NCT-2030M

GPS Products User Guide

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NCT-2030M *GPS* Products User Guide

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This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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This limited warranty period is one (1) year from date of purchase.

USG FAR

Technical Data Declaration (Jan 1997)

The Contractor, NavCom Technology, Inc., hereby declares that, to the best of its knowledge and belief, the technical data delivered herewith under Government contract (and subcontracts, if appropriate) are complete, accurate, and comply with the requirements of the contract concerning such technical data.

Global Positioning System

Selective availability (*S/A* code) was disabled on 2nd May 2000 at 04:05 *UTC*. The United States government has stated that present *GPS* users do so at their own risk. The US Government may at any time end or change operation of these satellites without warning.

The U.S. Department of Commerce Limits Requirements state that all exportable *GPS* products contain performance limitations so that they cannot be used to threaten the security of the United States. Access to satellite measurements and navigation results will be limited from display and recordable output when predetermined values of velocity and *altitude* are exceeded. These threshold values are far in excess of the normal and expected operational parameters of the NCT-2030M *GPS* Sensor.

Use of this Document

This User Guide is intended to be used by someone familiar with the concepts of *GPS* and satellite surveying equipment.

Note indicates additional information to make better use of the product.

Indicates a caution, care, and/or safety situation.

Warning indicates potentially harmful situations.

Items that have been *ITALICIZED* indicate a term or acronym that can be found in the Glossary.

Chapter 1 Introduction

The NCT-2030M *GPS* sensor delivers unmatched accuracy to the precise positioning community who need a cost-effective, high performance *GPS* sensor with internal data logging capability.

System Overview

GPS Sensor

The NCT-2030M sensor consists of a 24-channel *dual frequency* precision *GPS* sensor with two additional channels for receiving *Satellite Based Augmentation System (SBAS WAAS/EGNOS)* signals. The sensor can output proprietary raw data as fast as 50Hz (optional) and *Position Velocity Time* (*PVT*) data as fast as 25Hz (optional) through two 115kbps serial ports with less than 20msec latency. NavCom's NCT-2030M model sensor delivers unmatched positioning accuracy to system integrators in need of a cost-effective, high performance differential *GPS* sensor.

The NCT-2030M is packaged for mobility. It can be used for *Geographic Information System (GIS)*, aerial and hydrographic surveying, and *post-processed dual-frequency* surveys. The sensor can be carried in a backpack with the antenna pole-mounted from the backpack, or on a survey pole with a single cable connection. Optionally the NCT-2030M can be configured to accept *RTK DGPS* corrections via an external source for centimeter level survey accuracy. It is also possible to utilize NavCom's StarFire™ network to obtain real-time accuracies of about 10 centimeters through a factory upgrade. No external data-logging device is required since the receiver has 64MB of on-board storage memory.

The NCT-2030M is equipped with additional features allowing interconnectivity with a wide variety of antennas, vehicle data busses and other instrumentation to match specific applications and configurations. The NCT-2030M also has a 1 *PPS* output port and a combined *Event/CAN Bus* interface port.

The optional RTK DGPS horizontal accuracy of 1 cm or better and the vertical accuracy of 2 cm or better are maintained as each output is independently calculated based on an actual *GPS* position measurement, as opposed to an extrapolation between 1Hz measurements.

- **Integrated *GPS* and Inmarsat Antenna**

The all-in-one housing incorporates our compact *GPS* antenna with excellent tracking performance and a stable phase center for GPS L1 and L2. The robust housing assembly features a standard 5/8" *BSW* thread for mounting directly to a surveyor's pole, tripod, or mast and is certified to 70,000 feet.

Although rated to 70K feet, this antenna is not designed for aircraft installations. E-Mail *customerservice@navcomtech.com* for aircraft solutions.

- **Controller**

The NCT-2030M *GPS* sensor is designed for use with an external Controller Solution connected via one of the two serial ports.

This may be accomplished using an IBM compatible PC, Tablet PC or *Personal Digital Assistant* (*PDA*) and a software program which implements the binary driver appropriate to control NavCom *GPS* products. See the User's Guide of your Controller Solution for further information.

Included Items

Figure 1: NCT-2030M Supplied Equipment

❶ NCT-2030M *GPS* Sensor (*P/N* 92-310056-3004)

❷ *LEMO* 7 Pin to *DB9S* Data Communications Cable (*P/N* 94-310059-3006)

❸ Compact L1/L2 Tri-Mode *GPS* Antenna (*P/N* 82-001002-3002)

❹ *GPS* Antenna Cable (*P/N* 94-310058-3012)

❺ *LEMO* 4-Pin Universal AC/DC Power Adapter (*P/N* 82-020002-5001)

❻ CD-Rom (*P/N* 96-310006-3001) containing User Guides to NavCom Technology, Inc. product line, brochures, software utilities, and technical papers.

❼ NCT-2030M User's Guide {Not Shown} (Hard Copy *P/N* 96-310002-3002)

❽ American 2-Pin AC power Cord {Not Shown}

Applications

The NCT-2030M *GPS* sensors meet the needs of a large number of applications including, but not limited to:

- Land Survey / GIS
- Asset Location
- Hydrographic Survey
- Photogrammetric Survey
- Machine Control
- Railway, Ship and Aircraft Precise Location

Unique Features

The NCT-2030M *GPS* sensor has many unique features:

- **Positioning Flexibility**

The NCT-2030M is capable of using two internal *Satellite Based Augmentation System* (*SBAS*) channels that provide *Wide Area Augmentation System (WAAS)* or *European Geostationary Navigation Overlay Service (EGNOS)* code corrections. The NCT-2030M auto configures itself to use the most suitable correction source available and changes as the survey dictates.

- **Data Sampling**

GPS L1 and L2 raw data is 1 - 5Hz in the standard configuration and as an optional upgrade to 10, 25, and 50Hz via either of the two serial ports. The *PVT (Position, Time, & Velocity)* data is also 1-5Hz in the standard configuration and as an optional upgrade 10Hz for highly dynamic applications.

- ***GPS* Performance**

The NCT-2100 GPS engine at the heart of the NCT-2030M incorporates several patented innovations. The receiver provides more than 50% signal to noise ratio advantage over competing technologies. The benefit to the user is improved real time positioning. Independent tests have proven the NCT-2100 to be the best receiver when facing various *multipath* environments.

Rugged Design

The rugged design of the NCT-2030M system components provides protection against the harsh environments common to areas such as construction sites, offshore vessels, and mines.

Units have been tested to MIL-STD-810F for low pressure, solar radiation, rain, humidity, salt-fog, sand, and dust.

Chapter 2 Interfacing

This chapter details the NCT-2030M *GPS* sensor connectors and status display, appropriate sources of electrical power, and how to interface the communication ports.

