InsCore

User Manual

Abstract

This document introduces the Inscore high-precision GNSS/MEMS integrated navigation engine, focusing on its use from the end-user perspective.

Contents

1. Product Introduction

The Inscore high-precision GNSS/MEMS integrated navigation engine is an inertial navigation module built around a six-degree-of-freedom MEMS sensor. It seamlessly upgrades external single- or multi-frequency high-precision GNSS inputs into a more advanced integrated navigation system. Designed to maintain 100% high-precision positioning even in challenging environments such as urban canyons, signal-blocked areas, or interference-prone conditions, the module delivers robust performance without relying on odometer input. Its compact 9.7 × 10.1 mm package makes it ideal for space-constrained applications.

1.1 Functional Overview

The Inscore module combines advanced MEMS inertial sensors with satellite navigation technology, leveraging high-precision GNSS inputs along with the relatively angular and linear motion measurements provided by the inertial sensors (three-axis gyroscope and three-axis accelerometer). Using multidimensional extended Kalman filtering and other specialized algorithms, it delivers full 3D navigation and attitude measurement capabilities on a compact device. The algorithms running on the module feature rich environmental awareness, enhancing navigation performance while supporting flexible power modes.

Functionally, the module offers the following capabilities:

- Continuous navigation and positioning in complex environments, including urban canyons, tunnels, and severe multipath environments
- Standard NMEA GNSS input support
- 3D attitude output
- Flexible installation with free-angle, three-axis orientation
- Fast online calibration, achieving integrated navigation in as little as 30 seconds; supports low- and ultra-low-speed operations

- High-precision positioning without reliance on odometer input
- Support for external dual-antenna GNSS attitude input
- Configurable navigation update rates up to 50 Hz

The Inscore module is suitable for high-precision vehicle navigation, autonomous driving, and other end-user applications requiring accurate and reliable navigation performance.

1.2 System Architecture

The system architecture of the InsCore module is shown in the diagram below.

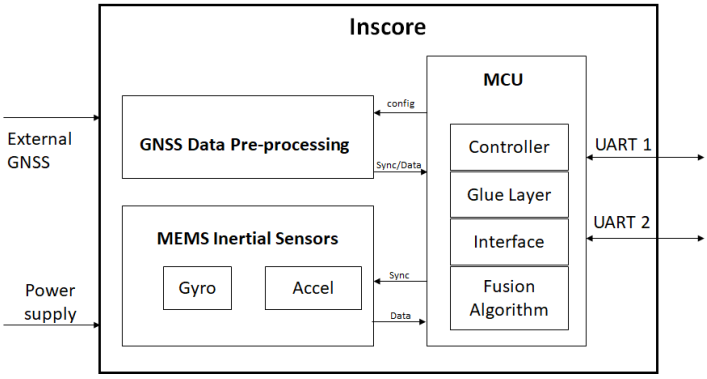

Figure.1.1 the system architecture of the InsCore

1.3 Pin Definition

The InsCore module uses an 18-pin package. The pin numbers are shown in Figure 1.2, and their specific definitions are detailed in Table 1.1.

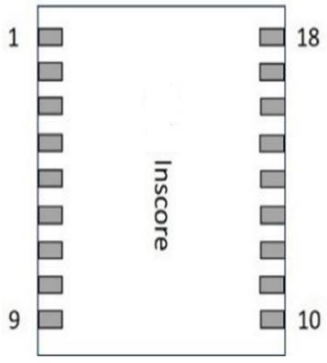

Figure 1.2 Pin Definition (Top View)

Note: Pin numbering and orientation are shown from the top view of the module

Table 1.1 Pin Assignment

No.	Name	I/O	Description
1	GND	I	Ground
2	TXD1	O	UART1 transmit, primary serial port
3	RXD1	I	UART1 receive, primary serial port
4	reserved	-	Reserved
5	NC (INT_OUT)	-	No Connection
6	Reserved	-	Reserved
7	NC	-	No Connection
8	VCC	I	Power supply 3.0V-3.6V
9	RESET_N	I	Reset
10	GND	I	Ground
11	Reserved (WT)	I	Reserved
12	GND	I	Ground
13	Reserved (FWD)	-	Reserved
14	Reverse	-	Reserved
15	NC	-	No Connection
16	RXD2	I	UART2 receive, reserved
17	TXD2	O	UART2 transmit, reserved
18	External PPS	I	Optionally pulse-per-second input

