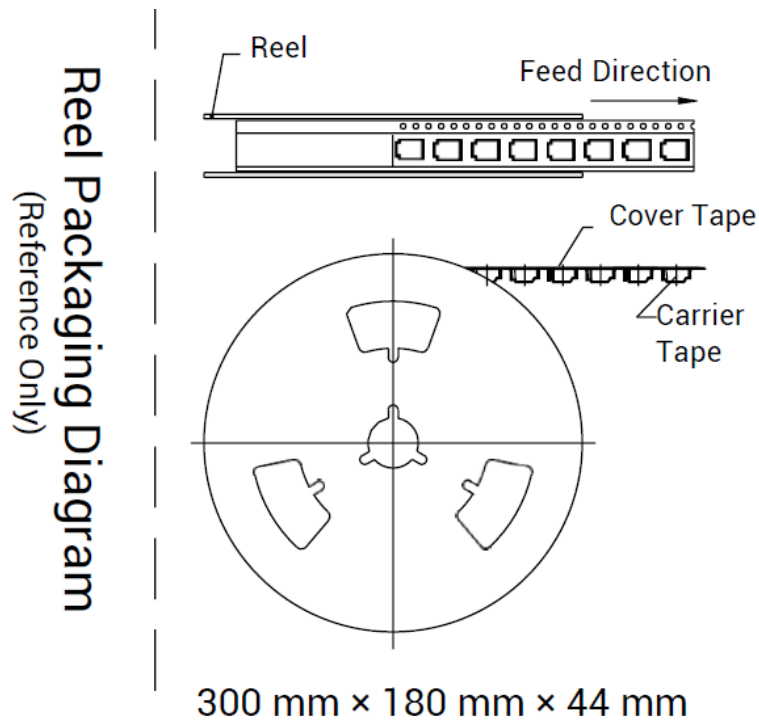
Figure 5-2 Packaging Diagram
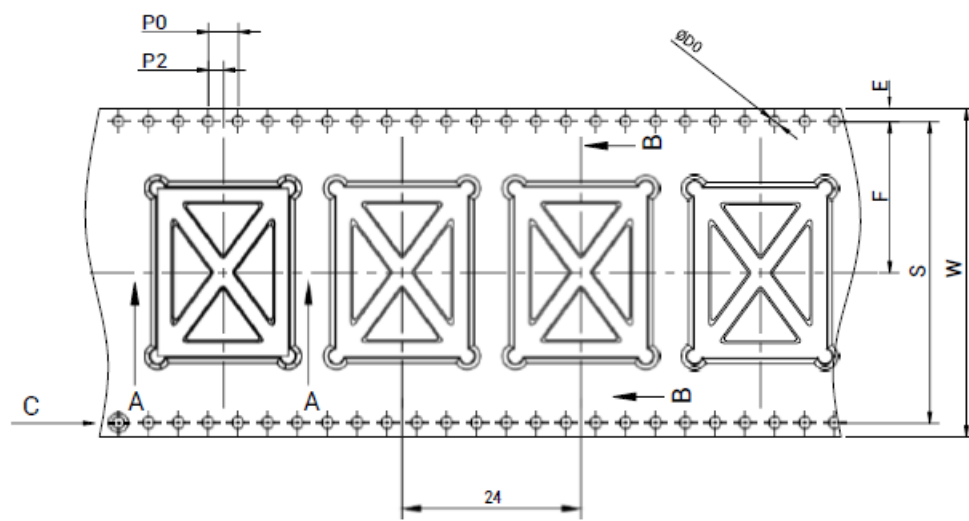
Dimension (mm)	
E	1.75 ±0.10
F	20.20 ±0.10
S	40.40 ±0.10
P2	2.00 ±0.10
ΦDo	1.50 ± 0.10 0.00
ΦD1	
Po	4.00 ±0.10
10Po	40.00 ±0.20
W	44.00 ±0.30
P	24.00 ±0.10
Ao	17.60 ±0.10
B0	23.20 ±0.10
K0	3.10 ±0.10
t	0.35 ±0.05

$1.70^{+0.15}_{-0.05}$

$1.50^{+0.10}_{-0.00}$

A-A

B-B
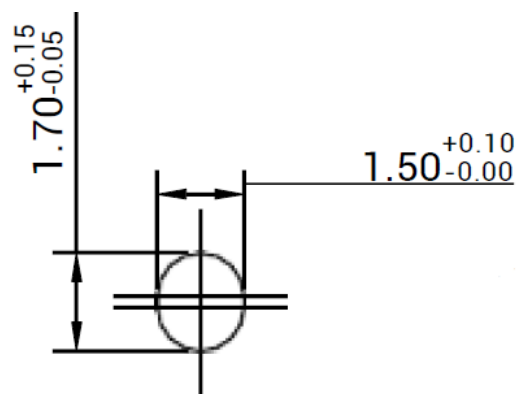
Note:

- The cumulative tolerance of 10 side holes should not exceed t0.2 mm.
- Material: Black antistatic PS (surface impedance 105-101) (surface static voltage <100 V), thickness: 0.35 mm.
- Total length of the 13-inch reel package: 6.816 m (Length of the first part of empty packets: 0.408 m, length of packets containing modules: 6m, length of the last part of empty packets: 0.408 m).
- Total number of packets in the 13-inch reel package: 284 (Number of the first part of empty packets: 17; actual number of modules in the packets: 250; number of the last part of empty packets: 17).