Electrical Power

Electrical power is input thru a 4-pin *LEMO* female connector located on the front panel of the NCT-2030, and labeled 'DC PWR.' The pin designations are shown in Table 1; see Figure 2 for pin rotation on unit.

Pin	Description
1	Return
2	
3	Power Input 10 to 30 VDC
4	

Table 1: External Power Cable Pin-Out

Pins 1 and 2 are connected together inside the NCT-2030M *GPS* sensor. Pins 3 and 4 are connected together inside the *GPS* sensor.

When using an external power cable longer than 5m (15ft), it is recommended that positive voltage DC be applied on both pins 3 and 4, and return on both pins 1 and 2.

Navcom P/N 82-020002-5001 Universal AC/DC 12 V 2 Amp Power Adapter comes standard with the NCT-2030M GPS receivers. An optional external power cable, NavCom *P/N* 94-310060-3010 a 3m (10ft) unterminated power cable fitted with a *LEMO* plug type (Mfr. *P/N* FGG.1K.304.CLAC50Z) and red strain relief, is suitable for supplying power to the NCT-2030 *GPS* sensor. The wiring color code and pin designations are labeled on this optional cable assembly.

The *GPS* sensor is protected from reverse polarity by an inline diode. It will operate on any DC voltage between 10 and 30 VDC, capable of supplying the required current, typically. Power Consumption of the NCT-2030 is typically 4 Watts Maximum

Voltages less than 10VDC will shut the unit down. When power is restored, the ON switch will need to be held down for more than 3 seconds.

Voltages in excess of 30VDC will damage the unit. It is extremely important to ensure that the power supply is well conditioned with surge protection. This is especially true for vehicular electrical systems, which can create voltage spikes far in excess of 30VDC.

Communication Ports

The NCT-2030M *GPS* sensor is fitted with two 7-pin female *LEMO* connector communication ports labeled *COM1* and *COM2* located at the bottom front of the *GPS* sensor as shown in Figure 2. Each conforms to the *EIA* RS232 standard with data speeds between 1200 bps and 115.2kbps. The pin-outs for these connectors are described in Table 2. An interface data cable (NavCom *P/N* 94-310059-3006) is supplied with the NCT-2030M for easy startup. The cable construction is described in Figure 4.

LEMO Pins	Signal Nomenclature [*DCE* w/respect to *DB9*]	*DB9S* Pins
1	CTS___Clear To Send	8
2	RD____Receive Data	2
3	TD____Transmit Data	3
4	DTR___Data Terminal Ready	4
5	RTN___Return [Ground]	5
6	DSR___Data Set Ready	6
7	RTS___Request To Send	7

Table 2: Serial Cable Pin-Outs

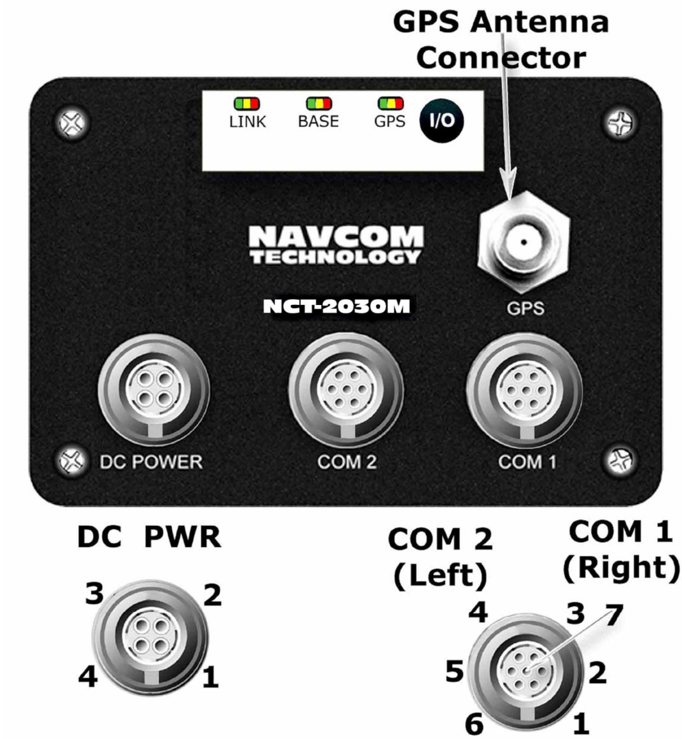

Figure 2: NCT-2030M Front View

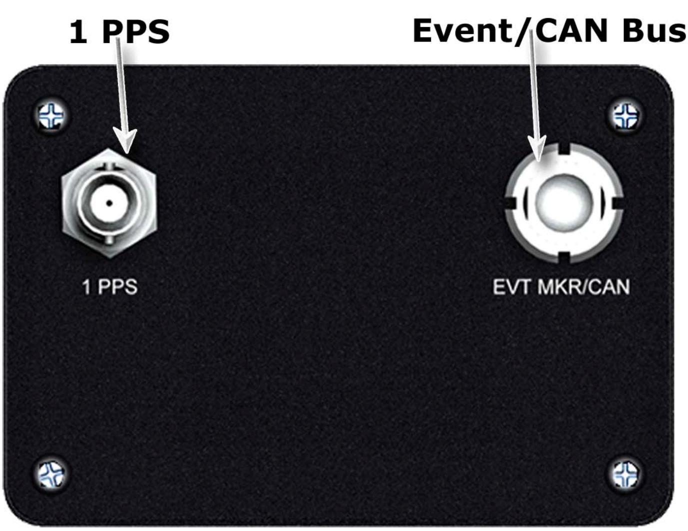

Figure 3: NCT-2030M Only Back View

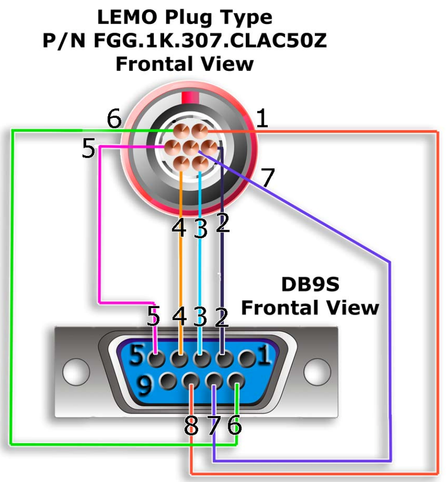

Figure 4: NavCom Serial Cable *P/N* 94-310059-3006

Pin 5 should connect to shield of cable at both ends.

