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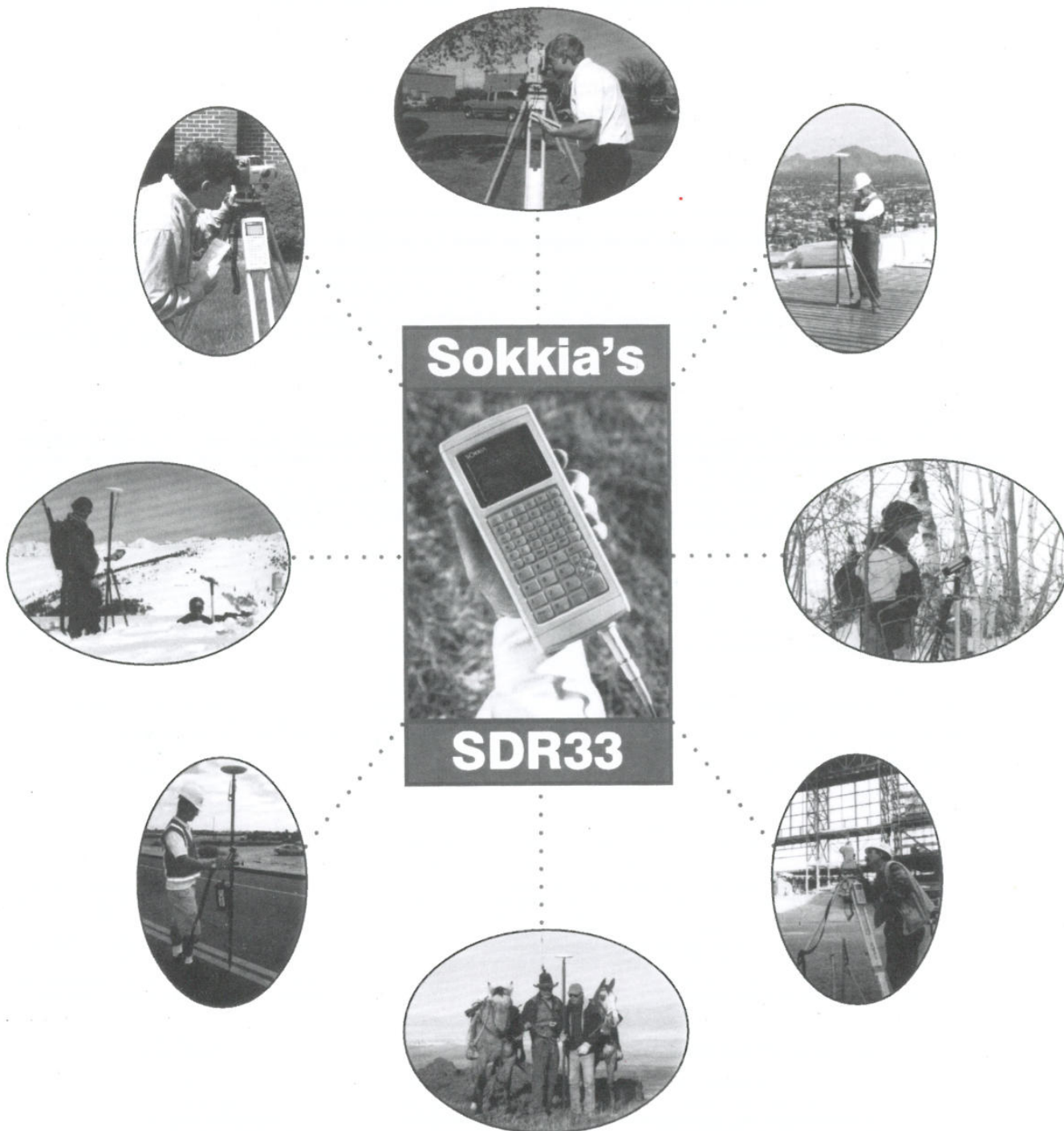


PROFESSIONAL LAND SURVEYORS OF WYOMING
AFFILIATE — AMERICAN CONGRESS ON SURVEYING AND MAPPING
MEMBER — WESTERN FEDERATION OF PROFESSIONAL SURVEYORS

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VOLUME 11, NO. 4 JANUARY 2000



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2000 PLSW MEMBERSHIP APPLICATION PROFESSIONAL LAND SURVEYORS OF WYOMING

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CLASS OF MEMBERSHIP APPLIED FOR: (check one only and please submit dues with application, prorated for the remainder of the calendar year)

☐ **MEMBER**, ANNUAL DUES \$75 (Persons duly registered, PLS or PE&PLS in Wyoming.)

AFFILIATE MEMBERSHIPS

☐ **Associate Member**, annual dues \$50. (Persons employed under the direction of a PLS and working toward PLS registration in Wyoming.)

☐ **Special Member**, annual dues \$50. (Not meeting above qualifications but with a particular interest in, or association with, the profession of land surveying.)

☐ **Special Member**, Student, annual dues \$15. (Pursuing a post secondary academic course of study, and currently enrolled.)

☐ **Sustaining Member**, annual dues \$100. (Persons, institutions or corporations desiring to assist PLSW financially.)

I AGREE TO OBSERVE THE CONSTITUTION AND BY-LAWS OF THE PROFESSIONAL LAND SURVEYORS OF WYOMING AND THE CHAPTER THEREOF TO WHICH I WILL BELONG AND TO SUPPORT SAID ORGANIZATIONS IN THEIR ENDEAVORS.

APPLICANT'S SIGNATURE

SPONSOR'S SIGNATURE
(For Affiliate Member applicants only.)

NOTE: All portions of the state have chapters. Chapter dues or assessments may vary in amount. Applications are considered by the board of Directors at quarterly meetings. Send completed application to PLSW, c/o Herbert W. Stoughton, Sec./Treas. 2821 Carey Ave. Cheyenne Wyoming 82001

Letters

Keith Rounds, Secretary
Transportation Commission of Wyoming
Box 1708

Cheyenne, Wyoming 82003
Re: Southwest Corner of Wyoming
Dear Keith

With the rehabilitation and the making into a tourist attraction of the foregoing state monument by the Professional Land Surveyors, it was hoped that you would show upon the 'Official Highway Map' of Wyoming the paved road access to encourage travel to this historical site.

There are paved County Roads Nos. 151 and 153 from Evanston leading to within five miles of the state line and then a treated road to the corner. The paved road tucks into Utah for a short distance but I suspect is still maintained by Uinta County.

From Utah, of course, there is a paved road up Chalk Creek and the County Commissioners graciously paved the short distance from the Chalk Creek Road over to the monument.

The Map shows the roadway from Pineview in Utah to the line as a graded or earth road. However it is paved and has recently been redone.

The graded or earth road that you show for Wyoming is not the best route with the paved County Roads much better. Actually traveling the Chalk Creek Road to the monument and then along the road to Evanston is a nice byway to get off of truck burdened 1-80.

Please let me know if I may be of assistance.

Thank you,

Very Sincerely Yours,

PROFESSIONAL SURVEYORS OF THE 6TH P.M.

Paul N. Scherbal

WES 80th ANNUAL CONVENTION

FEBRUARY 3-5, 2000, CHEYENNE, WYOMING

Following is the finalized surveying program for the 2000 WES Annual Meeting in Cheyenne:

Friday Morning

Sessions 1 & 2: *National Plane Coordinate System Used In Wyoming*

Dr. Herbert W. Stoughton; Head: Surveying and Mapping Program; Metropolitan State College of Denver; Cheyenne, Wyoming

Friday Afternoon

Sessions 1 & 2: *Designing and Using Local and Regional Plane Coordinate Systems Used in Wyoming*

Dr. Herbert W. Stoughton; Head: Surveying and Mapping Program; Metropolitan State College of Denver; Cheyenne, Wyoming

Saturday Morning

Session 1: *Understanding Transformations In GPS*
Andrew Hurley; Market Director, GPS Surveying; Leica Geosystems, Inc.; Englewood, Colorado

Session 2: *Understanding Radio Conununications In RTK Surveying* Andrew Hurley; Market Director, GPS Surveying; Leica Geosystems, Inc.; Englewood, Colorado

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SOUTHWEST CHAPTER SALE ITEMS

Baseball Caps (available in red or black) \$10 ea.
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Items may be purchased by sending check or money order and a list of the desired items to:

PLSW Southwest Chapter

476 Schultz St.

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Or contact Randy Rowley at 307-872-7152
for further information.

EDITORIAL POTPOURRI

O PLSW BOARD MEETINGS - The Board meetings for 2000 are as follows:

3 FEB 00 Cheyenne (WES Convention)
20 May 00 Rock Springs
26 AUG 00 Thermopolis
11 NOV 00 Casper

All members are welcome. Contact your Director for the time and place.

O Lines & Points FAX - Our fax numbers are 307-235-5604 or 307-235-8184.

O Lines & Points E-MAIL - Contact dond@trib.com. or johnhh@trib.com.

O IN MEMORY OF - The Board of Directors announced the passing of three members. They are as follows:

Mark E. Quillian, Associate Member
18 AUG 49 to 7 SEP 99

Dell Cazier, Special Member
6 JAN 25 to 16 SEP 99

Robert Jack Smith, Honorary Member
1923 to 6 OCT 99

Need a map? Check the Net

WASHINGTON - For the first time, 26 maps from the world's biggest collection went on the Internet on Monday from the Library of Congress, which has another 4.5 million to go.

More maps will be added every day, said Ralph E. Ehrenberg, chief of the library's geography and map section.

The web site is at <http://www.loc.gov/> - go the American Memory Collections.

**Front Cover Artwork
by
Ray Blaha,
Casper, WY**

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PLSW (Professional Land Surveyors of Wyoming) is a statewide organization of Registered Land Surveyors licensed to practice in the Equality State of Wyoming. PLSW is dedicated to improving the technical, legal, and business aspects of surveying in the State of Wyoming. PLSW is affiliated with the American Congress on Surveying and Mapping and the Western Federation of Professional Land Surveyors.

Editorial Staff: John Hibsman, Steve Strang, Don Davis.

Lines and Points subscription \$50/year

Advertising Information

Camera ready advertisements with payment should be mailed to *Lines & Points*, PLSW, Box 904, Casper, WY 82602

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	Year	Issue
Full page	\$300	\$80
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Employment	Free	

Special Rates for PLSW Chapters

Deadline for next issue — 15 March 2000

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PRESIDENT'S MESSAGE

QUARTERLY UPDATE - As of 27 November 1999

Your Board of Directors met following our Fall Technical Session in Casper on the 12th of November with six of the seven chapters represented, a noteworthy improvement in attendance. The arduous but essential adoption of next year's budget was just one focal point of the meeting. The minutes of that meeting are contained within this edition and I encourage all members to thoroughly read them since several items will require additional action by those of you attending our annual state meeting.

Our Fall Technical Session on the 11th and 12th of November at the Parkway Plaza in Casper was attended by over 100 surveyors and technicians who were educated, enlightened and entertained by Dr. Knud Hermansen on the topics of "Surveying Management and Liability" and "Monuments and Lines of Possession". Congratulations are in order to chairman Joel Ebner and all ' those members who assisted him in effecting the success of this year's event. Since PLSW will be participating in "Big Sky 2000" next April, there will be no fall technical session next year.

Another activity recently completed is the High Accuracy Reference Network (HARN) reobservation and densification project, coordinated by Mike Londe, Geodesist with the Wyoming State Office of the BLM. Observations were conducted throughout the month of October with 26 stations being added to the National Spatial Reference System (NSRS). Members from several chapters of PLSW donated equipment, personnel and time for the establishment of the majority of the Cooperative Base Network (CBN) stations. Those who participated in this project deserve the satisfaction and acknowledgment attendant to having made an enduring and valuable contribution to the NSRS, our profession and the public welfare. As a result of Dr. Londe's leadership, the successful completion of the project is ensured - we thank you Mike, for that leadership as well as the extraordinary time and effort.

Upcoming events include our annual state meeting on Thursday, the 3rd of February, immediately followed by the 80th annual Wyoming Engineering Society convention on Friday and Saturday, at the Holiday Inn in Cheyenne. If you have not already done so, I encourage every member to make plans now, yes right now, to attend both our meeting and the convention.

I close this report by saying to each of you that I have appreciated, enjoyed, and feel honored to have served as your president for the past two years. Through the collective effort of all of us, the PLSW membership, I am confident we will continue the betterment of our profession (and ourselves) within "the area encompassed and bounded by the four monumented corners of" Wyoming. Onward into the next millennium - lead, follow or get out of the way!

I extend a sincere "Merry Christmas " and "Happy New Year" to each and every one of you and your families.

Rick Hudson, President

REPRINTED MAP
SOURCES OF SNAKE RIVER

**SNAKE RIVER EXPEDITION –
JAMES STEVENSON, DIRECTOR**

The Northwest Chapter has reprinted, from an old (perhaps first printing) lithograph found in a cabin west of Cody, the map of the Hayden - Stevenson expedition and survey of Jackson Hole, Yellowstone National Park and surrounding vicinity. The map shows the campsites of the expedition, from July 12th, 1872, at Fort Hall, Idaho Territory, up the Snake River, into Yellowstone, and returning to Fort Hall on October 11th.

The reprint measures approximately 28 inches by 29 inches overall, black printing on white background, and is printed on heavy photographic paper.

The map is representative of the cartographic style of the time and uses shading to depict mountain ranges, water lining on lakes and artistic profiles of various ranges including the Tetons.

A 39-page excerpt from "Great Surveys of the American West", by Richard A. Bartlett, published by University of Oklahoma Press, is to be included with the map (reprint permission pending) and details the progress of the expedition.