1.4 System Performance

Table 1.2 performance specifications

Position（1σ）	Open Sky*	Standalone	1.5m
		RTK	0.1m
	GPS Outages	5s*	0.3m
		30s	8.0m
		>60s	2% of travel distance
Attitude（1σ）	Roll	1.5^0	
	Pitch	1.5^0	
	Heading	2.0^0	
Velocity（1σ）	0.1m/s		
Output Rate	1Hz （configurable to 10Hz/20Hz/50Hz）		
Gyroscope	Stability 5°/hr		
Accelerometer	Stability 3mg		

*: specifications depending on external GNSS RTK.

1.5 Electrical and Physical Characteristics

Table 1.3 Electrical and Physical Characteristics

Supply Voltage	3.0V – 3.6V
Power Consumption	10mA (typical)
Reflow Soldering Temp.	260℃
Dimensions	10.1mm×9.7mm×2.0mm
Operating Temperature	-40℃ - +85℃
Vibration Resistance	8g (20 – 2000Hz)
Shock Resistance	500g (20ms)

1.6 Software Data Interface

Table 1.4 data interface

I/O Interface	UART-1, Primary serial port: main data output, configuration, and firmware upgrade; baud rate: 115200 UART2, Outputs raw data and binary protocol, and receives GNSS NMEA input (1 Hz); baud rate: 230400
Input Protocol	NMEA
Output Protocol	NMEA, and InsCore proprietary text and binary protocol

1.7 Module Package Dimensions

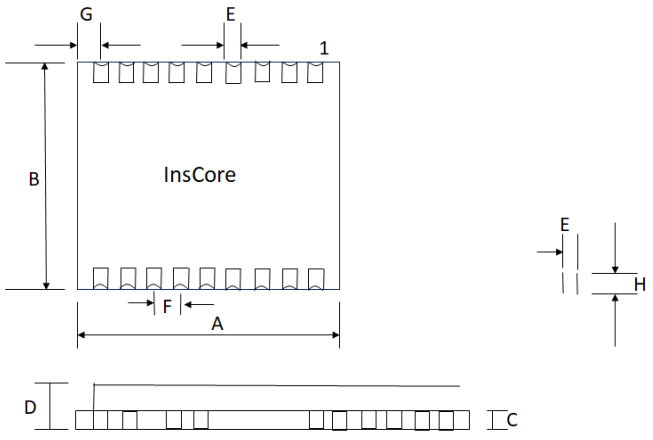

Figure 1.3 Module Package Dimensions (All dimensions in mm)

Table 1.5 Module Physical Dimensions

(All dimensions in mm, Tolerance: ±0.1 mm unless otherwise noted)

Dimension	Minimum (mm)	Nominal(mm)	Maximum (mm)
A	10.0	10.1	10.2
B	9.6	9.7	9.8
C	0.8	0.8	0.8
D	2.1	2.5	2.6
E	0.6	0.7	0.8
F	1.0	1.1	1.2
G	0.55	0.65	0.95
H	0.8	1.0	1.1