Indicator Panel

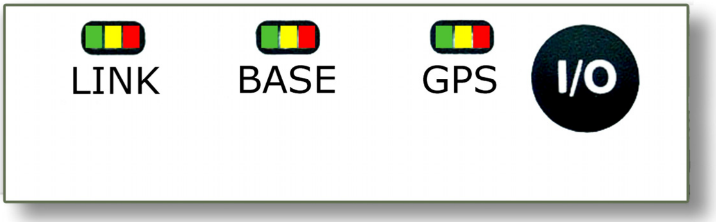

Figure 5: NCT-2030M Indicator Panel

The Indicator Panel provides the on/off (I/O) switch and a quick view of the status of the NCT-2030M *GPS* sensor, AND corrections source & type. Each of the three indicators has three LEDs, which depict status as detailed in the following tables.

To power the unit on or off, the on/off (I/O) switch must be depressed for more than 3 seconds. During power up of the *GPS* sensor, all LEDs will be on for a period of 3-5 seconds.

- Link LEDs

LINK	Status
□□□	The LINK LEDs are not utilized in the NCT-2030M *GPS* sensor (Enabled when receiver upgraded to either RT-3020M or NCT-2030M)

Table 3: Link Light Indication

- Base LEDs

BASE	Status
□□□	The BASE LEDs are not utilized in the NCT-2030M *GPS* sensor (Enabled when receiver upgraded to either RT-3020M or NCT-2030M)

Table 4: *Base station* Indication

- *GPS LEDs*

GPS	Status
	Power is off
	Power is on, No satellites tracked
	Tracking satellites, *position* not available yet
	Non-differential positioning
	Code based differential positioning
	*Dual frequency* Phase positioning

Table 5: *GPS* Light Indication

The *GPS* LEDs will blink at the *PVT* positioning rate selected.

1 PPS

The NCT-2030M has the ability to output a precise pulse every second that can be used for a variety of Time/ Mark applications where precise timing is critical.

Specifications:

- 12.5ns relative accuracy.

- Better than 100ns absolute accuracy.

- 50 Ohm, TTL level.

- Pulse width, default 100mS, range 10 – 999mS

- Pulse delay, default 0mS, range 0 – 999mS.

- Rising or Falling Edge Synchronization.

Connecting the 1*PPS* output requires a cable with a BNC male connector, NavCom *P/N* 94-310050-3003 0.9m (3ft) long, BNC male to BNC male cable can be obtained by contacting NavCom at customerservice@navcomtech.com.

CAN Bus/Event

The NCT-2030M also employs a balanced (differential) 2-wire *CAN Bus* technology interface, ISO11898 -24V compliant. The *CAN* interface uses an asynchronous transmission scheme employing serial binary interchange and is widely used in the automotive industry. The data rate is defined as 250K*bps* maximum with Termination resistors used at each end of the cable. This port/connector is shared with the *Even*t Input.

As CAN Bus specifications are diverse, drivers for the existing hardware must be tailored to the specific manufacturer's equipment being interfaced to. For further information, e-mail NavCom Customer Support at *customersupport@navcomtech.com* .

Event

The NCT-2030M also can utilize an event input pulse to synchronize any external incident that requires precise *GPS* time tagging, such as aerial photography. In this case, the action of a camera's aperture would output a pulse to the *Event* port and have the receiver output position and time information relative to when the photograph was taken.

Specifications:

- 50 Ohm input impedance
- 3Vdc > Input Voltage, High < 6Vdc
- 0Vdc < Input Voltage, Low < 1.2Vdc
- Minimum pulse width, 100nsec
- Rising or Falling edge Synchronization

Connecting the shared EVT MKR/CAN BUS port requires a five core, 5mm diameter, cable fitted with a *LEMO* plug, type FGG.0K.305.CLAC50Z, plus strain relief, NavCom P/N 94-310062-3003.

Detailed specifications of the *Event* Input and cable wiring and how to configure the Event input may be found in Appendix D of this User Guide.

Chapter 3 Installation

This chapter provides guidance on hardware should be installation for optimum performance.

Tri-Mode Antenna

The antenna is fitted with a 5/8 inch *BSW* threaded mount with a depth of 16mm (0.63 inch). This should be used as the primary means of mounting the antenna.

It is possible to remove the 5/8 inch *BSW* threaded alloy insert to reveal the secondary means of mounting the antenna which consists of a 1-14UNS-2B thread with a depth of 16mm (0.63 inch) typically used in the marine industry for navigation antennas.

Figure 6: Tri-Mode *GPS* Antenna

The eight Phillips screws on the base of the antenna should NOT be loosened or used for mounting the antenna as this will VOID the warranty and compromise the environmental seal of the antenna and will lead to internal damage.

There should be an unobstructed view of the sky above a 7-degree *elevation mask* for optimum *GPS* satellite visibility. Any obstructions above the horizon should be mapped using a compass and clinometer. Use satellite prediction software with a recent satellite *almanac* to assess the impact on satellite visibility at that location. Potential sources of interference should also be avoided when possible. Examples of interference sources include overhead power lines, radio transmitters and nearby electrical equipment.

Calculating the *azimuth* and *elevation* of these from a known *latitude*, *longitude* and height can be determined by contacting NavCom Customer Support personnel at *customersupport@navcomtech.com*.

GPS Sensor

The NCT-2030M *GPS* sensor can be mounted to a flat surface using the four screw slots shown in Figure 7. In environments with high vibration, shock absorbers suitable for 1.8kg (4lbs.) should be considered.

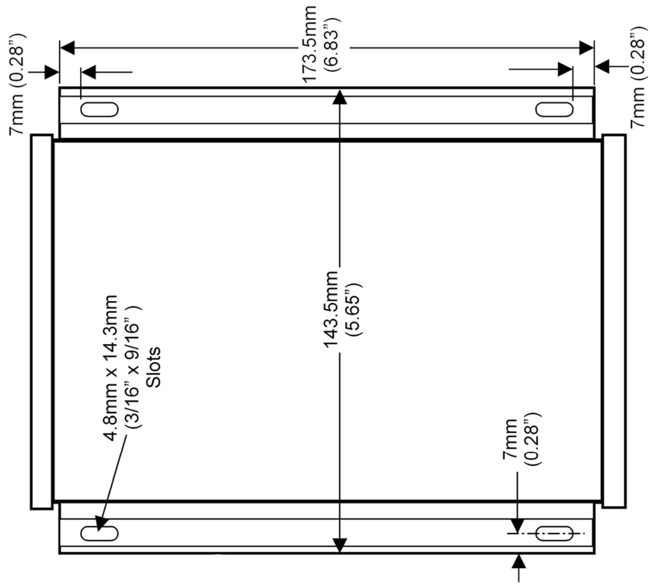

Figure 7: NCT-2030M Base Plate Dimensions

The NCT-2030M can be installed in a backpack for mobile surveying applications.

The sensor should not be placed in a confined space or where it may be exposed to excessive heat, moisture, or humidity.

There are no user serviceable parts inside the NCT-2030M *GPS* sensor. Undoing the four screws, which secure the front end plate, and the four securing the rear end plate will void the equipment warranty.