THE CHAPTER IS OFFERING PRINTS TO PLSW MEMBERS AT THE INTRODUCTORY PRICE OF \$40 PER PRINT, POSTPAID.

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METRIC PIPE

Pipe is one of the most ubiquitous products- in construction. It is made of a wide variety of materials, including galvanized steel, black steel, copper, cast iron, concrete, and various plastics such as ABS, PVC, CPVC, polyethylene, and polybutylene, among others.

But like wood 2-by-4s, which are not really 2 inches by 4 inches, pipe is identified by 'nominal' or "trade" names that are related only loosely to actual dimensions. For instance, a 2-inch galvanized steel pipe has an inside diameter of about 2-1/8 inches and an outside diameter of about 2-5/8 inches. It is called "2-inch pipe" only for the sake of convenience.

Since few, if any, pipe products have actual dimensions that are in even, round inch-pound numbers, there is no need to convert them to even, round metric numbers. Instead, only their *names* change from inch-pound to metric. Pipe cross sectional sizes do not change. Fittings, flanges, couplings, valves, and other piping components are renamed in like manner, as are pipe threads.

Here are the inch-pound names for pipe products (called NPS or 'nominal pipe size') and their metric equivalents (called DN or "diameter nominal"). The metric designations conform to International Standards Organization (ISO) usage and apply to all plumbing, natural gas, heating oil, and miscellaneous piping used in buildings. Reinforced concrete pipe and corrugated steel pipe used in highways and other civil works construction also use these designations.

Note that all whole-number inch designations on the following chart convert to multiples of 25 mm except for 3 inch pipe, which ISO designates as 80 mm.

METRIC RULES-OF-THUMB

- 1 mm=about 1/25 inch=thickness of a dime
- 25 mm=about 1 inch (1"=25.4 mm)
- 300 mm=about 1 foot (12"=304.8 mm)
- 1000 mm=1 m=about 3 feet+10% more
- 1 m²=roughly 10 square feet (1m²=10.76 ft²)
- 1 L=about 1 quart (1L=1.06 qt)
- 1 m³=about 35 cubic feet (about 30% more than a yd³)
- 1 kg=about 2.2 pounds
- 1000 kg=1Mg=1 metric tone=about 2200 pounds
- 100kPa=about 15 psi; 1 MPa=about 150 psi

-WEST FED

(Continued from Page 9)

legislation requiring a minimum of two years of formal college education as a criteria for licensure. It is felt among membership that with the advancement of technology and new methodologies, new surveyors will need the additional scholastic effort. They see the eventual need to encourage a 4 year degree to keep pace with the advancements in the industry.

The next two WFPS meeting dates were set and are as follows: January, 22, 2000 in Phoenix and May 20, 2000 in Las Vegas.

Action List Items for the next meeting was reviewed.
Meeting was adjourned at 3:20 p.m.

NPS	DN	NPS	DN
1/8"	6 mm	8"	200 mm
3/16"	7 mm	10"	250 mm
1/4"	8 mm	12"	300 mm
3/8"	10 mm	14"	350 mm
1/2"	15 mm	16"	400 mm
5/8"	18 mm	18"	450 mm
3/4"	20 mm	20"	500 mm
1"	25 mm	24"	600 mm
1-1/4"	32 mm	28"	700 mm
1-1/2"	40 mm	30"	750 mm
2"	50 mm	32"	800 mm
2-1/2"	65 mm	36"	900 mm
3"	80 mm	40"	1000 mm
3-1/2"	90 mm	44"	1100 mm
4"	100 mm	48"	1200 mm
4-1/2"	115 mm	52"	1300 mm
5"	125 mm	56"	1400 mm
6"	150 mm	60"	1500 mm

For pipe over 60", use 1" = 25 mm.





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DRAFT

Professional Land Surveyors of Wyoming

Board of Directors Meeting Minutes, 12 November 1999

1. The Board of Directors' Meeting of the Professional Land Surveyors of Wyoming.
 - a. Location: Casper, Wyoming, at the *Parkway Plaza*.
 - b. Date & Time: Friday, 12 November 1999 at 12:31 p.m., M.S.T.
 - c. Presiding Officer: Mr. Rick L. Hudson, P.L.S., President.
2. Agenda: The final agenda is appended. [Appendix A]
3. President Hudson introduced Honorary Member Joseph Popp; ACSM/NSPS District 7 Director Becky Braman; and PLSW WestFED Delegate Paul Reid, who were attending the meeting.
4. B.O.D. Minutes: Motion was made by K.D. Jones/J.B. Jones to approve the minutes of the Board of Directors' meeting of 28 August 1999 at Cheyenne. Motion approved.
5. President Hudson announced the passing of three members (various grades) of PLSW (in order of their passing).
 - a. Mark Edward Quillian, Associate Member; 18 August 1949 - 7 September 1999.
 - b. Dell Cazier, Special Member; 6 January 1925 - 16 September 1999.
 - c. Robert Jack Smith, 1986 Honorary Member; 1923 - 6 October 1999.
6. President's Report:
 - a. President Hudson distributed copies of a letter from Delbert A. McOmie, member of the WES Project of the Year Committee. The letter solicited submissions from the PLSW

membership for the WES President's Project of the Year Award. Copies of the letter and guidelines were distributed to the Board of Directors for distribution to the general membership.

- b. President Hudson made general comments concerning committee activities and duties. No action items were offered or official directions ordered.

- c. President Hudson presented a certificate of *Recognition of Service* for "instructing students in the execution of construction stakeout surveys for residential and light commercial/industrial buildings; Metropolitan State College of Denver, Surveying and Mapping Program, at the Auraria Campus" [16 October 1999].

7. Secretary's Report: Secretary Stoughton reported that he had completed the assignments directed to him by the Board of Directors at their 28 August 1999 meeting.

- a. Letter notifying ACSM/NSPS of the appointment of William Braman as PLSW ACSM/NSPS Governor.

- b. Letter to the Chairman Dolinar (PLSW Bylaws Committee) requesting review of the bylaws for creating the membership of *Retired Member*.

- c. Letter to Richard Greenwood requesting his task committee identify a WEB page service.

- d. Letter to *Professional Surveyor* thanking them for their offer for mailing labels.

- 8 Treasurer's Report:

- a. Income: A statement of the income from various sources through 1 November 1999 was presented [Appendix B].

- b. Checking Account: The activities of the checking account for calendar year 1999 was presented. The balance as of 31 October 1999 was \$19,825.17.

- c. Investment Policy Statement: The statement was revised based upon comments presented at the Board of Directors' meeting of 28 August 1999. This document was reviewed. Motion by K.D. Jones/Dawson to pass the policy as published and dated 28 August 1999. Motion approved. President Hudson will present the policy at the 2000 Annual Meeting. The approved statement was published in *Lines & Points*; V. 11, No. 3; pp 8 and 9.

- d. Treasurer Stoughton noted that the certificate of deposit would mature at the end of December 1999. Motion by K.D. Jones/Dawson to invest the funds in a three month certificate of deposit. Motion approved.

9. Committee Reports:

- a. Audit-Finance Committee - Submitted at the Annual Meeting.

- h. Bylaws Committee - no report.

- c. Convention Committee - The letter to WES identifying the technical programs scheduled.

- d. Education Committee - no report.

- e. History Committee - the update to the PLSW History is published and distributed in May of each year.

- f. Legislative Committee - S. Dennis Dawson circulated a

(Continued on Page 7)

Where Do the Questions Come From

by Becky Braman, PLS

The Survey Technician Certification examinations consist of many multiple choice questions. Where do these questions come from and how are they updated and maintained?

When the National Society of Professional Surveyors (NSPS) and the American Congress on Surveying and Mapping (ACSM) decided to begin testing and certifying survey technicians, a group of surveyors met to decide how to structure the program and what areas of knowledge to test. The program has developed and evolved into the present structure of four levels offering certification in office and field tracks. The tests consist of 200 questions for Level I, 180 questions for Level II, 150 for Level III and a special research-essay test for Level IV. Each test is drawn from a selection of more than three question banks.

There are over 3000 questions and for each there must be one correct answer and three incorrect answers. Each of these questions comes from asking: 'What does the technician do concerning this topic? What level of knowledge should be expected from an entry level worker/rod-person or an instrument person or a party chief? How can this knowledge be tested?'

Among the initial decisions made by the STCB were what topics to test for each level of technician and what emphasis to put on each topic. Such topics as field procedures, first aid, computations, and survey history are tested. A topic may be tested on all levels, but the questions will be more difficult and more in depth for the higher levels. What questions are asked? Some areas are clear-cut with the questions based on factual knowledge. In first aid, what is the priority for treating injuries? Why must cutting-equipment be well maintained? Other questions involve computations from the simple, like computing the distance represented by 2 inches at a scale of 1 inch equal 200 feet, to the complex, like determining the offset and station for a point when you know the angle and distance from a point and back sight on the road. Still, other questions are looking for ethics or leadership or judgement.

Surveying has many specialties such as construction layout, marine surveying, underground surveying, boundary retracement and geodetic surveying. In addition, surveying has local terms and techniques which vary from one part of the country to another. Underlying all the specialties and all local variations, are principles of mathematics, physics and the practical applications of field knowledge and experience. To bring all the possible ideas, the STCB has recruited surveyor members from academic backgrounds, from construction surveying, from drafting and office computations and from boundary surveying. The question writers are from many parts of the country including both the colonial states and the states surveyed under the General Land Office. Also, board members have both field and office experience, and all are in positions where they train and/or supervise survey technicians.

Question writing sessions are hard work but enjoyable. The surveyors working on the questions brainstorm about ideas on the topic. 'How can we test for knowledge of how to set catch points?' 'Can we write a question that is clear and that can be solved with the tools the technician has available at the test site?' 'Well, I'll give it a try.' When one board member has developed a question, other members then read through, solve and edit the question. It is evaluated as to appropriate difficulty for the level being tested. It is also reviewed to see if the information asked is nationwide and current. Several persons work the problem to verify the correct answer. Then the test writers must come up with incorrect answers which are believable but not so close to the correct answer as to be just as right.

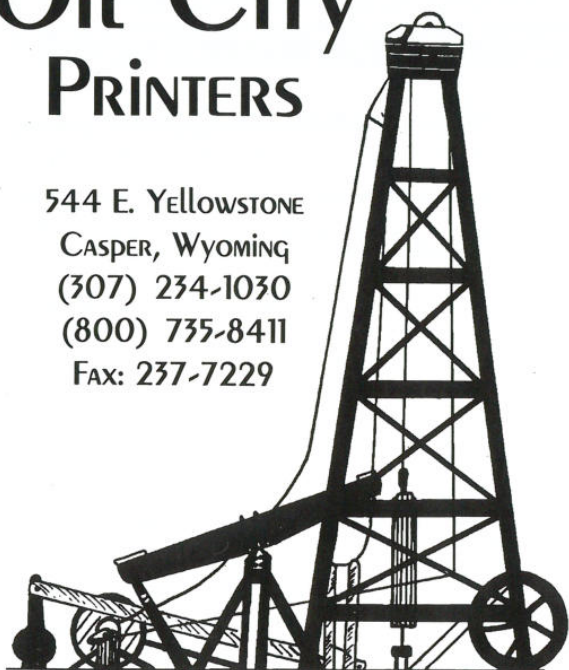
The questions on the tests for survey technicians are frequently changing. Four times a year members of the Board meet to review test results and challenges and to update questions. The examinees write challenges to questions which they feel are incorrect or do not have a correct answer. These challenges are carefully reviewed and the question checked over. If the challenge is accepted, the question is thrown out of the exam and each examinee is given credit. Most importantly the question is removed from the question bank, and replaced or rewritten.

The technology of surveying has been changing rapidly. This has made it very important to constantly review and replace questions. Transits and chaining are of decreased importance while GPS and geodetic positioning are of increasing importance. Since so much of surveying depends on understanding historical practices, all questions about older technologies are not eliminated, but most questions are about modern techniques. The question banks are reviewed at each meeting to keep the questions modern and pertinent.

The goal of the STCB is to provide tests which are up to date, broad based, and appropriate to the level of competence being tested. This goal is being met by revising and refining the existing test questions. The result is a series of tests for survey technicians which match the current technology but also test leadership skills and practical knowledge. Those surveyors who have worked on the questions have found it to be a challenging and enlightening experience. All of them have had to study and think in order to develop and check the test questions. This continues to be a rewarding part of being involved with the survey technician certification program.

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RULES

NSPS BOARD OF GOVERNORS CONTEST - \$1,600.00 PRIZE

- Open to all NSPS Governors.
- Contest began at the close of the NSPS Board of Governors Meeting in Grand Rapids, Michigan, October 17, 1999.
- Contest ends at the beginning of the NSPS Board of Governors Meeting in the Fall of 2000.
- To qualify, the Governor's name must appear in the sponsor's space on a new member's application.
- Application must be for full membership and dues must be paid-in-full.
- A Governor must sign up a minimum of ten (10) new members to qualify.
- The decision of the ACSM/NSPS Membership Committee is final.

NSPS BOARD OF DIRECTORS CONTEST - \$1,100.00 PRIZE

- Open to all ACSM Members.
- Contest began at the close of the NSPS Board of Directors Meeting in Grand Rapids, Michigan, October 19, 1999.
- Contest ends at the beginning of the NSPS Board of Directors Meeting in the Fall of 2000.
- To qualify, the ACSM Member's name must appear in the sponsor's space on a new member's application.
- Application must be for full membership and dues must be paid-in-full.
- A Member must sign up a minimum of ten (10) new members to qualify.
- The decision of the ACSM/NSPS Membership Committee is final.