1.8 Hardware PCB Reference Design

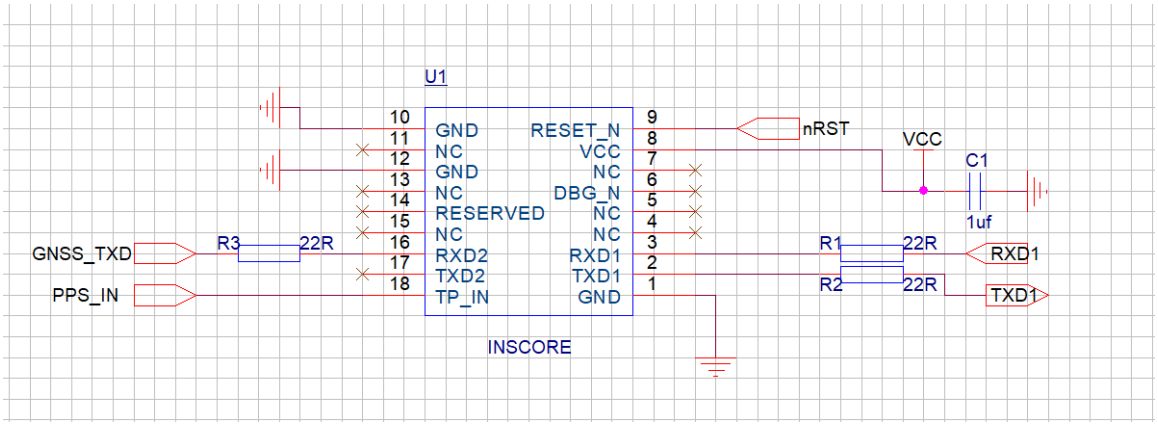

Figure 1.4 the recommended PCB design for the InsCore module

Note: When nRST is connected (controlled by another device or MCU), the RESET_N pin should be held high (external pull-up recommended). To reset the module, keep the pin low for at least 20 µs.

When nRST is not connected, it is recommended to leave the RESET_N pin floating.

2. Product Features

2.1 External High-Precision GNSS Input

The Inscore module receives external high-precision GNSS input data at a frequency of 1 Hz in the NMEA0183 format (unless otherwise specially defined). The required NMEA messages are listed in Table 2.1.

Table 2.1 Required NMEA Messages for Inscore Module

Message	Description
GGA	Required
RMC	Required
GSA	Required
GSV	Required

There is no strict requirement on the input sequence of NMEA messages. By default, the Inscore module processes messages in the order GGA → RMC → GSA → GSV and extracts the relevant information accordingly. If the external input sequence differs from the default, a configuration command can be issued (according to the data protocol) to explicitly define the message sequence. For details, refer to Reference 2: Inscore Data Protocol.

2.2 Fast Online Calibration

The Inscore module features advanced fast online calibration technology that automatically corrects sensor bias at every startup—without the need for special maneuvers or external calibration equipment. Calibration completes seamlessly during normal driving, allowing the system to enter integrated navigation mode quickly. Combined with support for free-angle installation, this ensures consistently high accuracy and reliability in real-world applications.

2.3 Free-Angle Installation

The InsCore module does not require a specific mounting position on the vehicle and can be installed at any 360-degree angle. An adaptive algorithm automatically identifies and estimates the installation angle error and compensates for it in the inertial navigation calculation. For optimal performance, it is recommended that the angle between the module's pitch axis and the vehicle's pitch axis be less than 20 degrees after installation (front-to-back direction is not restricted).

note: While the module supports free-angle installation, its performance depends on a rigid connection to the vehicle. Ensure the module is tightly secured and does not move or shake during use to maintain optimal performance.

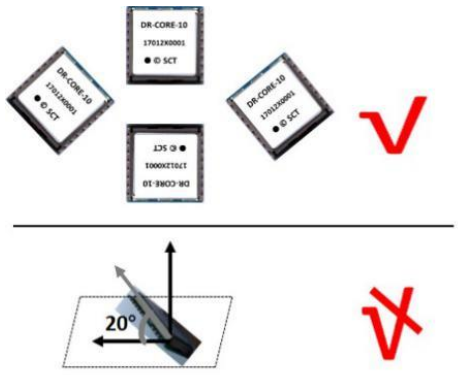

Figure 2.1 Recommended Installation Method

2.4 Low-Speed System Initialization

In certain applications—such as agricultural machinery, sanitation vehicles, inspection vehicles, bicycles, and light motorcycles—low-speed or ultra-low-speed motion (<1 m/s) is common. The Inscore module incorporates dedicated algorithms that enable the integrated navigation system to quickly initialize and enter navigation mode even under low-speed conditions.