Communication Ports

Connect the supplied *LEMO* 7-Pin end of the NavCom serial cable (NavCom *P/N* 94-310059-3006) to *COM 2* (factory default Control Port) connector of the NCT-2030M. Connect the *DB9* end to your serial controlling device. Note that some devices may require an additional adaptor, as the receiver is configured as a DCE device.

By factory default *COM 2* is the control port for the NCT-2030. *COM 1* can be designated as the control port by using the appropriate NavCom *proprietary commands*. NOTE: Some output data types, such as NMEA messages, cannot output on the Control Port

Figure 8: Communication Port Connections

GPS Antenna Connector

The connector used on the NCT-2030M is a TNC female, labeled “GPS ANT” on the front panel of the sensor as shown in Figure 2.

The center pin of the TNC connector carries a voltage of nominally 4.6, which is used to power the preamplifier in the *GPS* antenna. When the *GPS* unit is powered on, the antenna cable should not be disconnected.

The cable length between the NCT-2030M and the Tri-Mode antenna should not exceed more than 10dB loss at 1.5GHz. Examples are:

Cable Type	Maximum Length
RG58/U	13.7m (45ft)
LMR400	59.7m (196ft)

NavCom cable *P/N* 94-310058-3012 provides a 3.6m (12ft) length of RG58/U cable with a right angle male TNC connector to a straight male TNC connector suitable for connecting the NCT-2030M *GPS* sensor to the Tri-Mode antenna.

In-line amplifiers suitable for all *GPS* frequencies may be used to increase the length of the antenna cable, but care should be exercised that tracking performance is not degraded due to multiple connections, noise from the amplifier, and possible ingress of moisture and dust.

The antenna cable can degrade signal quality if incorrectly installed, or the cable loss exceeds NavCom specifications. Care should be taken not to kink, stretch or damage the antenna cable. Do not place the cable adjacent to cables carrying electrical power or radio frequencies.

Where the *GPS* antenna is exposed to sources of electromagnetic discharge such as lightning, an in-line electrical surge suppressor, properly grounded, should be considered between the *GPS* sensor and antenna. Such installations should comply with local regulatory codes and practices.

Chapter 4 Configuration

The NCT-2030M *GPS* sensors have a rich interface and detailed control language, which allows each unit to be tailored specifically to the required application.

Factory Default Settings

COM1

Configuration - Data port

Rate – 19.2Kbps

Output of NMEA messages GGA & VTG scheduled @ 1Hz rate

COM2

Configuration - Control Port

Rate – 19.2Kbps

Input/output of Navcom Proprietary messages used for Navigation and receiver setup. Table 7 describes the default messages that provide the user the best opportunity to initiate surveying with minimal effort.

The user has full control over the types of messages utilized and their associated rates by using either Navcom Technologies StarUtil or a third party software/Utility.

Message	Rate	Description
44	On Change	Packed *Almanac*
81	On Change	Packed *Ephemeris*
86	On Change	*Channel* Status
A0	On Change	Alert Text Message
AE	600 Seconds	Identification Block
B0	On Change	Raw Measurement Data
B1	On Change	*PVT* Block

Table 7: Factory Setup Proprietary Messages COM 2

The term "On Change" indicates that the receiver will output the specified message only when the information in the message changes. Thus in some cases, there may be an epoch without a message block output.

- 44 Packed *Almanac*: This message provides data corresponding to each satellite in the *GPS* constellation. This information includes *GPS* Week number of *almanac* collected, *GPS* Time of week [in seconds] that *almanac* was collected, *almanac* reference week, *almanac* reference time, *almanac* source, *almanac* health, pages 1-25, and subframes 4 & 5.

- 81 Packed *Ephemeris*: This message provides information as it relates to individual satellites tracked, including *GPS* Week number of *ephemeris* collected, *GPS* Time of week [in seconds] that *ephemeris* was collected, IODC, and Sub-frame 1, 2, & 3 data.

- 86 Channel Status: Provides receiver *channel* status information and contains the *GPS* week, *GPS* Time of Week, NCT-2100 Engine status, solution status, number of satellites being tracked and the number and identity of satellites used in solution, *PDOP* and the satellite *PRN*.

- A0 Alert Text Message: Details if a message has been properly received and processed.

- AE Identification Block: Details the receiver software versions.

- B0 Raw Measurement Data: Raw Measurement Data Block that contains the *GPS* Week, *GPS* Time of Week, Time Slew Indicator, Status, *Channel* Status, CA *Pseudorange*, L1 Phase, P1-CA *Pseudorange*, P2-CA *Pseudorange*, and L1 Phase. This data stream is repeated for any additional satellite.

- B1 *PVT*: Provides *GPS* Week number, satellites used, latitude, longitude, navigation mode, velocity, and *DOP* information.

Advanced Configuration Settings

If a third party *Controller* Solution was provided with your NCT-2030M *GPS* sensor, please refer to that manual/user guide.

Chapter 5 Safety Instructions

The NCT-2030M *GPS* sensor is designed for precise navigation and positioning using the *Global Positioning System*. Users must be familiar with the use of portable *GPS* equipment, the limitations thereof and these safety instructions prior to use of this equipment.

FCC Notice

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Transport

The NavCom equipment should always be carried in its case. The case must be secured whilst in transit to minimize shock and vibration.

All original packaging should be used when transporting via rail, ship, or air.

Maintenance

The NavCom equipment may be cleaned using a new lint free cloth moistened with pure alcohol.

Connectors must be inspected, and if necessary cleaned before use. Always use the provided connector protective caps to minimize moisture and dirt ingress.

Cables should be regularly inspected for kinks and cuts as these may cause interference and equipment failure.

Damp equipment must be dried at a temperature less than +40°C (104°F), but greater than 5°C (41°F) at the earliest opportunity.

External Power Source

The NCT-2030M can be external powered using optional NavCom cable (*P/N* 94-310060-3010). This must be connected to the chosen external power solution in accordance with Chapter 2 Interfacing\Electrical Power. It is important that the external power source allow sufficient current draw for proper operation. Insufficient supplied current will cause damage to your external power source.

If your chosen external power source is a disposable battery, please dispose of the battery in accordance with your local regulations.

Safety First

The owner of this equipment must ensure that all users are properly trained prior to using the equipment and are aware of the potential hazards and how to avoid them.

Other manufacturer's equipment must be used in accordance with the safety instructions issued by that manufacturer. This includes other manufacturer's equipment that may be attached to NavCom Technology, Inc. manufactured equipment.

The equipment should always be used in accordance with local regulatory practices for safety and health at work.

There are no user serviceable parts inside the NCT-2030M *GPS* sensor. Accessing the inside of the equipment will void the equipment warranty.

Care should be taken to ensure that the NCT-2030M does not come into contact with electrical power installations, the unit is securely fastened and there is protection against electromagnetic discharge in accordance with local regulations.