Prize money was donated by individual ACSM Members.
Membership applications can be downloaded from the ACSM Web Site at:
<http://www.aacsm.org/membership/membership3.htm>

DO WE NEED A NATIONAL SURVEYORS ORGANIZATION?

As you may be aware, ACSM, the American Congress on Surveying and Mapping, the umbrella organization for the National Society of Professional Surveyors, has been undergoing a financial crisis. As many of us in business have experienced, the cash flow was not adequate to meet the ongoing expenses. During the summer of 1999, cash and available loan funds approached zero. NSPS stepped in with a short term loan and with grants from the Western Federation of Surveyors and from many states including Wyoming. Many individual surveyors contributed their own money to help in this crisis.

Why was there such a crisis? In a short term viewpoint, the organization had made some expensive commitments for mortgage payments and had more staff than it could afford. However, from a longer view, the organization is suffering and continues to suffer from a membership that is below "critical mass". By this, I mean that the surveying community expects certain functions to be performed on a national level, but not enough of the surveyors are paying dues to pay for these services.

Many surveyors tell me that ACSM/NSPS does not do anything for them specifically. It is true that NSPS is in safe financial condition, so why not just let ACSM die? What would we lose?

We surveyors would lose a very important set of links to other national and international organizations. We would lose representation on some very important decision making committees and agencies. For example, ACSM is a representative for surveying on the National Council for Examining Engineers and Surveyors. These are the people who write and grade the tests for LSIT and PLS. ACSM is providing important input as to what they should test and how.

Other important agencies and committees for which ACSM is the representative include the North American Free Trade Agreement talks to determine reciprocity and ability to work in and with Canada and Mexico. Also, ACSM has a very active representation to the Federal Emergency Management Agency to give ideas and help in the updating and revision of Flood Insurance Rate Maps. Another group of individuals from ACSM work with the American Land Title Association to develop standards for title surveys. Before the work of ACSM, these title surveys were ordered only from the viewpoint of the title companies and did not take into account the needs and responsibilities of the surveyor. For example the title companies used to request a certification as to the existence and location of all underground utilities. Now through the effort of ACSM, surveyors are now required only to located and certify to visible improvements. (Go to the ACSM web page "www.survmap.org" to download a copy of the new standards.)

An important committee of which ACSM is a member is COFPASS (sorry, I do not know the full name on this one). This is the coordinating committee for engineers, architects and surveyors. It was begun in the 1960s and was instrumental; in developing "quality based" selection of professionals for federal projects. COFPASS has fought and is currently fighting to keep surveying recognized as a fellow profession with engineering and architecture in federal contracting and classification.

Several other important links which come to mind include the International Right-of-Way Association, the educators for

representation with the Department of Labor and the Department of Health, Education and Welfare.

ALL surveyors are benefitting from these activities, and most of these activities are being done with the aid of many devoted volunteers. ONLY a few surveyors out of many belong to ACSM. Most of us are riding along on the work and money of others. If all surveyors who belong to state surveying societies were to belong to ACSM, the ACSM dues could be reduced drastically, from the current \$173 yearly to \$60 or probably even \$45 per year. As it is many are benefitting but too few are paying.

This year ACSM/NSPS is trying a situation where the societies of New Jersey and Alaska have committed to pay ACSM dues for all of their members. This will be a reduced rate of \$60-\$70 per member. Since only one-third of each state society are ACSM members, ACSM will benefit even at this reduced rate. In addition, ACSM will have much more legislative clout with larger numbers of members.

Obviously, ACSM has made some mistakes. It did not respond promptly and correctly to reduced membership and reduced cash flows. ACSM needs to move out into a larger geographic area with smaller, more member-friendly conventions. It needs to inform all surveyors of what it is doing for their benefit. ACSM needs to review and restructure its dues and its services. I do not think the solution is to throw ACSM out, but rather to change it, improve it, and to all pay our share.



NSPS Foundation Bar-B-Q

Don'T miss ACSM's PREMIER
SOCIAL EVENT OF THE MILLENNIUM!

WHERE?
Little Rock, Arkansas

WHEN?
Monday, March 20, 2000, 6-10 PM

Join us at the NSPS Foundation's "Millennium Bar-B-Q",
the official social event of ACSM's Convention in Little Rock.

If you attended our Bar-B-Q at the Fort Worth, Texas, meeting, then you know what a treat is in store for you in Little Rock! Brisket, beef & pork ribs, sausage and more, prepared by the State Affiliate cook-off teams.

All proceeds go to Your Foundation. Come on out and have a great time! Supporting the NSPS Foundation supports your profession through scholarship programs, disaster and medical relief funds, and more.

See you at the Bar-B-Q!

The Bar-B-Q will be held at the "Little Rock River Market". The event will feature live entertainment, and the main meal course will be entries from the State Affiliate cook-off competition. Tickets for the event cost only \$40 apiece, which includes the meal, beer, wine, soft drinks, and side dishes.

WHAT A DEAL!

-BOD MEETING

(Continued from Page 6)

copy of "WDEQ Reduces Subdivision Application Requirements for the Greater Cheyenne Area Within Laramie County (October 1999)". It was also stated that there might be an attempt to modify the existing legislation during the 2000 Legislative Budget Session.

8. Lines & Points - Don Davis reported on the inclusion of a special advertising insert for the first issue of 2000 (the convention issue). Other matters were discussed but did not require any Board action.

h. Manual of Professional Practice - Chairman Oakley reported that the existing WACES manual was on disk and distributed to the committee for review and comments. Revision of the exhibits and comments are in progress. A draft of the new manual is anticipated to be prepared in time for presentation at the February 2000 WES convention/PLSW Annual Meeting. No Board action required.

i. Membership Committee - Motion by J.B. Jones/K.D. Jones, to accept the following applications for various membership categories: Member: Garry L. Davis; Gary Gronsid; Daniel B. Kennedy; Merwin Kehl; Russell D. Schamel; and Randy Stelzner; Associate Member: James Asher; John M. Hale; Terry M. Janssen; Arthur F. Schubert; Dan Starr; and Greg Zelazny. Motion approved.

j. Nominations & Elections Committee - Nominations for the 2000 election are:

1. President: Jeffrey B. Jones
2. Vice President: S. Dennis Dawson
3. Secretary/Treasurer: Herbert W. Stoughton

Motion by Lee/McMahon to accept the Nominations'

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Committee report. Motion approved.

k. P.L.S.W. Handbook Committee - Copies are printed and distributed to new members after each meeting.

l. Professional Awards Committee - Report is submitted at the Annual Meeting.

m. Public Relations Committee - Secretary/Treasurer Stoughton brought the newly published brochure. Each director received copies for distribution. A copy of the brochure will be mailed to the general membership in the May 2000 mailing.

n. S.O.S. Committee - The competition was conducted at the Fall Technical Session. Rick Hudson received the most votes, and was declared the winner of the competition. He will receive \$100 for his efforts.

During the review of the 2000 Budget, it was agreed that PLSW budget for a Second Place award (\$50.00) and Third Place award (\$25.00).

The ACSM/NSPS Map Competition was conducted, and winners in five categories were selected for submission. These are:

1. Miscellaneous Category: *Smith No. 1 & Smith No. 2 Pipelines*; John David Sayers; Steil Surveying Services, LLC.

2. Subdivision Category: *North Star Ranch*; Michael Shane Hansen; Steil Surveying Services, LLC.

3. ALTA Category: *Joannides Family Properties*; Michael Shane Hansen; Steil Surveying Services, LLC.

4. Boundary Category: *Record of Survey - Sections 22 & 24 & 34; T 16 N, R 67 W*; Larry T. Perry; Terrestrial Surveying Services.

5. Topographic Category: *Site Survey for Brad Graham*; John David Sayers; Steil Surveying Services, LLC.

These maps will be submitted to ACSM/NSPS for the national competition at the Annual Meeting in Little Rock, Arkansas.

Since there is no 2000 PLSW Fall Technical Session, the ACSM/NSPS Map Competition will be conducted at the November Board of Directors' meeting. The judges will be the attendees at that meeting.

o. Scholarship Committee - no report.

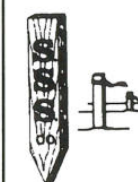
p. Standards, Ethics & Professional Practice Committee - Chairman Campbell reported: "Please be advised that as of this date (8 November 1999) there has not been any action items for this committee. Thank you.

q. Trig-Star Committee - no report.

10. Delegate Reports:

a. ACSM-NSPS Board of Governors - William Braman's report for the Fall 1999 meeting at Grand Rapids was submitted.

(Continued on Page 8)



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-BOD MEETING

(Continued from Page 7)

The entire report will be published in *Lines & Points*.

b. West Fed - Paul A. Reid's report of the latest meeting has been submitted to the editors of *Lines & Points*. He highlighted several items. The most critical was the NCEES model law for land surveying. No one seems to be able to obtain a copy of the version approved at the 1999 Annual Meeting of NCEES.

11. State Board of Registration for Professional Engineers and Professional Land Surveyors:

a. It was noted that the SBRPEPLS has published draft regulations for comment in a newsletter mailed recently. The deadline for comments is 31 December 1999. Although PLSW is not submitting comments as an organization, President Hudson recommended that each chapter submit comments and invited all PLSW members provide their comments to the SBRPEPLS. Since these proposed rules and regulations affect professional practice, each member should provide comments.

12. Old Business:

a. Big Sky 2000 Conference: Kevin D. Jones reported that a conference call scheduled in the previous week was being rescheduled. At this time (12 November), the registration fees for attendees and exhibitors have not been finalized.

b. Wyoming HARN: President Hudson reported that the HARN had been observed between 4 October and 4 November. WYDOT provided no support. It was noted that several volunteers were not contacted to assist in the observations.

c. WEB page: no report.

d. New Jersey P.L.S. G.I.S. video project - each chapter was assessed \$36.00 to pay fifty percent of the costs for receiving a "PLSW" copy of the film. The Central; South Central; Southwest; and Upper Platte Chapters have not paid their assessment. The Board of Directors directed that this matter be moved to the Treasurer business matters on future agendas.

e. Ad Hoc Committee regarding the PLSW Secretary/Treasurer position: The 1998 Nominations Committee requested

that the Board of Directors review the possibility of separating the two offices. The Ad-hoc committee of B. Braman, Hudson, and Stoughton (the last three individuals holding the office of PLSW Secretary/Treasurer, encompassing over twelve years) studied the matter, and concluded that, considering the size of the organization, the amount of effort expended could be handled by a single individual. Also, because of the size of PLSW and the inter-twining of the two offices to complete various activities, it would be a logistical nightmare to separate the functions. It was the conclusion of the Ad-hoc committee *not to recontinue* division of the positions of Secretary and Treasurer into two separate offices. Ad Hoc Committee was disbanded.

f. Surveyors' Hall of Fame for deceased surveyors (Southeast Chapter): no report.

g. Student Chapters (Southeast Chapter): no report.

h. GIS and digital maps: President Hudson stated that the previous report would stand.

i. Dain - Rauscher investment plan: The report was not received. Motion by K.D. Jones/Davis to table until the next meeting. Motion approved.

13. 2000 Budget: Treasurer Stoughton presented a draft budget document. The document was discussed and modified. Motion by Dawson/J.B. Jones to submit the modified document to the general membership at the 2000 Annual Meeting.

14. New Business:

a. The Board of Directors' meetings for 2000 are scheduled as:

1. 3 February 2000; Cheyenne; time and location to be announced at the PLSW Annual Meeting.

2. 20 May 2000; Rock Springs; 10:30 a.m. MDT; location to be determined.

3. 26 August 2000; Thermopolis; 10:30 a.m. MDT; location to be determined.

4. 11 November 2000; Casper; 10:30 a.m.; location to be determined.

b. GPS control data bases: John P. Lee led a discussion about interest in building and maintaining a non-Federal GPS data base for survey control established in Wyoming. The Board and guests discussed various pros and cons concerning matter. President Hudson appointed an Ad Hoc committee (John P. Lee and S. Dennis Dawson) to review the matter and hopefully present a report for the general membership at the PLSW Annual Meeting.

15. Announcements:

a. The Annual Meeting of the Professional Land Surveyors of Wyoming for 2000 will be conducted on Thursday, 3 February 2000 at the *Holiday Inn*, Cheyenne at 1:00 p.m. M.S.T.

b. The next meeting of the PLSW Board of Directors will be conducted on Thursday, 3 February 2000, at a location and time to be announced at the Annual Meeting.

c. John P. Lee reported that a discussion took place with some title people concerning the Record of Survey and its effect on matters. While no conclusive actions have taken place, it was reported that the informal, frank dialogue seemed to clarify some misunderstandings. More discussions are needed, but both groups were interested in resolving the matter, as the land surveyors are interested in introducing legislation.

16. Adjournment: The meeting was adjourned at 4:56 p.m. M.S.T.

Herbert W. Stoughton, Secretary/Treasurer



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WESTFED BOARD MEETING MINUTES

On September 25, 1999, 1 attended the Board of Director's meeting of the Western Federation of Professional Surveyors in Denver, Colorado.

Chairman Jim Dorsey called the meeting to order at 9:05 a.m.

The primary focus of the meeting was the installation of new officers, committee appointments and objectives of WFPS.

WFPS Treasurer Jerry Tippin was unable to attend the meeting but provided a written Profit and Loss Statement along with a Balance Sheet for the Federation for the fiscal year ending August 31, 1999. WFPS currently has \$125,446.45 cash on hand including three c.d.'s of which one in the amount of \$21,437.73 is restricted for the scholarship fund. The final accounting for the 1999 Conference was reported as a net profit of \$79,724.21. The net profit for WFPS was \$19,931.15.