Reel Packaging Diagram
(Reference Only)

Reel

Feed Direction

Cover Tape

Carrier
Tape

300 mm × 180 mm × 44 mm

- All dimension designs are in accordance with EIA-481-C-2003.
- The maximum bending degree of the carrier tape within the length of 250 mm should not exceed 1mm (see the figure below).
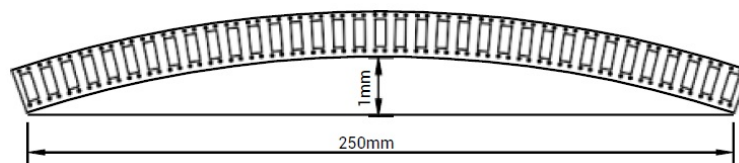
(Unit: mm)

Figure 5-3 Carrier Tape Drawing

Table 5-1 Packaging Description

Item	Description
Modules	250 pieces/reel
Reel Size	Tray: 13'' External diameter: 330 ±2 mm, Internal diameter: 180 ±2mm, Width of internal diameter: 44.5 ±0.5 mm, Thickness: 2.0 ±0.2 mm
Carrier Tape	Module spacing (center to center distance): 24 mm

UT986 module is rated at MSL level 3. For more information about packaging and handling precautions related to the Moisture Sensitivity Level, please refer to the
IPC/JEDEC J-STD-020 standards. Users may access to the website **www.jedec.org** to find out more details.

The shelf life of the UT986 module packaged in vacuum-sealed aluminum foil antistatic bags is one year.

Maintenance

Disassembly

When disassembling the module, it is recommended to melt the soldering tin of the pins on both sides of the module with an electric soldering iron and remove the module with a tweezer. Do NOT use other means to remove the module (for example, blow off the module with a hot air gun), which may damage the module.

Clean
Do NOT use alcohol or other organic solvents to clean the module, or it may lead to flux residues entering into the shielding shell, causing mildew and other problems.

Reflow Soldering

- In order to prevent falling off during soldering of the module, do not solder it on the back of the board during design, and it is not recommended to go through soldering cycle twice.
- The setting of soldering temperature depends on many factors of the factory, such as board type, solder paste type, solder paste thickness, etc. Please also refer to the relevant IPC standards and indicators of solder paste.
- Since the lead soldering temperature is relatively low, if using this method, please give priority to other

- components on the board.
- The opening of the stencil needs to meet your design requirement and comply to the examine standards. The thickness of the stencil must be larger than 0.15 mm and it is recommended to be larger than 0.18 mm.

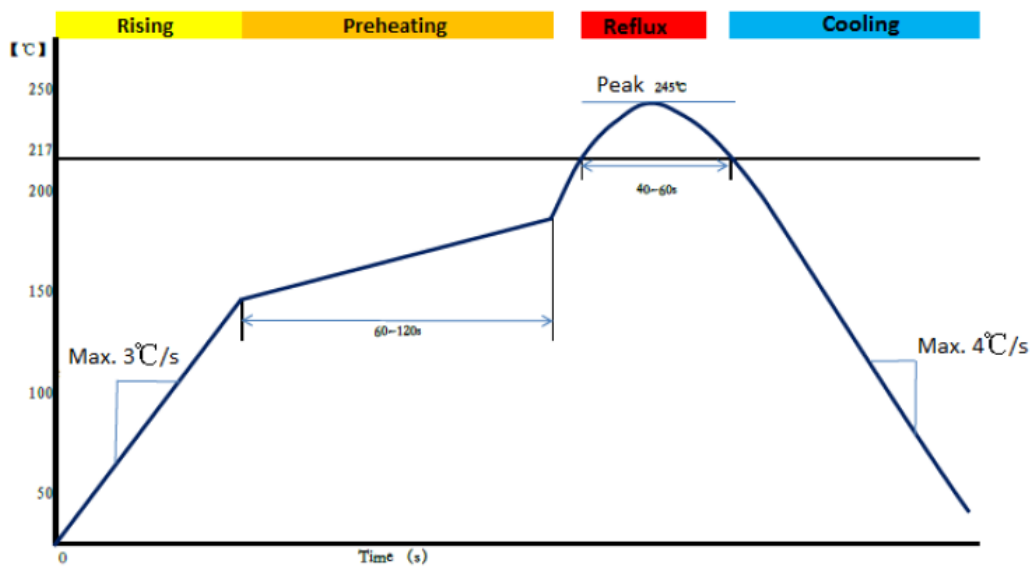The recommended reflow temperature curve is shown in the figure below.

Figure 6-1 (M705-GRN360) Reflow Soldering Temperature Curve

Temperature Rising Stage

- Rising slope: Max. 3 °C/s
- Rising temperature range: 50 °C to 150°C

Preheating Stage

- Preheating time: 60 s to 120 s
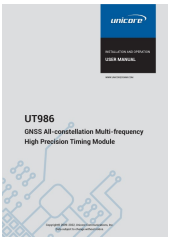- Preheating temperature range: 150 °C to 180 °C

Reflux Stage

- Over melting temperature (217 °C) time: 40 s to 60 s
- Peak temperature for soldering: No higher than 245 °C

Cooling Stage

- Cooling slope: Max 4 °C/s

Documents / Resources

UT986 GNSS All-constellation Multi-frequency High Precision Timing Module	**[unicore UT986 GNSS All Constellation Multi Frequency High Precision Timing Module](#)** [pdf] User Manual UT986 GNSS All Constellation Multi Frequency High Precision Timing Module, UT986, GNSS All Constellation Multi Frequency High Precision Timing Module, Multi Frequency High Precision Timing Module, High Precision Timing Module, Timing Module

References

- **[Home | JEDEC](#)**
- **[Home | JEDEC](#)**
- **[U   -   OEM   ](#)**
- **[U   -   OEM   ](#)**