The *GPS* sensor has been tested in accordance with FCC regulations for electromagnetic interference. This does not guarantee non-interference with other equipment. Additionally, the *GPS* sensor may be adversely affected by nearby sources of electromagnetic radiation.

The *Global Positioning System* is under the control of the United States Air Force. Operation of the *GPS* satellites may be changed at any time and without warning.

A GPS Sensor Technical Specifications

The technical specifications of this unit are detailed below. NavCom Technology, Inc. is constantly improving, and updating our technology. For the latest technical specifications for all products go to: *support.navcomtech.com*

NCT-2030M

The NCT-2030M *GPS* sensor is fitted with an internal Lithium coin cell used to maintain *GPS* time when power is removed from the unit. This allows faster satellite acquisition upon unit power up. The cell has been designed to meet over 10 years of service life before requiring replacement at a NavCom approved maintenance facility.

Features

- Fully upgradeable receiver in robust housing
- "All-in-view" tracking with 26 channels (12 L1 GPS + 12 L2 GPS + 2 SBAS)
- L1 & L2 full wavelength carrier phase tracking
- C/A, P1 & P2 code tracking
- User configurable as base or rover
- User programmable output data and navigation rates
- 64MB internal memory for data recording
- Output format NMEA 0183 or NavCom binary
- Superior interference suppression
- Patented multipath rejection
- LED Display for GPS
- CAN bus hardware compatible
- 1PPS Output (12.5ns relative timing precision)
- Event Marker Input

Upgrades

- Real Time Kinematic with on-the-fly initialization
- Raw data rates as fast as 50Hz
- Positioning rates as fast as 25Hz
- Upgrade to the NCT-2030M for global StarFire real-time decimeter performance
- Upgrade to the RT-3020M for integrated Spread Spectrum RTK Radio

Physical and Environmental

- Size (L x W x H): 208 x 144 x 78mm (8.18″ x 5.67″ x 3.06″)
- Weight with antenna: 1.6 kg (3.6 lbs)
- External Power:
  - Input Voltage: 10 VDC to 30 VDC
  - Consumption: 4 W
- Connectors:
  - I/O Ports: 2 x 7 pin Lemo
  - DC Power: 4 pin Lemo
  - RF Connector: TNC (with 4.4 VDC output for antenna/ LNA)
  - CAN / Event: 5 pin Lemo
  - 1 PPS: BNC
- Temperature (ambient):
  - Operating: -40°C to +55°C (-40° to +131° F)
  - Storage: -40°C to +85°C (-40° to +185° F)
- Humidity: 95% non-condensing
- Tested in accordance with MIL-STD-810F for: low pressure, solar radiation, rain, humidity, salt fog, sand & dust, and vibration

GPS Receiver Performance

- Pseudo-range Measurement Precision (RMS):
  Raw C/A code : 20cm @ 42 dB-Hz
  Raw carrier phase noise: L1: 0.95 mm @ 42 dB-Hz
  L2: 0.85 mm @ 42 dB-Hz

- Enhanced SBAS (WAAS/EGNOS) Positioning Accuracy:
  Horizontal: ± 0.5m RMS
  Vertical: ± 0.7m RMS

- RTK Positioning <10kms (Software option):
  Horizontal: ± 1 cm + 1ppm RMS
  Vertical: ± 2 cm + 1ppm RMS

- Code Differential GPS Positioning <200kms:
  Horizontal: ± 12 cm + 2ppm RMS
  Vertical: ± 25 cm + 2ppm RMS
  Velocity: 0.01 m/s RMS

- User programmable output rates:
  Position Velocity Time: Up To 5Hz,(10Hz,Opt.)
  Raw data: Up To 5Hz,(10Hz, 25Hz, 50Hz Opt.)

- Data Latency:
  Position Velocity Time: < 20 ms at all rates
  Raw data: < 20 ms at all rates

- Time-to-first-fix:

Cold Start, Satellite Acquisition: < 60 Seconds (Typical)
Satellite Reacquisition: < 1 Second

- Dynamics:
  (Speed and Altitude restricted by USA export laws.)
  Acceleration: up to 6g
  Speed: < 515 m/s (1000 knots)
  Altitude: < 18.3km (60,000ft)

Connector Assignments

•Data Interfaces:

2 serial ports
(1200 bps to 115.2 kbps)
CAN Bus I/F
Event Marker I/P
1PPS

Input/Output Data Messages

• NCT Proprietary Data: PVT
Raw Measurement
Satellite Messages
Nav Quality
Receiver Commands

• NMEA Messages (Output Only):
ALM, GGA, GLL, GSA,
GSV, RMC, VTG, ZDA,
GST

Proprietary NMEA Type (Output Only) SET

• Code Corrections: RTCM 1 or 9
WAAS/EGNOS

LED Display Functions (Default)

• Link ∗ Non-Operational in NCT-2030M
• Base ∗ Non-Operational in NCT-2030M
∗(Operational in SF-2050 & RT-3020 Upgrades)
• GPS Position Quality

B GPS Antenna Technical Specifications

The standard antenna supplied with the NCT-2030M *GPS* sensor is capable of L1 & L2 *GPS,* and L-Band Inmarsat reception.

L1+L, L2 GPS Antenna

1525-1585 MHz	GPS L1 plus Inmarsat L Band
1217-1237 MHz	GPS L2
L1 Phase Centre	58.7mm
Polarization	Right Hand Circular (RHCP)
Finish	Fluid resistant Ultem, UV stable
Cable Connector	TNC Female
Pre–Amplifier	39dB gain (+/-2)
Input Voltage	4.2 to 15.0 VDC
Impedance	50 Ohms
VSWR	≤ 2.0:1
Band Rejection	20 dB @ 250MHz
Power Handling	1 Watt
Operating Temp	-55°C to +85°C
Altitude	70,000′

NavCom *P/N* 82-001000-0008 is an optional aircraft mount antenna, also rated to 70,000 feet.