The meeting was turned over to the new officers as follows: Chairman Bud Campbell (Alaska Delegate), Secretary Steve Parrish (Nevada Delegate) and Chairman Elect Chuck Paddock (Arizona Delegate).

Chairman Bud Campbell reported on his attendance to the Alberta Land Surveyors Association meeting in Canada. Bud cited many of the differences between the Canadian association and the professional organizations in the United States. Generally the Canadian association is fully autonomous, self-governing with the dues structure in the neighborhood of \$1,000+ a year. A 4-year degree in land surveying is also mandatory as a prerequisite to becoming a member to the association.

Review of committee reports and appointments was done by Chairman Bud Campbell.

Present and future role of WFPS was reiterated by Chairman Bud Campbell with his recitation of the Articles of Incorporation's Purposes and Powers of the Federation.

There was a considerable amount of discussion on the NCEE's Model Law, A.C.S.M., the establishment of a web site for WFPS and dissemination of information on WFPS meetings.

It was motioned and approved to send ACSM \$10,000 to assist in their financial crises. Additionally, as part of the motion, WFPS delegates are to go back to their respective state associations and inform them that WFPS will match up to \$500.00 for each state contribution to A.C.S.M.

It was motioned and approved to increase the WFPS scholarships to \$1,000 each. Also, as part of the motion, 10% of the profits from conferences is to go towards the scholarship fund.

Highlights of the State Reports are as follows:

Alaska has adopted regulations that all LSIT applications after 2003 will be required to have at least two years of college level education in surveying prior to taking the LSIT exam.

Arizona's 19th annual conference is scheduled for March 30th to April 1st at Little America in Flagstaff, Arizona. "Mandatory Voluntary Continuing Education" program is progressing well.

Colorado surveying activity continues at a brisk pace. Arthur W. Hipp, Executive Director for PLSC says it is a rare week when he does not receive a call from someone seeking to hire a surveyor. The increased activity is a mixed blessing because with the increased volume of work comes the inevitable increase in complaints. As presently structured the Colorado Board of

is a backlog of 5 to 6 years of unresolved issues. PLSC has volunteered to assist in any way possible to alleviate the situation but as of yet their offer has not been accepted. The NCEES proposed Model Law has been distributed to all Board Members for advance study and a position on it will be adopted. Colorado membership continues to increase. The 1999 Roster has 585 active members of all classes. There is a three-day Technical Program underway for December 2, 3 and 4h at the Colorado School of Mines in Golden, Colorado.

Montana and Idaho surveyors successfully found and rehabilitated the north corner common to the two states recently. This activity served to commemorate the 100-year anniversary of the initial establishment of the corner by the USGS in 1899.

Nevada Association of Land Surveyors joined the California Land Surveyors Association for its Annual Conference March 28 thru April 1, 1999 in Sparks, Nevada. Attendance was great, the programs were great and the scholarship auction raised in excess of \$20,000. Nevada continues to sponsor two individual scholarships in the amount of \$2,000 each and makes sizeable contributions to the 2 years surveying program in Las Vegas and the Fresno scholarship program. Legislation was passed requiring a 4-year surveying degree prior to examination. The legislation goes into effect on July 1, 2010 - IF- there is a 4-year program in place within the state on or before the 2006 school year. The 2-year program is in full operation now in Las Vegas and negotiations are vigorously proceeding to establish a 4 year program ASAP. Continuing efforts to increase association membership include complimentary one-year memberships for new Survey Intems and newly Licensed surveyors. Current membership is 445 with three active Chapters centrally located in Las Vegas, Elko and Reno, Nevada. Nevada's February 2000 Conference will again be shared with CLSA and hosted in Las Vegas.

New Mexico's Annual Convention 2000 will be held February 21, & 22 in the Albuquerque Convention Center.

Oregon has had a very busy legislative year for Oregon Surveyors. PLSO sponsored legislation (HB2866) to overcome a number of issues that affect how they deal with County surveyor review of maps. Oregon's annual conference is set for December 8, 9 and 10 in Eugene, Oregon.

Utah's year 2000 convention is to be held in Ogden, Utah on February 9th, 10th and 11th, 2000. It will be held at the Ogden Eccles Conference Center in Ogden, Utah. The Idaho, Nevada and Utah Associations of Surveyors is looking into combining for a tri-state conference to be held in Elko, Nevada in 2002. A considerable effort has gone into a project by the Utah Council of Land surveyors to remonument the Northwest Corner of the state. For several years the council has had a large granite monument stored waiting for the Bureau of Land Management to provide the location for its placement. This year the Executive Board set a goal to have the monument placed and dedicated. Through the help of the Idaho, Nevada and Utah associations and help of each states BLM offices, the location has been determined and a dedication date has been set for October 2nd 1999 at 1:00 p.m. at the site. You can read about the efforts on their web page at WWW.UCLS.ORG under the section of Foresights. The Utah Council of Surveyors are striving to advance

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ETHICAL DILEMMAS - HOW WILL YOU ACT?

It has often been said that one of the main elements that separates professionals from others is a focus on ethical issues. FIG recently completed revising its model code of ethics; the work being led by Commission 1 past-chairman Ken Allred. Those not familiar with the results can find them on the FIG web site.

Commission 1 Working Group 2 is currently investigating the area of business practices, including how the revised code of ethics can be applied to situations that surveyors encounter in their work. To help the working group develop its thinking, we are keen to stimulate debate around ethical issues. We have therefore prepared three ethical dilemmas on which we would like to hear your comments, whether by email, fax, or other means of communication. We will report the responses (anonymously) on the Commission 1 web site, in an attempt to broaden the debate further, and will summarise responses in forthcoming issues of the Commission 1 newsletter, before preparing a paper for the Prague Working Week.

The working group very much looks forward to receiving your comments!

Dilemma 1 - the client and the environment

Whilst undertaking a site survey for a private sector client, it becomes apparent to you that the client intends to ignore potentially serious environmental impacts of the development of the site. You reflect on your obligations to your client and to the community. What do you do?

Dilemma 2 - cross-cultural issues

As a partner in a firm of surveyors, you have successfully

won a tender for some work in a country where bribes are considered a normal part of doing business. In your own country, bribes are illegal (or, at the very least, not accepted practice). Will you use bribes to get the project completed successfully?

Dilemma 3 - commercial matters

You have successfully tendered for a survey. Other work means that you cannot complete by the required date, so you subcontract the work to another surveyor who only charges you a small fraction of the fee you have agreed with the client. What do you charge the client?

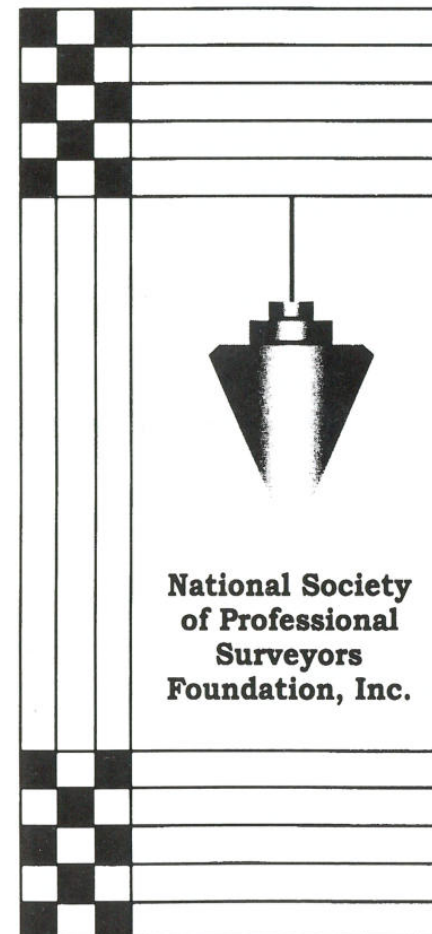
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Tracking Specifications:			
Tracking channels	40 L1 channels, 20 L1+L2 channels GPS/GLONASS (optional)		
Signals Tracked	L1/L2 C/A and P Code and Carrier		
Performance Specifications:			
Static/RapidStatic	3 mm+1 ppm (x baseline length) for dual frequency 5 mm+1 ppm (x base line length) for single frequency		
Horizontal			
Vertical	5 mm+1 ppm (x baseline length) for dual frequency 7 mm+1 ppm (x base line length) for single frequency		
Kinematic	10 mm+1.5 ppm (x baseline length) for dual frequency 15 mm+1.5 ppm (x base line length) for single frequency		
Horizontal			
Vertical	15 mm+1.5 ppm (x baseline length) for dual frequency 20 mm+1.5 ppm (x base line length) for single frequency		
Cold start	< 60 sec		
Warm start	< 10 sec		
Reacquisition	< 1 sec		
Physical Specifications:			
Dimensions (cm)	24.0 x 22.5 x 9.4 H (avg)	37.1 D x 12.6 H (avg)	22.5 x 20.5 x 3.5 H
Weight (kg)	1.7	3.1	0.7
Power Specifications:			
Battery	Internal & External	External	
External power input	6 to 28 Volts DC		
Power Consumption	3.0 Watt		
Environmental Specifications:			
Packaging	Weatherproof, high tech material enclosure, mechanically more stable than aluminum		
Storage Temperature	-40°C to +75°C		
Operating Temperature	-40°C to +55°C		
GPS Antenna Specifications:			
GPS Antenna	Internal	External	
Antenna Type	Microstrip (Zero-Centered)		
Ground Plane	Antenna on a flat ground plane	Antenna on a choke ring	Flat ground plane or choke ring
Radio Specifications:			
SpSp Radio Modem	Internal		
Type	Frequency hopping and direct spread spectrum		
Range	1 km without power amplifier, 10 km with one Watt amplifier		
SpSp radio antenna	Internal	External	
Antenna Type	1/2 wavelength equivalent	Whip or AntPole	
SpSp External Antenna	Whip or AntPole		
UHF Radio Modem	Internal or External	External	
Range	15 km with 35 Watt amplifier (may go up to 30 km under perfect condition of no obstruction)		
I/O:			
Communication Ports	4 serial (RS232), 1 high speed parallel port (500 Kbyte/sec)		
Other I/O signals	Two 1pps, two event marker, frequency output, frequency input		
Status indicator	Two 3-color LED's, two function keys (MINTER)		
Memory & Recording:			
Internal Memory	Up to 112 Mbytes		
Raw Data Recording	Up to 20 times per second		
Data Type	Code and carrier from L1 and L2 of GPS and GLONASS		
Data Outputs:			
Real time data formats	RTCM 104 version 2.2, messages 1,2,3,6,9,16		
ASCII Output	NMEA 0183 version 2.2		
Other Outputs	JPS Format		
Output Rate	Up to 20 times per second		
Technical Specifications:			
Multipath Rejection	Strobed Sequence Sampler		
In-band interference rejection	Up to 60 dB		
RTK	Solutions up to 20 times per second		

The New Kid on the Block...ISN'T

Hello! My name is Javad Ashjaee. I am the founder of Javad Positioning Systems (JPS), an engineer and former professor by profession. Field experience has taught me that innovations are not measured by fancy formulas and integrating sophisticated electronics and algorithms. They are measured by the smiles of the users in the field, the confidence and security they feel every time they turn on the instruments, and the ease with which they perform their tasks. With regard to this definition, we have a lot to offer in our new generation of products.

During my tenure in the GPS industry, I have been fortunate to deal with many aspects of the business ranging from inventions, detail technical designs, and writing complete receiver software, to founding a company and leading it to technical and financial success. My work has been concentrated on high precision applications of GPS, such as geodesy.

I have also worked extensively in the field. I will not forget collecting data at 2 a.m. in December on the sub-zero, snow-covered plains of Nebraska with the customer crew! Equally educational were the mid-noon August days in the Arizona deserts. Those were the days when limited GPS coverage would not give much choice for survey time. I enjoyed this hands-on experience as much as my laboratory and office work, and I learned a lot about harsh field operations and requirements.

With Javad Positioning Systems (JPS), I have been fortunate to assemble an impressive team of scientists, engineers, and GPS professionals. Our team includes several scientists, each with over 30 years of experience in this technology, who are authors of academic work on the subject as well. Our antenna team includes those that have pioneered many deep space probe antenna innovations. The hardware team includes experts who have designed advanced systems for space applications. Our software team authored several generations of GPS software during the past 15 years. A group of 20 mathematicians, geodesists and software engineers has been dedicated to create the most advanced post-processing system ever.

All of us have devoted the past three years to creating the next generation of high precision GPS instruments. These are technically and operationally superior to instruments now on the market and they cost less!

Javad Ashjaee

Our Communications Backbone

In order to speed up communications and provide a better service JPS utilizes the Internet to be our communications backbone. Whatever needs to be done can be achieved via the Internet.

What is GPS? For those new to GPS, its concepts, applications and technology JPS has a "Tutorial for High Precision GPS" section on our web Page - plus Links to other source material.

About JPS A section on the Web covers JPS press release and information specific to JPS and its philosophies.

Competitors JPS provides links to our competitors Web pages in order to make the task of product selection much easier, check out our product specifications against the competition (using our Product Selection guide).

Configurations Our Products page is laid out so that potential GPS purchasers can look at our products from three standpoints - **Products, Applications and Components View.**



Dealer Network We have listed our Worldwide Dealer Network on the web - they can either be found by using the World Map or scrolling through text information, followed by email on-line.

Place PO Once the web has been 'searched' for configurations and competitive information a fully priced Purchase Order can be placed on-line, followed by a PO confirmation number.

Artwork In order to simplify the procedure for any user who needs photography of JPS products we have a "Picture Gallery" section.