For scenarios involving sustained low-speed operation, it is recommended to include two stationary periods longer than 20 seconds each during the initial phase of movement to ensure optimal initialization performance.

2.5 Navigation Data Rate

The module's navigation rate can be configured by the user to 1Hz, 5Hz, or 10Hz. The filter state of the integrated navigation system will change according to the configured rate. The navigation rate should be set based on the vehicle's dynamics. For applications that are not attitude-controlled platforms, a 1Hz navigation rate is recommended.

3. Default Data Output

The following are the default output settings for the module. Output content can be changed using configuration commands; refer to the data protocol for details.

Table 3.1 Default Output

Output Rate	1Hz
Baud Rate	115200
Protocol	NMEA0183 and Custom Text Format
NMEA0183	GGA、RMC

4. Product Packaging

4.1 Tape and Reel

The module is packaged in a tape and reel format.

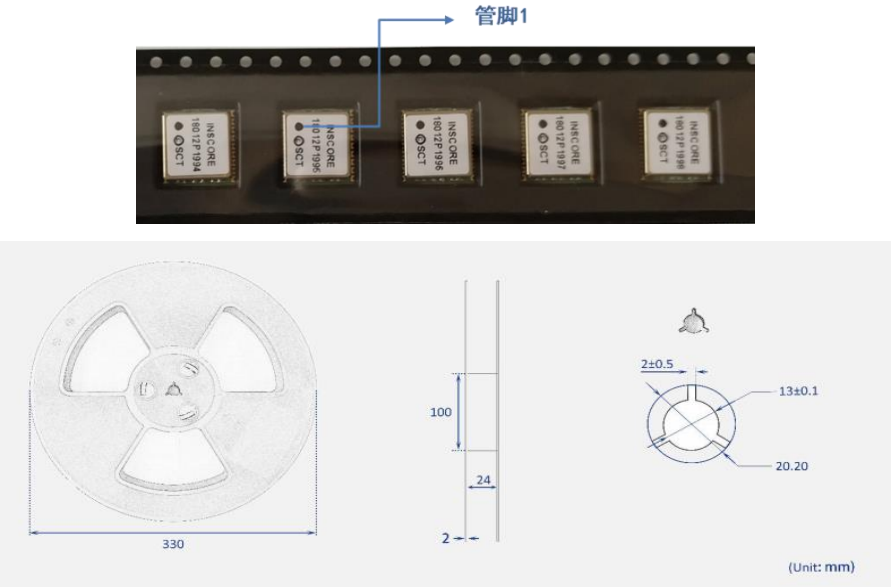

Figure 4.1 Packaging Specifications

The LaneTo is available in two packaging specifications: 250 pieces per bag and 800 pieces per reel. The 800-piece reel has a diameter of 33cm

4.2 Storage

To prevent moisture and electrostatic discharge, the product's sealed packaging bag contains a desiccant and a humidity indicator card. The humidity indicator card allows the user to check the

humidity level of the environment. The product's moisture sensitivity level is MSL3. GNSS positioning modules contain highly sensitive electronic circuits and are considered electrostatic discharge sensitive devices (ESD).

5. Installation and Handling Notes

- After power-off, VCC reliably drops below 0.7 V and remains stable.
- Connect the GND pin to ground.
- Ensure Serial Port 1 is stably connected to the external processor; this port is used for data transmission and firmware upgrades.
- Power supply ripple should not exceed 50 mV (peak-to-peak).
- Avoid routing traces directly underneath the module.
- The module is sensitive to temperature changes; keep it away from high-temperature airflow and high-power heat-generating components.
- To achieve optimal navigation performance, the module’ s radial (pitch) installation angle should be less than 20° (no requirement for radial orientation).
- When removing a soldered module, it is recommended to melt the solder on both sides with a soldering iron and then lift the module with tweezers to avoid damage.