Designed to DO-160D Standard

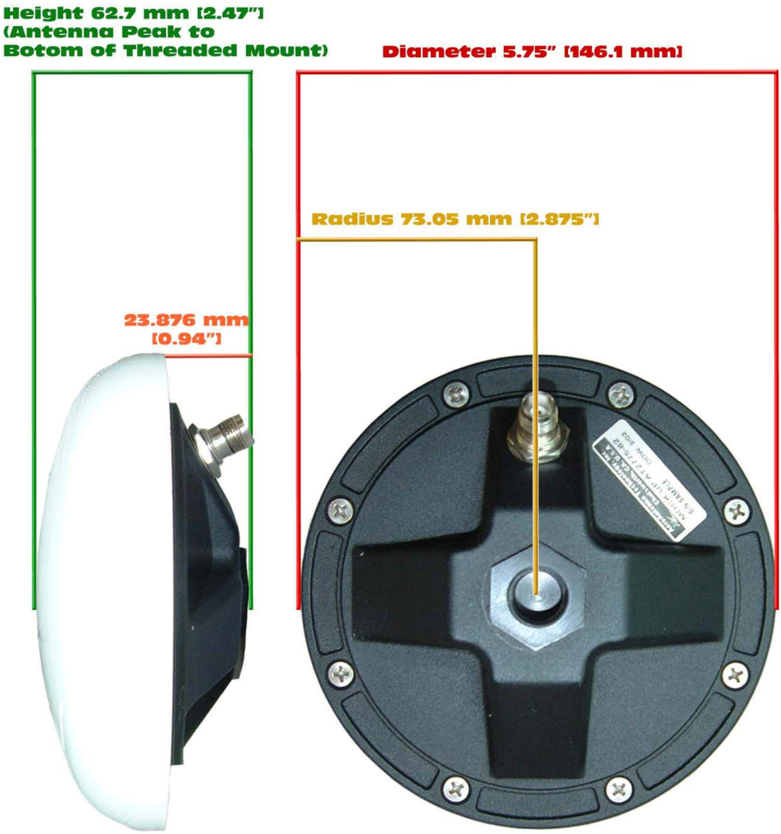

Figure B1: Tri-Mode Antenna Dimensions

In order to achieve the greatest level of accuracy, the absolute phase center values must be incorporated into your processing. For phase center information for the Tri-Mode Antenna go to *Navcomtech.com/support.cfm*.

C Event Input Configuration

Figure C1 details the wiring of the Event/Can cable assembly NavCom part number P/N 94-310062-3003.

Refer to Chapter 2, Event for detailed electrical specifications.

Table D1 details the wiring configuration required for Event-Hi, and Event-Lo pulse sensing.

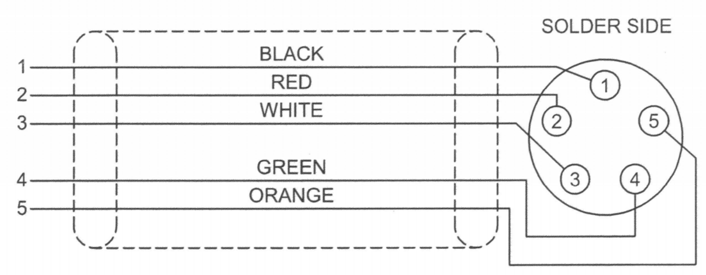

Figure C1: Event Cable Wiring Diagram

Pin #	Signal Name	Event Sync Wiring
1	Event Lo	Tie Event-Hi to Ground
2	Event Hi	Tie Event-Lo to Ground
3	Ground	N/A

Table C1: Event Wiring Connections

Once the cable is wired to correspond with the event pulse requirements, the receiver must be configured to output the message containing a time mark, referenced to the time kept within the receiver, indicating when the event is sensed..

The Event Input can be triggered on the Rising or Falling edge of the input pulse. Configuration is possible thru Navcoms StarUtil program. Figure D2 shows a screen capture of the programs PPS & Event Latch window.

Figure D2: PPS & Event Latch Configuration

Next, the Event Latch message (0xB4) must be enabled in the NCT 2000 Message Output list. The Message Rate for the 0xB4 must be set to "On Trigger". This is carried out by Right- Clicking on the Rate area adjacent to the B4 Message ID, and following the menus as seen in Figure D3. Once configured. the Event Latch Message 0xB4 will only be output when the chosen pulse edge of the incoming event is sensed by the receiver.

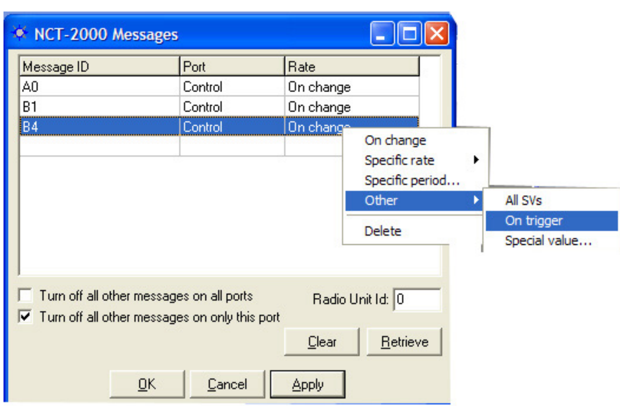

Figure C3: Event Latch Output Rate Configuration

Glossary

.yym files see meteorological files (where yy = two digit year data was collected).

.yyn files see navigation files (where yy = two digit year data was collected).

.yyo files see observation files (where yy = two digit year data was collected).

almanac files an almanac file contains orbit information, clock corrections, and atmospheric delay parameters for all satellites tracked. It is transmitted to a receiver from a satellite and is used by mission planning software.

alt see *altitude*.

altitude vertical distance above the *ellipsoid* or *geoid*. It is always stored as height above *ellipsoid* in the *GPS* receiver but can be displayed as height above *ellipsoid* (HAE) or height above *mean sea level* (*MSL*).

antenna phase center (APC) The point in an antenna where the *GPS* signal from the satellites is received. The height above ground of the APC must be measured accurately to ensure accurate *GPS* readings. The APC height can be calculated by adding the height to an easily measured point, such as the base of the antenna mount, to the known distance between this point and the APC.

APC see *antenna phase center or phase center*.

Autonomous positioning (*GPS*) a mode of operation in which a *GPS* receiver computes *position* fixes in real time from satellite data alone, without reference to data supplied by a *reference station* or orbital clock corrections. *Autonomous positioning* is typically the least precise positioning procedure a *GPS* receiver can perform, yielding *position* fixes that are precise to 100 meters with Selective Availability on, and 30 meters with S/A off.

azimuth the *azimuth* of a line is its direction as given by the angle between the *meridian* and the line measured in a clockwise direction from the north branch of the *meridian*.

base station see *reference station*.

baud rate (*bits per second*) the number of bits sent or received each second. For example, a *baud rate* of 9600 means there is a data flow of 9600 bits each second. One character roughly equals 10 bits.

bits per second see *baud rate.*

bps see *baud rate*.

BSW (British Standard Whitworth) a type of coarse screw thread. A 5/8" diameter *BSW* is the standard mount for survey instruments.

C/A code see *Coarse Acquisition code*.

CAN BUS a balanced (differential) 2-wire interface that uses an asynchronous transmission scheme. Often used for communications in vehicular applications.

channel a *channel* of a *GPS* receiver consists of the circuitry necessary to receive the signal for a single *GPS* satellite.

civilian code see *Coarse Acquisition code*.