Tech Support The Support Page on the web provides all users with the capability of downloading files (all JPS manuals are available here), obtaining software upgrades, reviewing the "How To" section, subscribe to the JPS News Page and a section covering simple typical Questions and Answers. Within the support section users can ask questions and transmit by email while on-line or by using email off-line. These questions can be about "support" in general to support@javad.com or to more specific technical issues at hardware@javad.com, rtk@javad.com, pinnacle@javad.com, pc-cdu@javad.com, face@javad.com. The status of all orders can be checked at shipments@javad.com.

Make the Best DataBase (Fast Geodesy for GIS)

Geographic Information Systems (GIS), like other databases, should be designed for wide scope of usage and with long term goals. You can't possibly know all of the questions you may ever need to ask of a database in the future.

For example, when a telephone company records the locations of its junction boxes in GIS, its immediate need may be for the crew to find them quickly - even a few meters of accuracy is more than enough.

But the future always arrives faster than expected. When it is time to widen the road, the information in the database won't be accurate enough to tell what will happen to the junction boxes and all the other assets on that road.

The solution is to create GIS databases with the best accuracy that is feasible at the time. Feasible is the key word. Everyone agrees that centimeter accuracy is better than one to five meters, but not if it takes an hour and expensive equipment to obtain such high accuracy at each point.

Now what if the Phone Company discovers that the cost of centimeter accuracy is the same as one to five meters accuracy? In creating a GIS database, the total cost of getting to points costs much more than the equipment price. Field operator, vehicle, and support systems can add up to over \$250,000 per year. Based on JPS innovations, the most accurate equipment costs only few thousand dollars more than the least accurate now available. And, our high precision equipment will solve your problems for years to come!

Furthermore, with JPS dual frequency instruments you can survey the points faster, which quickly pays back for the price difference. Cost-per-point for centimeter accuracy, using the right equipment, may be even less than for one to five meters.

With JPS innovations in quick, accurate and cost-effective equipment, GIS has truly become Fast Geodesy!

Real-Time Kinematic (RTK) System

We offer robust and reliable RTK solutions with On-The-Fly (OTF) ambiguity resolution up to 20 times per second. It has the following advantages:

- The cleanest GPS data free from multipath based on the most advanced antenna and signal processing techniques.
- Co-Op tracking that virtually eliminates any possibility of undetected cycle slips. Cycle slips are detected and repaired instantly.
- Precise and efficient algorithms for finding float and fixed ambiguities and computing the results.

The most reliable RTK results can be obtained by using dual frequency GPS+GLONASS systems. Resolving ambiguity is much easier with dual frequency data even for very short baselines. The combination of GPS and GLONASS satellites always provides enough satellites for fast and reliable results.

INMARSAT- and WAAS-Ready

Wide Area Augmentation Systems (WAAS) is under development to broadcast GPS corrections and integrity messages in wide areas. All of our receivers are hardware-ready to accept such signals and messages, as well as all GPS-related signals and messages from INMARSAT satellites.

Less Than 3W Power Consumption

We have used the state of the art, the most power efficient electronic technology and integrated circuits resulting in less than 3 Watts of power consumption with our 20 channel dual frequency GPS/GLONASS receiver.

Waterproof and Elegant Packaging

All our receivers are packaged in water proof and high tech housings that are light yet can withstand the harshest of field environments.

GLONASS Option

Much has been reported on the advantages of complimenting GPS with GLONASS. It substantially improves the speed, reliability and accuracy of the results. Ashtech Web site includes good details on this topic.

All of our receivers have the option of including GLONASS. All the innovations reported on this Website on GPS, applies to the GLONASS option too. In fact in all innovations when we say GPS, we mean GPS/GLONASS. Since each channel in our receivers can independently be assigned to GPS or GLONASS, we can assign our 40 universal channels to track the L1 and L2 signals from 20 GPS and GLONASS satellites. Since at any given time there will be at most 20 GPS/GLONASS satellites visible, our receivers are the only "GPS/GLONASS All-in-View" receivers available today.

How Do You Contact JPS



Javad Positioning Systems

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San Jose

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pccdu@javad.com

hcdcu@javad.com

support@javad.com

face@javad.com

E-mail - regarding sales

sales@javad.com

E-mail - regarding orders

shipments@javad.com

E-mail - general information

info@javad.com

Send data files for analysis

<ftp://ftp.javad.com/pub/incoming>

High Dynamic, Shock and Vibration

We have achieved about 10 dB improvement in tracking high dynamics due to Co-Op tracking in which the dynamic of the receiver is tracked with the strength of all satellites combined in a third order tracking loop with a 20 Hz bandwidth. The limitation on tracking high dynamic is now strictly limited to the survival of the equipment package when subjected to severe dynamics.

Type and Quality of Measurements

A good geodetic quality receiver should be able to deliver code and carrier phase measurements from both L1 and L2 signals. The number of satellites tracked also plays a major role in obtaining fast and reliable results. Having information from at least 9 satellites, combined with a good low multipath antenna guarantees almost instantaneous geodetic quality results.

In our receivers we deliver all the code and carrier measurements from all GPS and GLONASS satellites. We can track up to 20 satellites simultaneously. Due to our Co-Op tracking, which narrows the bandwidth of all satellite tracking loops to 1 or 2 Hz, we have about 10 dB improvement in reducing the noise level of measured data and provide the best data that is available in the market today.

We track, record and use C/A and P codes and carrier phases from all satellites. Also, in anticipation of possible availability of C/A code on L2 in future, we have already included C/A code on all of our L2 channels.

Real-Time Detection and Correction of Cycle Slips

High precision results in GPS positioning is achieved by using the carrier phases of GPS signals. This involves solving for a quantity called the initial integer carrier cycle. This task is somewhat time consuming and if this number is not computed correctly, substantial position error can result. Furthermore, after each temporary loss of lock to a satellite, this number must be recalculated.

One of the advantages of our Co-Op tracking is that it removes any possibility of erroneous calculation of the integer cycles after temporary losses of tracking and virtually eliminates the possibility of errors due to cycle slips.

High Quality Reference Frequency Generator

The local oscillator in our receivers can optionally be locked to the GPS timing system. This prevents drifts in the data that are generated by local frequency offset. The locked frequency is also available as an output signal of 20 MHz that has long term stability of the cluster of cesium clocks maintained by the GPS Control Segment. Furthermore, since tracking of the oscillator is achieved through Co-Op tracking, the corrected output frequency has much better stability and noise compared to conventional methods.

External Frequency Input

All of our receivers accept external 5, 10 and 20 MHz frequencies to be used as the main oscillator of the receiver. This option is sometimes used in monitoring and reference stations.

Event Marker (Photogrammetry)

All of our receivers have the option of two separate event marker input that can measure the time of the external event with the accuracy of 25 nanoseconds.

1-PPS and Programmable Timing Signals

All of our receivers have the option of two timing signals whose period or event can be programmed by the user. The signals may have the offsets of up to 25 nanoseconds, which will be common in all receivers. Such offsets, however, are known with the accuracy of better than one nanosecond and can be reported.

High Output Rate

All of our receivers can provide complete raw data and position results up to 20 times per second. This is true even when the maximum of available GPS and GLONASS satellites are tracked.

Our parallel port with data transfer rate of half of megabyte per second reduces the data transfer latency. It also substantially reduces the download time of the collected data. Output faster than 10 Hz is via parallel port only.

Integrated GPS-Aided Spread Spectrum Radio Modems (Direct and Frequency Hopping)

Two types of spread spectrum radios are popular: Direct and Frequency Hopping. Direct Spread Spectrum typically performs better but is more susceptible to interference and jamming. We have eliminated the interference and jamming problem by the suppression techniques integrated in our Paradigm® chip.

In the Direct spread spectrum technique we not only lock to the direct signal, but also to the reflected signal (multipath) and we use all to determine the transmitted data. Here we benefit from radio multipath signals. This technique is not possible with frequency hopping.

There may exist conditions that Frequency Hopping may have advantages still. In our integrated spread spectrum radio modem we have integrated high-speed versions of both techniques. Our Frequency Hopping Spread Spectrum radio has the speed of up to 64Kbit/second and the Direct Spread Spectrum radio has the speed of up to 32Kbit/second.

The tight integration with GPS timing has resulted in a more robust synchronization and a reliable communication system. One advantage of this GPS-aided time synchronization is that we can lower the baud rate as much as we need to increase the transmission range and reliability and faster initial connection.

The user may select to transmit and receive through either one of Frequency Hopping or direct Spread Spectrum radio or simultaneously use both for maximum reliability.

All the signal processing section of our spread spectrum radio transceivers are integrated in our Paradigm® chip, resulting in a compact system with low power consumption and increased reliability.

A specially designed spread spectrum antenna is integrated inside two of our systems (Odyssey and Regency) along with the GPS antenna. All of our systems also accept external antennae for radio modem and GPS. When an external antenna is connected, the internal antenna is automatically deactivated.

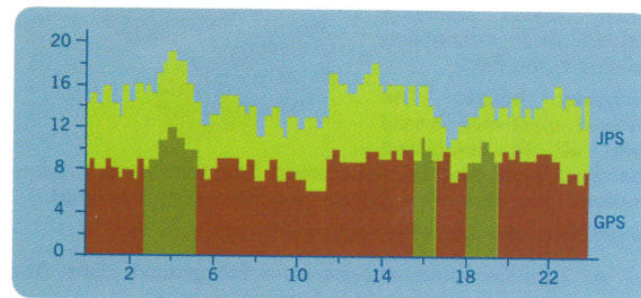
Integrated UHF Radio Modem

In cooperation with Pacific Crest Corporation, we have integrated their newest UHF radio modem receivers in a module that is inserted in Odyssey. This UHF radio has certifications in many countries. Their standard packages, as well as any other radio modem, can also be used with all of our GPS systems.

JPS Has More GPS Satellites

RTK needs 10 Dual Frequency Satellites

Reliable and instant RTK needs at least 10 dual frequency satellites. A GPS constellation of 27 satellites rarely provides 10 visible satellites. The green area shown in the diagram below is an example. Imagine what happens when you have sky blockage too.



More Dual Frequency Satellites

We treat the **GLONASS satellites as GPS** and use them in combination with other GPS satellites. The 'JPS' constellation of "GPS" satellites always has more than 12 visible satellites. The white area in the diagram illustrates this fact. GLONASS satellites do not suffer from **SA** and **AS**, the intentional degradations of GPS by the US DoD.

Technology Years Ahead

Our unique technical advantages include advanced multipath reduction, dual depth choke ring, in-band interference rejection, Co-Op tracking and other features not provided by other manufacturers.

L1 is Half of a Satellite

When you use only the L1 frequency of a satellite, you benefit from only half of that satellite's data. However, what you miss is really more than half. You miss productivity and reliability by a factor of at least 4, even if the L1 receiver is offered to you at no cost. Even with very short baselines dual frequency gives you much faster and more robust results.

A Lot of Money Free

Every satellite costs over 100 million dollars to build and 100 million dollars to launch and maintain. Access to their data is free. If your receiver misses any satellites you are missing valuable signals that a JPS receiver can convert to profit for your business and use to provide more accurate, more reliable and faster results for your projects.

Cinderella Saves You

We do offer L1 only receivers - however, we offer them with the **Cinderella** option, which turns your GPS (currently 27 satellites) single frequency to GPS/GLONASS (currently 51 satellites) dual-frequency **every other Tuesday for 24 hours**. You can then see the advantages of L1+L2 and the benefits of more satellites in your actual jobs. Then, when you are convinced of the benefits you can permanently activate all features by entering the passwords that we give you. Our 20-channel GPS L1 system with zero-centered precision antenna (2 Legacy, 2 LegAnt and Pinnacle) starts at **\$11,900** for a complete system.

The World is not perfect!

Most GPS equipment works beautifully, unless observation conditions are not ideal. You might have seen specifications such as: "99.9% reliability for achieving 2 ppm accuracy in less than one minute", which is later qualified by:

"All real-time survey performance criteria are a function of the number of satellites visible, obstructions, baseline length, multipath, reference station position accuracy and environmental effects."

Or statements such as:

"FastStatic accuracy is a function of occupation time and observation conditions."

Of course, the real world is less than perfect 99.9% of the time.

Even more problematical, GPS errors that are a result of unfavorable conditions may be hard to detect. In old style geodesy, surveyors used to calibrate their instruments. With GPS, you cannot calibrate your instrument. Even if you could is it possible to calibrate it under favorable and then use it under unfavorable conditions?

The result is that performance specifications remain unchallenged and very difficult to compare. It may be next to impossible to predict or even detect unfavorable conditions until it is too late. Therefore, we must be able to obtain good results in unfavorable conditions. The receiver specifications must include information about how it copes with unfavorable conditions.

Environmental Effect 1: Interference

This effect is caused by signals from other radio frequency sources. It can mask GPS signals totally, or reduce their apparent strength (that is, reduce the signal to noise ratio by adding noise). Interference can cause a perfectly functioning receiver to stop working completely.

In a less severe interference, this effect can cause frequent losses of lock and cycle slips that may render the results useless. The least effect of interference is increasing noise and degrading the accuracy slightly.

With rapid expansion of satellite communications, interference is no longer limited to urban areas. You may see the presence of interfering signals by frequent losses of lock and lower signal to noise numbers displayed by the receiver.

JPS equipment solves this problem with superior interference protection by detecting and elimination or suppression interfering signals. JPS receivers also track under lower signal to noise conditions, whether they are caused by extra noise interference or by low signal strength (e.g.: under foliage and canopies). Details are discussed in the following articles:

Environmental Effect 2: Multipath

Multipath can ruin your day! It is worse than interference in the sense that interference mostly disrupts tracking and you will get no results. On the other hand multipath will give you wrong results without you knowing it. Because of this, some people deny its existence.