Coarse Acquisition code (C/A or *Civilian code*) the pseudo-random code generated by *GPS* satellites. It is intended for civilian use and the accuracy of readings using this code can be degraded if *selective availability* (*S/A*) is introduced by the US Department of Defense.

COM# shortened form of the word Communications. Indicated a data communications port to/from the *GPS* sensor to a *controller* or data collection device.

controller a device consisting of hardware and software used to communicate and manipulate the I/O functions of the *GPS* sensor.

Compact Measurement Record (CMR) a standard format for *DGPS* corrections used to transmit corrections from a *reference station* to *rover* sensors.

data files files that contain Proprietary, *GPS*, NMEA, *RTCM,* or any type of data logged from a *GPS* receiver.

datum A reference datum is a known and constant surface which can be used to describe the location of unknown points. Geodetic datums define the size and shape of the earth and the origin and orientation of the coordinate systems used to map the earth.

DB9P a type of electrical connector containing 9 contacts. The P indicates a plug pin (male).

DB9S a type of electrical connector containing 9 contacts. The S indicates a slot pin (female).

DGPS see *Differential GPS*.

Differential *GPS* **(***DGPS***)** a positioning procedure that uses two receivers, a *rover* at an unknown location and a *reference station* at a known, fixed location. The *reference station* computes corrections based on the actual and observed ranges to the satellites being tracked. The coordinates of the unknown location can be computed with sub-meter level precision by applying these corrections to the satellite data received by the *rover*.

Dilution of Precision (*DOP***)** a class of measures of the magnitude of error in *GPS position* fixes due to the orientation of the *GPS* satellites with respect to the *GPS* receiver. There are several *DOP*s to measure different components of the error. Note: this is a unitless value. see also *PDOP*.

DOP see *Dilution of Precision*.

dual-frequency a type of *GPS* receiver that uses both L1 and L2 signals from *GPS* satellites. A *dual-frequency* receiver can compute more precise position fixes over longer distances and under more adverse conditions because it compensates for ionospheric delays. The NCT-2030M is a dual frequency receiver.

dynamic mode when a *GPS* receiver operates in *dynamic mode*, it assumes that it is in motion and certain algorithms for *GPS position* fixing are enabled in order to calculate a tighter *position* fix.

EGNOS (European Geostationary Navigation Overlay Service) a European satellite system used to augment the two military satellite navigation systems now operating, the US *GPS* and Russian GLONASS systems.

elevation distance above or below Local Vertical Datum.

elevation mask the lowest *elevation*, in degrees, at which a receiver can track a satellite. Measured from the horizon to zenith, 0º to 90º.

ellipsoid a mathematical figure approximating the earth's surface, generated by rotating an ellipse on its minor axis. *GPS* positions are computed relative to the WGS-84 *ellipsoid*. An *ellipsoid* has a smooth surface, which does not match the earth's geoidal surface closely, so *GPS altitude* measurements can contain a large vertical error component. Conventionally surveyed positions usually reference a *geoid*, which has an undulating surface and approximates the earth's surface more closely to minimize *altitude* errors.

epoch literally a period of time. This period of time is defined by the length of the said period.

geoid the gravity-equipotential surface that best approximates *mean sea level* over the entire surface of the earth. The surface of a *geoid* is too irregular to use for *GPS* readings, which are measured relative to an *ellipsoid*. Conventionally surveyed positions reference a *geoid*. More accurate *GPS* readings can be obtained by calculating the distance between the *geoid* and *ellipsoid* at each *position* and subtracting this from the *GPS altitude* measurement.

GIS (Geographical Information Systems) a computer system capable of assembling, storing, manipulating, updating, analyzing and displaying geographically referenced information, i.e. data identified according to their locations. GIS technology can be used for scientific investigations, resource management, and development planning. GIS software is used to display, edit, query and analyze all the graphical objects and their associated information.

Global Positioning System (GPS) geometrically, there can only be one point in space, which is the correct distance from each of four known points. *GPS* measures the distance from a point to at least four satellites from a constellation of 24 NAVSTAR satellites orbiting the earth at a very high *altitude*. These distances are used to calculate the point's *position*.

GMT see Greenwich Mean Time.

GPS see *Global Positioning System*.

GPS time a measure of time. *GPS* time is based on *UTC*, but does not add periodic 'leap seconds' to correct for changes in the earth's period of rotation. As of September 2002 *GPS* time is 13 seconds ahead of *UTC*.

Greenwich Mean Time (*GMT*) the local time of the 0° *meridian* passing through Greenwich, England.

HAE see *altitude*, and *ellipsoid*.

JPL Jet Propulsion Laboratory.

Kbps kilobits per second.

L-Band the group of radio frequencies extending from approximately 400MHz to approximately 1600MHz. The *GPS* carrier frequencies L1 (1575.4MHz) and L2 (1227.6 MHz) are in the *L-Band* range.

L1 carrier frequency the primary *L-Band* carrier used by *GPS* satellites to transmit satellite data. The frequency is 1575.42MHz. It is modulated by *C/A code*, P-code or Y-code, and a 50 bit/second navigation message.

L2 carrier frequency the secondary *L-Band* carrier used by *GPS* satellites to transmit satellite data. The frequency is 1227.6MHz. It is modulated by *P-code* or Y-code, and a 50 bit/second navigation message.

lat see latitude.

latitude (lat) the north/south component of the coordinate of a point on the surface on the earth; expressed in angular measurement from the plane of the equator to a line from the center of the earth to the point of interest. Often abbreviated as Lat.

LED acronym for Light Emitting Diode.

LEMO a type of connector.

LES Land Earth Station the point on the earth's surface where data is up linked to a satellite.

logging interval the frequency at which positions generated by the receiver are logged to *data files.*

long see longitude.

longitude (*long*) the east/west component of the coordinate of a point on the surface of the earth; expressed as an angular measurement from the plane that passes through the earth's axis of rotation and the 0° *meridian* and the plane that passes through the axis of rotation and the point of interest. Often abbreviated as *Long*.

Mean Sea Level (*MSL*) a vertical surface that represents sea level.

meridian one of the lines joining the north and south poles at right angles to the equator, designated by degrees of longitude, from 0° at Greenwich to 180°.

meteorological (.YYm) files one of the three file types that make up the *RINEX* file format. Where YY indicates the last two digits of the year the data was collected. A meteorological file contains atmospheric information.

MSL see *Mean sea level.*

multipath error a positioning error resulting from interference between radio waves that has traveled between the transmitter and the receiver by two paths of different electrical lengths.

navigation (.YYn) files one of the three file types that make up the *RINEX* file format. Where YY indicates the last two digits of the year the data was collected. A navigation file contains satellite *position* and time information.

observation (.YYo) files one of the three file types that make up the *RINEX* file format. Where YY indicates the last two digits of the year the data was collected. An observation file contains raw *GPS position* information.

P/N Part Number.

P-code the extremely long pseudo-random code generated by a *GPS* satellite. It is intended for use only by the U.S. military, so it can be encrypted to Y-code deny unauthorized users access.

parity a method of detecting communication errors by adding an extra parity bit to a group of bits. The parity bit can be a 0 or 1 value so that every byte will add up to an odd or even number (depending on whether odd or even parity is chosen).

PDA Personal Digital Assistant.

PDOP see *Position Dilution of Precision.*

PDOP mask the highest *PDOP* value at which a receiver computes positions.

phase center the point in an antenna where the *GPS* signal from the satellites is received. The height above ground of the *phase center* must be measured accurately to ensure accurate *GPS* readings. The *phase center* height can be calculated by adding the height to an easily measured point, such as the base of the antenna mount, to the known distance between this point and the *phase center*.

Position the latitude, longitude, and *altitude* of a point. An estimate of error is often associated with a *position*.

Position Dilution of Precision (PDOP) a measure of the magnitude of Dilution of Position (*DOP*) errors in the x, y, and z coordinates.

Post-processing a method of differential data correction, which compares data logged from a known reference point to data logged by a *roving receiver* over the same period of time. Variations in the *position* reported by the *reference station* can be used to correct the positions logged by the *roving receiver*. Post-processing is performed after you have collected the data and returned to the office, rather than in real time as you log the data, so it can use complex, calculations to achieve greater accuracy.

Precise code see *P-code*.

PRN (Uppercase) typically indicates a *GPS* satellite number sequence from 1 – 32.

prn (Lower Case) see Pseudorandom Noise.

Protected code see *P-code*.

Proprietary commands those messages sent to and received from *GPS* equipment produced by NavCom Technology, Inc. own copyrighted binary language.

pseudo-random noise (*prn*) a sequence of data that appears to be randomly distributed but can be exactly reproduced. Each *GPS* satellite transmits a unique *PRN* in its signals. *GPS* receivers use *PRN*s to identify and lock onto satellites and to compute their pseudoranges.

Pseudorange the apparent distance from the *reference station*'s antenna to a satellite, calculated by multiplying the time the signal takes to reach the antenna by the speed of light (radio waves travel at the speed of light). The actual distance, or *range*, is not exactly the same because various factors cause errors in the measurement.

PVT *GPS* information depicting Position, Velocity, Time in the NCT proprietary message format.

Radio Technical Commission for Maritime Services
see *RTCM*.

range the distance between a satellite and a *GPS* receiver's antenna. The *range* is approximately equal to the *pseudorange*. However, errors can be introduced by atmospheric conditions which slow down the radio waves, clock errors, irregularities in the satellite's orbit, and other factors. A *GPS* receiver's location can be determined if you know the ranges from the receiver to at least four *GPS* satellites. Geometrically, there can only be one point in space, which is the correct distance from each of four known points.

RCP a NavCom Technology, Inc. proprietary processing technique in which carrier phase measurements, free of

Ionospheric and Troposphere effects are used for navigation.

Real-Time Kinematic (*RTK*) a *GPS* system that yields very accurate 3D *position* fixes immediately in real-time. The *base station* transmits its *GPS position* to *roving receivers* as the receiver generates them, and the *roving receivers* use the *base station* readings to differentially correct their own positions. Accuracies of a few centimeters in all three dimensions are possible. *RTK* requires *dual frequency GPS* receivers and high speed radio modems.

reference station a *reference station* collects *GPS* data for a fixed, known location. Some of the errors in the *GPS* positions for this location can be applied to positions recorded at the same time by *roving receivers* which are relatively close to the *reference station*. A *reference station* is used to improve the quality and accuracy of *GPS* data collected by *roving receivers*.

RHCP Right Hand Circular Polarization used to discriminate satellite signals. *GPS* signals are RHCP.

RINEX (Receiver Independent Exchange) is a file set of standard definitions and formats designed to be receiver or software manufacturer independent and to promote the free exchange of *GPS* data. The *RINEX* file format consists of separate files, the three most commonly used are: the observation (.YYo) file, the navigation (.YYn) file, and the meteorological (.YYm) files; where YY indicates the last two digits of the year the data was collected.

rover any mobile *GPS* receiver and field computer collecting data in the field. A *roving receiver's position* can be differentially corrected relative to a stationary reference *GPS* receiver or by using *GPS* orbit and clock corrections from a *SBAS* such as StarFire™.

roving receiver see *rover*.

RTCM
(Radio Technical Commission for Maritime Services) a standard format for *Differential GPS* corrections used to transmit corrections from a *base station* to *rovers*. RTCM allows both *real-time kinematic* (*RTK*) data collection and post-processed differential data collection. RTCM SC-104 (RTCM Special Committee 104) is the most commonly used version of RTCM message.

RTK see *Real-time kinematic*.

RTG Real Time GIPSY, a processing technique developed by NASA's Jet Propulsion Laboratory to provide a single set of real time global corrections for the *GPS* satellites.

S/A see *Selective availability*.

SBAS (Satellite Based Augmentation System) this is a more general term, which encompasses *WAAS*, *StarFire*™ and *EGNOS* type corrections.

Selective Availability (S/A) deliberate degradation of the *GPS* signal by encrypting the *P-code*. When the US Department of Defense uses *S/A*, the signal contains errors, which can cause positions to be inaccurate by as much as 100 meters.

Signal-to-Noise Ratio (*SNR*) a measure of a satellite's signal strength.

single-frequency a type of receiver that only uses the L1 *GPS* signal. There is no compensation for ionospheric effects.

SNR see *signal-to-noise* Ratio.

StarFire™ a set of real-time global orbit and clock corrections for *GPS* satellites. StarFire™ equipped receivers are capable of real-time decimeter positioning

Spread Spectrum Radio (SSR) a radio that uses wide band, noise like (pseudo-noise) signals that are hard to detect, intercept, jam, or demodulate making any data transmitted secure. Because spread spectrum signals are so wide, they can be transmitted at much lower spectral power density (Watts per Hertz), than narrow band transmitters.

SV (Space Vehicle) a *GPS* satellite.

Universal Time Coordinated (*UTC*) a time standard maintained by the US Naval Observatory, based on local solar mean time at the Greenwich *meridian*. *GPS* time is based on *UTC*.

UTC see *Universal time coordinated*.

WAAS (Wide Area Augmentation System) a set of corrections for the *GPS* satellites, which are valid for the Americas region. They incorporate satellite orbit and clock corrections.

WAD*GPS* (*Wide Area Differential GPS*) a set of corrections for the *GPS* satellites, which are valid for a wide geographic area.

WGS-84 (World Geodetic System 1984) the current standard datum for global positioning and surveying. The WGS-84 is based on the GRS-80 *ellipsoid*.

Y-code the name given to encrypted *P-code* when the U.S. Department of Defense uses *selective availability*.