If a GPS receiver does not have enough protection against multipath and the manufacturer claims 2 ppm accuracy in less than one minute with 99.9% reliability, then the reliability can easily go down to 0% in the presence of multipath. Those receivers that don't have effective signal processing multipath mitigation technique can have errors in excess of 10 meters in differential mode (DGPS). This is typical of all low cost receivers.



Environmental Effect 3: Ionosphere

The ionosphere is a shell of electrons and electrically charged atoms and molecules that surrounds the earth. GPS signals, like any electromagnetic signal propagating through an ionized medium, are affected by the non-linear dispersion characteristics of this medium causing range errors. The ionospheric range errors may vary from less than 5 meters to more than 150 meters depending on the solar activity, the time of the day, and other factors.

The ionosphere, in the absence of selective availability (SA), can be the greatest source of range error for GPS users. Dual frequency can completely remedy the effects of ionosphere by making measurements on two widely spaced frequencies and combining them.

Tracking the L2 signal is more difficult for civilians because the code on L2 is not available for public use (so called Anti-Spoof or AS). GPS manufacturers have devised techniques to track the L2 signal without the knowledge of this code. Some of these techniques may not work well when the activities of ionosphere exceed some limits. The activity of ionosphere has an 11-year cycle and is more apparent in equator regions.

We have achieved 10-fold improvement in GPS L2 Tracking under AS. Our innovations substantially reduce the need for having code on second frequency.

Environmental Effect 4: Impact on Radios

The environment has a large impact on radios. Fading, interference and multipath are some examples. A common complaint of RTK users is the need for a reliable radio that is easy to install and operate. We have made significant improvements for radios for RTK systems:

These improvements are based around the Paradigm® Chip which includes 6 separate high data rate spread spectrum communication channels that operate both in frequency hopping (64 Kbit/second) and direct spread spectrum (32 Kbit/second.) Furthermore, our spread spectrum communication technique has perfect time synchronization using tight integration with GPS timing (patent pending).

Impact on Your Wallet

The electronic industry is probably the only industry that has made substantial improvement in performance and at the same time reduced the cost. Personal computer is a fascinating example.

Keeping up with this trend, and benefiting from the state of the art developments in electronic and integrated circuit technology we have achieved the advancements described earlier and at the same time reduced the cost by half.

Another result of our state-of-the-art technology is reduction in power consumption. Our receiver consisting of 20 channels of dual frequency GPS and GLONASS and additional radio receiver consumes less than 3 Watts of power.

JPS Receivers

Odyssey

Odyssey is a fully integrated GPS receiver. With all the components in one compact package, the user doesn't need to worry about annoying cables and connection failures in the field.

Odyssey houses The Wheel electronic board with all its associated features, which also include Spread Spectrum radio modem receiver and transmitter (Direct and Frequency Hopping).

In addition, the following components are built in:

- Zero-Centered antenna on a flat ground plane (the same construction as in LegAnt antenna).
- Half-wavelength Spread spectrum radio antenna.
- Removable UHF radio receiver module.
- Removable Lithium Ion battery module.
- Detachable CDU-1.

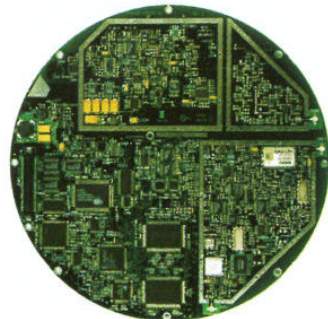
Made out of a high quality, high strength, lightweight, UV stable material, Odyssey is extremely durable and rugged. The fully weatherproof and shock resistant enclosure is designed for the harsh field environment. It is ergonomically designed for the user's ease of operation and comfort.

Odyssey is equipped with two trays to accept the Lithium Ion battery and the UHF radio receiver modules. Both trays may also be used for batteries, which are sufficient for 14 hours of continuous operation. In addition, an external power input connector is available. The selection among the different power sources is done by the microprocessor or the user can pick amongst different battery selection scenarios and priorities.

The Wheel supports MINTER (Minimum INTERface) and the 9-conductor I/O that is used in all of our receivers. MINTER has two LED's and two function keys that provide receiver operation and data recording status to the user. The optional detachable controller (CDU-1) is wireless and can perform all receiver commands and controls as well as simple data entry.

CDU-1

CDU-1 controller and data collector can be used with Odyssey, Regency, and Legacy receivers. The one hand operation design can access all receiver commands and controls and can perform simple data entry such as site name, antenna height, meteorological data and more.



combination of our Co-Op tracking, adding all the available signals weighted by their strength, and using the resultant signal as the basis for tracking decisions. Since we do not feed any signal from one frequency to the other, we can track the code and the carrier of each of the L1 and L2 signals independently. With our technique we have also improved the effective signal-to-noise and reduced the probability of cycle slips by a factor of 10.

GPS officials have also been investigating the options of adding C/A code on L2 or adding a third frequency for civilian applications.

Our technique provides the highest performance level required for all precision applications at costs comparable to single frequency receivers. It also does not compromise or interfere with the stated security objectives of AS. These substantially reduce the need for any costly and risky addition or modification to the existing GPS signal structure. However, in anticipation of possible availability of C/A code on L2 in future, we have already included C/A code on all of our L2 channels.

Multipath Reduction with Signal Processing

As it is known from the multipath theory, the two techniques of mitigating multipath by choke ring antenna and by signal processing are two complimentary techniques and one cannot substitute for the other.

Choke ring antenna can mitigate multipath signals reflected from objects below the antenna. It has no effect on multipath signals reflected to the antenna from objects above the antenna (e.g. tall buildings or trees).

Signal processing techniques to mitigate the effect of multipath have little effect when the multipath distance (the difference in distance between the direct signal and the reflected signal) is less than few meters, irrespective of whether the reflected signal comes from objects above or below the antenna.

Fortunately most of the reflected signals from objects above the antenna (that cannot be mitigated by choke ring) have multipath distances of more than several meters which can be mitigated by signal processing techniques.

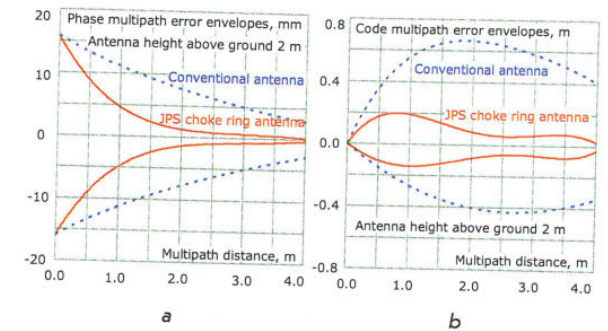
The new technique of multipath rejection employed in our receivers (patent pending) has a simpler hardware approach with improved performance over all that existed before. It also removes any possibility of false lock points that existed in some of the earlier techniques. The false lock points could occasionally introduce substantial error when a strong multipath distance is in the range of 30 to 300 meters. Figures below show the comparison with other techniques for multipath relative amplitude 0.5.

Instantaneous Re-acquisition

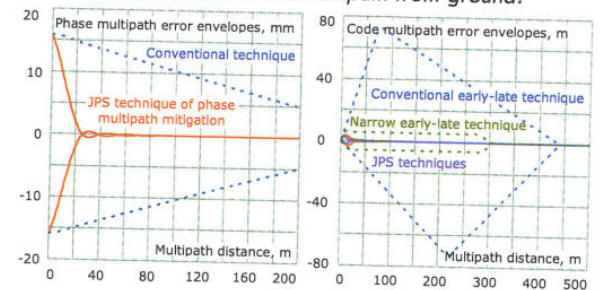
Due to Co-Op tracking, re-locking to satellites that were locked is almost instantaneous, irrespective of the loss of lock period. However if the loss of lock happens for a short period of time (few seconds), then the re-locking occurs without any cycle slip.

Fast Initial Acquisition and Re-acquisition

Every one of the forty channels in our Paradigm® chip contains four correlators. During the initial search and acquisition of satellite signals, each correlator in each channel can separately act as a channel to search for satellites. Therefore, in every millisecond we can search for satellite energy in 160 C/A code chips. This is up to 13 times faster than any existing 12-channel receiver in the market today.



Comparison of multipath error envelopes of JPS choke ring and conventional antenna (Minimum of Down/Up=-15 dB), (a) for phase and (b) code. Multipath from ground.



Comparison of multipath error envelopes of JPS techniques of multipath mitigation and other techniques, (a) for phase and (b) code. Multipath from objects above the antenna.

The Co-Op tracking additionally helps the initial search of low signal satellites. Furthermore, we have devised improved algorithms for satellite "symbol synchronization" and "energy search".

The combination of the above results in the most sophisticated initial acquisition and re-acquisition technique.

Acquisition and Tracking under Very Low Signal/Noise Ratio

For acquisition of satellite signals under very low signal/noise condition, we use an algorithm that improves such acquisitions by a factor of 10. It is based on much longer energy integration time at acquisition when signal synchronization is not yet achieved.

During tracking, in addition to Co-Op tracking, we have sophisticated algorithms to track satellites with weak signals. The combination of the two provides more than 10-dB improvement on tracking of low signals (typical of low satellites or tracking under canopy). This technique also improves tracking of satellites under presence of interference/jamming, in addition to the interference suppression technique discussed earlier.



amplifier. With zero-power interference and with disconnected suppression system, the receiver tracked 8-10 satellites. Then, after smooth increasing interference power, the number of tracked satellites decreased. After that, interference power increased up to the value when the receiver lost lock on all satellites. Finally, being switched on the suppression system resulted in receiver's lock on 7-9 satellites.

To our knowledge no commercially available GPS receiver includes any in-band interference/jamming suppression system.

Co-Op® Tracking

Locking to satellites, tracking them and taking accurate measurements are the main function of a receiver. The merits that distinguishes a receiver from others is how well it can track satellites under all environmental conditions and dynamics, and the type and quality of measured data.

Tracking satellites in an open field with no interfering signal and no partial obstruction is not much of a challenge. The challenge comes when there are interfering signals that partially mask satellite signals or there are partial blockage that reduces the amount of signal energy that reaches the receiver.

The problem is that more interfering signals appear every day from new communication systems. The interfering signals also appear from power lines, radar systems and equipment operated by police cars and ambulances. More each day applications of GPS receivers expand to include urban areas where the GPS receiver is subject to more of such interference and partial obstructions.

In tracking satellite's carrier signals we have to track three main dynamics:

1. dynamic due to the motion of the satellite,
2. dynamic related to the motion of the receiver,
3. dynamic related to the oscillator (clock) of the receiver.

The motion of the satellite is the most smooth compared to the other two. It can be predicted with the accuracy of few meters per day. Even if we don't track the satellite for an hour and only rely on prediction, we will not be off by more than one meter.

The motion of the receiver is unpredictable. The behavior of the clock of the receiver can also be unpredictable and abrupt, especially when it is subjected to shock, vibration, and temperature changes. The change in the behavior of the receiver clock happens even when the receiver is not moving and, for example, it is sitting on a survey point.

All of the above three dynamics add together and result in a relative dynamic between the receiver and the satellite. And it is this total dynamic that the receiver must track.

There is a direct relationship between the ability to track a satellite and its signal strength. Consider the following analogy: You can easily observe a bright star in a clear night. If the brightness of the star decreases and starts to move randomly (forgive the moving star) you may have difficulty tracking it. Imagine that you are observing a weak star with a binocular. You may have no difficulty tracking its smooth motion. Now imagine you are following the same star with a binocular but this time you are sitting in a four-wheel drive driven by a teenager in a bumpy road. Now you must track not only the motion of the star but also the motion of the car. If some imaginary instrument could track the motion of the car and compensate for it, you again will have no problem to follow the smooth motion of the star, even if the star becomes dimmer or if you drive under a tree which partially blocks your view. Even if you momentarily lose it you can quickly find it again when the

obstruction disappears because you can predict the smooth motion of the star.

The concept of Co-Op tracking is to track the carrier dynamics of the receiver (and its oscillator) separate from tracking the carrier of each individual satellite. To track the dynamics of the receiver (and its oscillator) we combine the strength of all satellites together. Knowing this, we compensate for the dynamics of the receiver and its oscillator and then we track the carrier of each satellite separately based on the signal strength of the satellite. By this revolutionary technique (patent pending) we put ourselves back to the case of observing stars on a stable ground. We can track satellites even under heavy foliage. The more satellites we track the more signals we have to add together and track the dynamics of the receiver and its clock. The satellites "cooperate" together to perform this difficult task. Then we need the strength of each satellite separately to track only its own smooth and highly predictable motion.

The power of Co-Op tracking is not only in tracking low signal satellites (e.g. under foliage or low elevation angles) but also under high dynamic and interfering signals (that effectively reduce signal-to-noise ratio). In summary with Co-Op tracking we achieve the following advantages:

- The satellites can be tracked with much less signal strength.
- The satellites can be tracked in the presence of interfering signals. This advantage is separate from and in addition to the hardware interference suppressors that we discussed in In-Band Interference/Jamming Suppression section. The combination of the two provides much stronger protection.
- Cycle slips will not occur unless many satellites are obstructed simultaneously. This is because the dynamic of the receiver and the oscillator that are the main source of cycle slips are tracked with the combination of all satellite signals. This is particularly important for tracking of GPS L2 signal in the presence of Anti Spoof (AS).
- Satellites can be re-acquired almost instantaneously (few milliseconds) when some are temporarily blocked.
- The quality of measured data has up to 10-dB improvement due to much narrower tracking loops of individual carrier of satellites (2 Hz vs. 20 Hz).
- The initial acquisition of low signal satellites is faster because the dynamic of the receiver and the oscillator is isolated from the task of acquiring and tracking satellites.

GPS L2 Tracking

GPS L1 signal is modulated by C/A and P codes, while L2 is modulated only by P. In the so called Anti Spoof (AS) mode, the P codes of both L1 and L2 signals are scrambled for security reasons and not available to civilians. In AS mode, which is the current mode of GPS operation, the L1 signal can still be tracked via its C/A code, but since there is no C/A code on L2, it cannot be tracked with conventional code-tracking techniques.

Since high precision applications of GPS require access to the carrier of the L2 signal, GPS manufacturers devised techniques to track the carrier of L2 in AS mode.

We have developed a new technique for tracking the GPS L2 signal that has many advantages over all earlier techniques. This technique (patent pending) is a

CDU-1 is designed to directly attach to the Odyssey (docking system). Communication between the receiver and the CDU-1 is wireless while the option for communicating through the serial ports is still available.

Communication between CDU-1 and Regency or Legacy is done through the serial ports via a cable connection.

Other features include:

- 4 line by 20 characters display.
- One-handed operation keypad (7 keys).
- Removable PCMCIA card slot (4 to 96 megabytes memory cards available). Data can be recorded directly on the card. If desired, recorded data from the receiver's internal memory can also be transferred to the PCMCIA card in the CDU-1.
- Voice generation and recording interface (64 voice segments can be recorded for a total recorded length of 240 seconds).
- Infra-red for cordless connection with Odyssey.
- Operates on one AA size battery.

Regency

Regency is the first integrated GPS and choke ring antenna. It houses The Wheel electronic board with all its associated features, which also include Spread Spectrum radio modem receiver and transmitter



(Direct and Frequency Hopping). In addition, the following components are built in:

- Zero-Centered antenna on a single-depth (Regency-1) or dual-depth (Regency-2) choke ring. It has the same construction as RegAnt.
- Half-wavelength Spread spectrum radio antenna.

Made out of a high quality, high strength, lightweight, UV stable material, Regency is extremely durable and rugged. The fully waterproof and shock resistant enclosure is designed for the harsh field environment. It also has three anchor points for securing the unit on permanent observation points.

Legacy

Legacy has no antenna integrated inside. It houses The Wheel electronic board and associated features, which also include Spread Spectrum radio modem receiver and transmitter (Direct and Frequency Hopping). The housing is made out of a high quality, high strength, lightweight, UV stable material that makes Legacy extremely durable and rugged. The fully waterproof and shock resistant enclosure is designed for the harsh field environment.



Legacy gives you the flexibility to use LegAnt, RegAnt or any other antenna. The cable connecting the Legacy to the GPS antenna can be up to 100 feet long. For longer lengths, one line amplifier should be used for every additional 100 feet.

The internal spread spectrum radio in the Legacy requires an external antenna. The optional 1-watt amplifier for the spread spectrum radio is also external.

JPS Antennae

GPS Antenna with High Phase Center Stability (Zero-Centered®)

The "electrical center" of a GPS antenna is the point whose location we compute. To determine the coordinates of a point we must co-locate this center with that point by positioning the "physical center" of the antenna exactly above the point and measuring the vertical offset. This offset will then be used when calculating the coordinates of the point. It is assumed that the "physical center" of the antenna is at the same location as its electrical (phase) center. This is only true in antennas designed for precision use. The phase center of a typical antenna can change by many centimeters as the positions of the satellites change. "Phase center stability" is the main characteristic for precision applications.

We have achieved phase center stability by having four feed points for the antenna, we believe this is the minimum required for an antenna to have stable phase center.

A Zero-Centered antenna is not broad band. It accepts only GPS and GLONASS signals on L1 and L2 rejecting all others in between. A broadband antenna allows the unwanted signals to enter the system and increase the noise level.

Another important characteristic of a GPS antenna is its ability to reject the signals that are reflected from underneath the antenna. Such reflected signals can introduce centimeters of error when using carrier phase and meters of error for code phase. This characteristic (**multipath rejection**) requires the antenna to be mounted on a **choke ring** ground plane. Mounting the antenna on a **flat** ground plane results in a smaller/lighter package, but with less rejection capability.

Our particular choke ring design also improves the phase center stability of the antenna.

An antenna, called "Micro-centered", has been reported to have similar phase center stability as a choke ring. We reviewed the US Patent Number 5,694,136, presumably covering that technology. Our simulation shows that the multipath rejection capability of this antenna is only 5 dB better than a conventional flat ground plane. In our simulations, this antenna has a Down/Up ratio (the ratio of antenna gain in any angle below the horizon to the gain in the same angle above the horizon) of about -18 dB. The **smaller** the down/up ratio, the **better** the multipath rejection capability. While the JPL choke ring has a ratio of -28 dB the JPS choke ring has -40 dB.

The reported technology has no effect on improving the phase center stability of the antenna. The negative effect of the reported technology is that it causes 10% power loss which, according to our estimate, results in additional 30 to 60 degrees error in code and carrier phase measurement due to thermal noise.

The GPS antenna should also reject all signals that are outside the GPS band, "out of band". To further improve this capability, the amplifier section of the antenna (LNA) should have good and separate filters for each of the L1 and L2 bands. The LNA of our antenna contains a separate ceramic filter for each of L1 and L2 frequencies and has noise figure of about 1 dB. It can operate with any voltage from 3 to 10 volts. GLONASS option is available on all of our antennae.

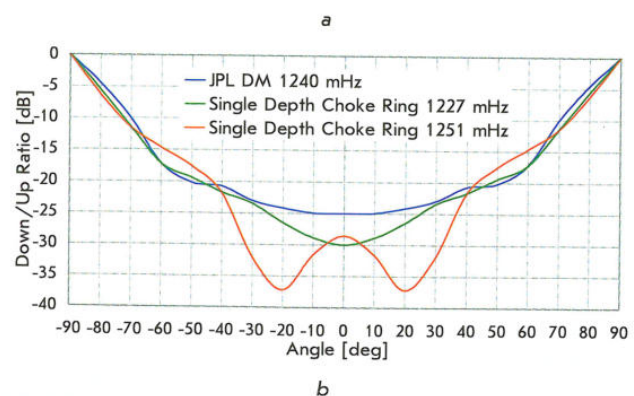
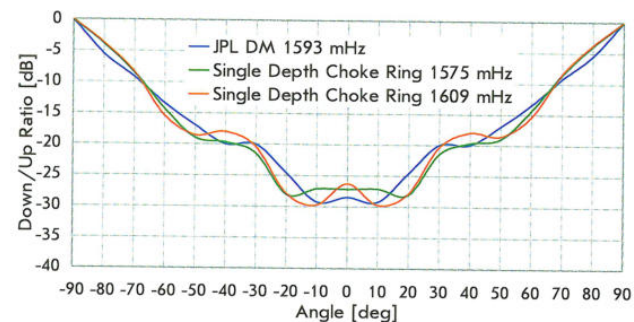
Single-Depth Low-Multipath Choke Ring

Multipath is a limiting factor in obtaining high precision results with GPS. Signal processing techniques can mitigate this effect provided that the multipath distance (difference between the direct and the indirect path) is more than 10 meters. For an antenna is mounted less than 2 meters above ground (typical for geodesy) the multipath distance is at most 4 meters and signal-processing techniques cannot fully mitigate this. Fortunately, choke ring ground planes can.

Jet Propulsion Laboratory (JPL) introduced a design of choke ring that is in popular use today. After analysis of the literature, we determined that the principle design for this was based on the direct application of conical choke ring theory to flat choke rings.

A constraint in this is that the depth of grooves must be slightly larger than a quarter of the wavelength to avoid generation of yet another surface wave. In our research we decided that this constraint theoretically applies to choke rings with infinite diameter. We were able to block the generation of this additional wave in our design. After many months of simulations, we found that the optimum result happens when the grooves depths are slightly less than a quarter of the wavelength and the diameter is about 6 centimeters less than the JPL choke ring. Yet with these smaller dimensions the multipath rejection for L2 is about 10 dB better than the JPL choke ring while for L1 the performance is the same.

In the figure below, the blue line represents the down/up ratio for the JPL choke ring antenna while green and red lines represent the same quantity for our choke ring, (a) is for L1 frequency and (b) for L2.



The reason why the performance of the choke rings are better for L2 than for L1 is that the choke rings can be designed only for one frequency. If a choke ring is designed for L1 then it has no effect for L2, while if it is designed for L2 then it has some benefits for L1.

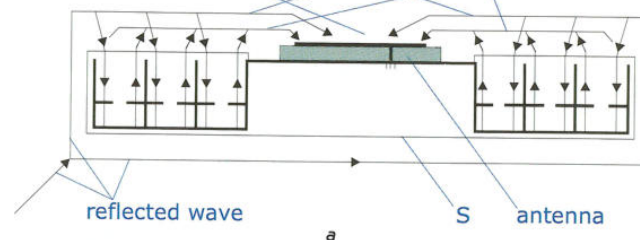
To further improve the design of choke rings we conceived choke rings that could be optimized separately for L1 and L2 (patent pending).

Dual-Depth® Dual-Frequency Low-Multipath Choke Ring

As explained above all existing choke rings are single-depth and can optimally reduce multipath only in one frequency. They work sub-optimal for L1 or for both L1 and L2.

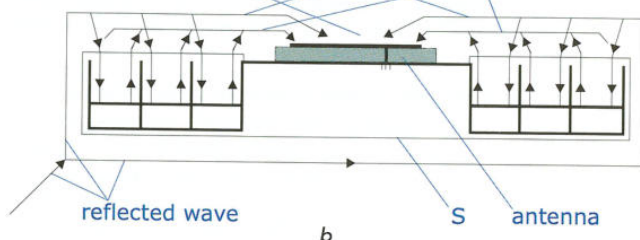
It is not possible to select a groove depth that is optimized for both L1 and L2 frequencies. The optimal depth for L1 must be about 30% less than the depth for L2. Decreasing the depth will cause fast deterioration of the multipath rejection for the L2 range. Therefore in all existing choke rings the multipath rejection is for the L2 signal with much less multipath rejection for L1 signal.

L2 direct wave primary wave secondary wave

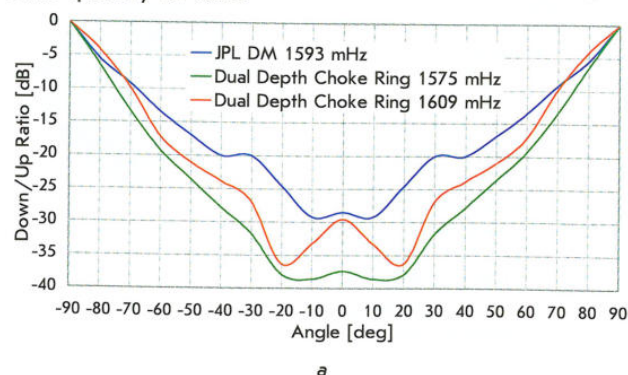


We designed choke rings whose effective groove depth is different for L1 and L2 and can be optimized separately. In our approach we install a PC board containing special design, in the middle of the grooves and parallel to the bottom surface. This PC board acts as a metal surface for L1, therefore the effective groove depth for L1 is from the top of the grooves to this PC board (a). For L2, this PC board has no impact, so the effective groove depth for L2 is from the top to the bottom of the grooves (b).

L1 direct wave primary wave secondary wave



With such design the multipath rejection for both L1 and L2 are about 10 dB better than the JPL choke ring. In Figure below, the blue line represents the down/up ratio for the JPL choke ring while green and blue lines represent the same quantity for ours.



and you can decide what type of battery to use. Lower power consumption also increases the life of the electronics. Our state-of-the-art 20-channel GGD receiver consumes about 3.5 Watts.

9.2. The receiver is preferred to have an integrated battery without cable connections.

In some applications you may prefer an integrated battery to minimize cables connection. This is not significant for many applications and external batteries may be acceptable.

10. Environmental

10.1. The system must be able operate in temperatures ranging from [-40 to +55] degree C.

Significance: Depends on your operating environment, but most receivers allows you operate within the above range.

10.2. The system must work in driving rain.

Significance: This is significant if you are taking your unit to the field. For units in applications such as monitoring stations only the antenna must have this characteristics.

11. Accessories

Don't let accessories interfere with getting the core of your systems. You can always get whatever accessories you need, from other companies that are specialized in GPS accessories.

12. Physical Characteristics

12.1. A complete system of a receiver, antenna, CDU, battery, charger, HI rod, and notebook computer for post processing must fit in a carrying case of dimensions [55x40x20] cm.

Significance: This may be important if you need to carry the equipment with you inside the cabin of commercial airlines.

13. Post Processing Software

13.1. The post processing software should be a Windows-based software capable of processing static, stop-and-go, and kinematic modes of operation with on-the-fly ambiguity resolution.

Significance: These modes are the three types of precision applications of GPS.

13.2. The post processing software should have tools to plan the geodetic network and then to execute the plan.

Significance: Planning the network first and then executing is the process by which all network survey jobs are actually performed. It is good to have the software that does both in an integrated fashion.

13.3. The post processing software should include network adjustment, coordinate conversion and transformation.

Significance: These operations are necessary in any survey job.

14. Accuracy

If you specify all the above correctly, then the accuracy of your measurement will depend on what you do with the system and not much else. For example, your errors will be greater when you have longer baselines, or shorter occupations, or when you have larger GDOPs. While you need to understand the overall accuracy that you can expect, through analysis, you should not confuse this accuracy with your receiver contribution and performance, which have been specified above.

GPS Electronics Innovations and Features

The Paradigm® Chip

At the heart of our GPS technology is our Paradigm® chip. It uses the state-of-the-art low power integrated circuit technology. In this single chip, we have integrated 40 universal super channels that each can track all signals of either L1 or L2 frequencies of either GPS or GLONASS, or can be used for high data rate (32 Kbit/sec) communication (patent pending).



The new GPS technology employed in Paradigm®, provides enhancements in data quality and the ability to track satellites under adverse condition (low signal to noise). In particular it has new quality level for tracking GPS L2 in the presence of AS (Anti Spoof) - patent pending. In addition, C/A code has been implemented on all L2 channels in anticipation of possible inclusion of C/A code on L2.

The chip also includes 6 separate high data rate spread spectrum communication channels that operate both in frequency hopping (64 Kbit/second) and direct spread spectrum (32 Kbit/second.) Furthermore, our spread spectrum communication technique has perfect time synchronization using tight integration with GPS timing (patent pending).

Also integrated in this chip is an Interference/Jamming Suppression System (patent pending) that can simultaneously suppress up to 6 in-band jammers.

The Paradigm® chip also includes a new innovation in signal processing technique for multipath mitigation for both code and carrier which uses less hardware and better performance than other published techniques (patent pending).

In-Band Interference/Jamming Suppression

The operation of a GPS receiver can severely be limited or completely disrupted in the presence of in-band interference and jamming signals. The threat of in-band interference and jamming signals increases daily as new communication systems are put in place and the radio frequency spectrum becomes more populated. The threat is not only from the interfering signals themselves but also from their harmonics that fall inside the GPS band. GPS World Magazine has a good article on this subject on its November 97 issue.

To mitigate this problem, separate interference suppression boxes are designed by leading companies such as Mayflower Communication.

We have devised an efficient and totally different interference/jamming suppression system (patent pending) integrated into our GPS chip. This all-digital compensation type system estimates the parameters of the interfering signal (e.g. bandwidth, frequency, amplitude and phase) and suppresses it. With six separate such suppressing systems, we can suppress up to six simultaneous in-band narrow-band, pulsed and CW interference and jamming signals by up to 60 dB. This interference suppression system protects our integrated direct spread spectrum communication channels for RTK data transmission as well as GPS and GLONASS L1 and L2 bands.

A good demonstration of the suppression system efficiency is the following experiment. A narrow-band interference (in C/A GPS band) from the signal-oscillator output was admixed to GPS L1-signal arriving at antenna's low noise

operation (depends upon recording interval) to determine the memory needed. If you record data every 10 seconds then for one hour of data you need $360 \times 10 \times 100 = 0.36$ megabytes. If you need the capacity for 20 hours you need 7.2 megabytes of data storage. If you want to record 6 hours of data with a one-second recording interval you need 21.6 megabytes of data storage. For the majority of users, 16 MB is more than enough. JPS offers memory options up to 112 MB.

4.2. The receiver must have the means for fast transfer of data to a computer, about [500] kilobyte (not kilobits) per second.

Significance: Transferring data to the computer via serial port it will take about 100 seconds per megabyte of data. Transferring 16 megabytes of data will take about half an hour. If the receiver has a fast parallel port, this download time can be reduced to less than 30 seconds. Alternatively, one can use removable PCMCIA cards. The drawback with this approach is that you need to have a PCMCIA card reader at your computer and PCMCIA cards are not designed for field use with frequent removal from their socket in the receiver. The delicate pins in the receiver can get damaged and render the receiver useless. If your application does not deal with megabytes of data, a serial port may be sufficient.

5. Radio Modems

5.1. Radio modem [Spread Spectrum (Frequency Hopping and Direct), UHF, and VHF]

Significance: In each country and region certain frequency spectrums are allowed for public use. You need to find the specification for your region.

5.2. Transmitter power requirement or transmission range

Significance: Depending on the distance you need to have a certain transmission power to reach. It is much easier to obtain authorization for lower power transmissions and beneficial to keep the base close to the rover during operation. This means establishing a known point near the area in which you need to do RTK (less than a mile if possible) such that you can use low power transmission. If you cannot reduce the range (by establishing known points near the RTK applications), then you need higher power.

5.3. The radio must be integrated inside the receiver without a need for an external cable

Significance: External cabling can be inconvenient and a source of failure.

6. DGPS

6.1. Each receiver must support RTCM DGPS formats for base and rover.

Significance: DGPS consists of transmitting code phase corrections from base to rover. This technique gives meter level accuracy. There are some standard data formats for transferring the corrections, some manufacturers have proprietary formats also. Standard formats allow users to mix receivers from different manufacturers.

7. RTK

7.1. Each receiver must support RTCM RTK formats for the base and rover.

Significance: RTK consists of transmitting carrier phase corrections from base to rover. This technique gives centimeter level accuracy. There are some standard data formats for transferring the corrections, some manufacturers have proprietary formats also. Standard formats allow users to mix receivers from different manufacturers.

It is difficult to specify the performance of RTK under all conditions. A good way to protect yourself is to reserve the right to return the receivers and cancel the order if the RTK performance does not meet your expectation.

8. Control/Display Unit

To specify a CDU, review what you need to do in the field. There is no reason to specify graphic capability if all you need to do is to start and stop data recording for static or kinematic applications. Limit data entry in the field, it is easier to make mistakes in the cold, or in the dark, or under other adverse conditions. Information such as site name and antenna height does not necessarily have to be entered in the receiver in the field.

8.1. The system must include means to turn the receiver on and off, to start and stop data recording, and to indicate the proper operation of the receiver.

Significance: This is the minimum interface that you need. If this is sufficient for you, don't specify anything more. If you ask for more complicated user interface than you really need, it increases training time with little benefit. You pay more and you increase the probability of errors in the field. See our MINTER as an example of a simple but sophisticated user interface. It is similar to today's advanced photo cameras: wait for the green light and push the button.

8.2. The receiver must include means to enter information such as site name and antenna height.

Significance: This may not be necessary or significant. In fact, we do recommend that you should look at recording this information by other means (such as external digital voice recorders) and creating a log file in the office and merging it with the data.

8.3. The post processing system should be able to merge field log files including site names, antenna heights, stop-and-go times with GPS data and generate a complete file for post processing.

Significance: This capability removes inconvenient operation of field data entry and the need for a hand held unit in the field.

For applications such as RTK you need to have a display unit, for example, to guide you to the stakeout points and perform geodetic calculations.

The best solution is to try to select systems that are written based on standard operating systems so that you are free to select your platform.

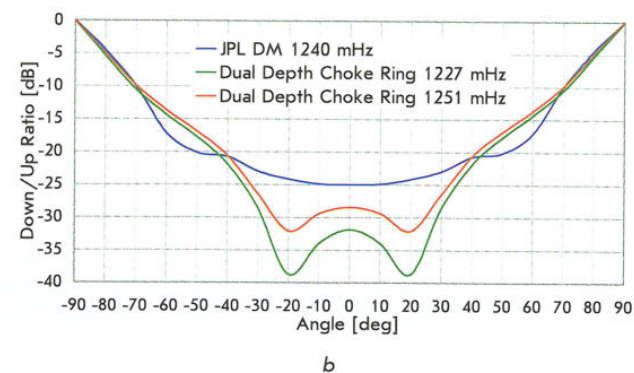
8.4. The CDU for performing RTK and stakeout applications (or similar) must be based on Windows CE. (or accept a temporary system until replacement with the Windows CE system when available).

Significance: Consider the example of post processing software. By specifying that the software must run under Windows 9x, you don't need to buy a special computer. Similarly Windows CE will soon be the standard operating system for hand held devices and many controllers. If the controller program is written based on Windows CE, you have the freedom of buying whatever device you want.

9. Power Consumption and Batteries

9.1. The complete receiver and antenna must have a power consumption of less than [4] watts.

Significance: You may have a system that is light, but has a high power consumption, which makes you carry a heavy battery to the field. It is also not easy to specify the weight of the battery because different battery technologies have different weights and costs. A non-rechargeable Lithium battery is light but very expensive. Lead acid is much cheaper but also heavier. Specify the power consumption



RegAnt

RegAnt incorporates our "Zero-Centered" antenna element mounted on a lightweight single-depth or dual-depth choke-ring ground plane in a fully waterproof enclosure. In addition to the tripod mount, RegAnt has three anchor points for securing the unit on an observation point for permanent, stable and accurate setup.

RegAnt comes in two versions. RegAnt-1 is our single depth choke-ring antenna and RegAnt-2 is our dual-depth choke-ring antenna. Single or dual-frequency GPS and GPS/GLONASS versions are available on both antennas.



LegAnt

LegAnt incorporates our "Zero-Centered" antenna element mounted on a lightweight flat ground plane and housed inside a fully waterproof enclosure.

JPS Software

Pinnacle™

Pinnacle™ is the first post processing software that is based on the concept of "Plan-and-Execute". You can design your network graphically and identify the "channels" for receiving data. Then by clicking the "Make" button the software will perform what you had planned. Channels for importing data can be from any media accessible by your computer, including Internet, telephone lines, serial and parallel ports, and computer files (hard disk, floppy, CD ROM, etc.).

You can also plan a repeating scenario that the computer can automatically execute periodically according to the schedule.

Pinnacle™ is a seamless integration of all the functions you need to perform a complete survey project and to generate reports. It is designed and developed for Windows 95 and Windows NT from the start.

Pinnacle™ includes powerful tools to test the planned project for consistency and accuracy and check against standards (e.g. NGS requirements) before you start the field operation.

Pinnacle™ has an excellent data integrity structure. It is based on a data management system that shields your data from inadvertent mismanagement, while allows it to be shared by different projects and applications.

Project View and Report Generation

Pinnacle™ provides extensive tools to view the contents of your projects. Network View, Subnet Matrix View, Baseline View, Occupation View and Receiver View give you immediate access to the contents of your project. The object-oriented approach treats data as objects that are available to all views and modules with a common interface.

All functions and user interfaces are based on simple graphical tools and dragging or clicking the mouse. Many functions or views can be activated in "child" (or client) windows and processed concurrently.

Pinnacle™ has powerful report generators that can be easily custom designed. The reports can be in text, binary and HTML formats. It supports standard reports like NGS Blue Book.

Processing Engine

The processing engine supports Stop-and-Go, Rapid Static, and Kinematic (with On-The-Fly ambiguity resolution) as well as classical Static survey. It can process any combination of single and dual frequency GPS and GLONASS data. The least-square processing of both static and kinematic data allows short occupation time and renders the processing insensitive to cycle slips because they are repaired very effectively. The program automatically chooses the processing parameters for each session. This allows it to handle arbitrarily long occupations and long baselines (up to 1000 km and longer).

Network Adjustment

The Network Adjustment engine operates automatically while it has the option of changing parameters manually for geodetic analysis. You may intervene at any step and decide on the next step options. It has powerful tools for analysis of the adjusted data like estimating misclosures and differences in repeated vectors as well as control tie analysis in easy to follow graphical form. When assigning GPS points

to control points their closeness is automatically tested; that is, there is no need to have identical names.

The adjustment process runs in two steps. In the first step, the vector adjustment detects blunders and estimates internal accuracy of vector network. Possible bad vectors may then be rejected or down-weighted. For detecting blunders and managing the adjustment, extended statistical tests are used. On the second step, the GPS network is constrained by local controls. The control data (plane coordinates and heights) may be used as fixed and/or weighted. As a result the adjusted coordinates for new points in local coordinate system are computed. Extended statistical tests enable the user to assess the quality of the adjusted data (both vector and terrestrial networks).

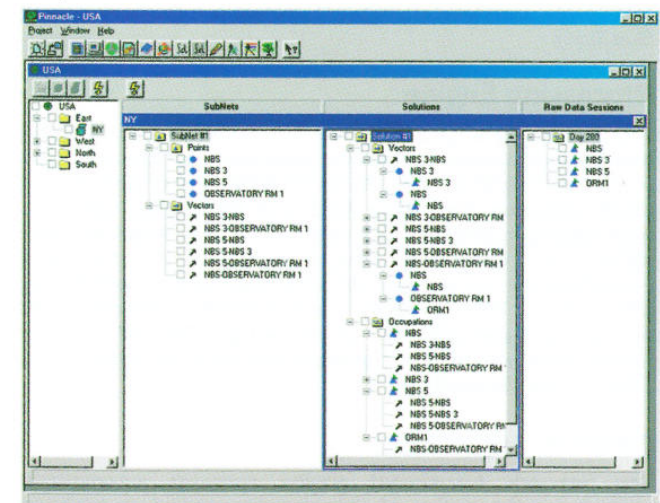
Coordinate and Datum Transformation

Pinnacle™ has complete datum and coordinate transformation system. For converting GPS-surveyed ellipsoidal heights into orthometric heights, the software uses 3 types of geoid models: global (like OSU91 and EGM96), regional (e.g., Geoid96 for USA) and also "user derived" models. The latter may be created and directly used in our software. For this, the geoid heights are calculated as differences between ellipsoidal and orthometric heights for control points and then, after rejecting possible anomalous data, the derived undulations are interpolated in order to calculate orthometric heights for all the surveyed points. You may select this approach when global or regional models do not give accurate geoid data for your survey area.

Coordinate transformations enable you to compute coordinates for numerous local datum and grid systems like SPC27, SPC83, UTM (N and S), Universal Polar Stereographic (N and S) and other national systems. Also, you may create a new coordinate system. For this, the extended lists of projections, datum and ellipsoids are provided.

Another capability is calculating transformation parameters between two sets of coordinates (i.e., WGS-84 and local) for common points and using them to get local coordinates for other GPS-surveyed points.

Project Control Window

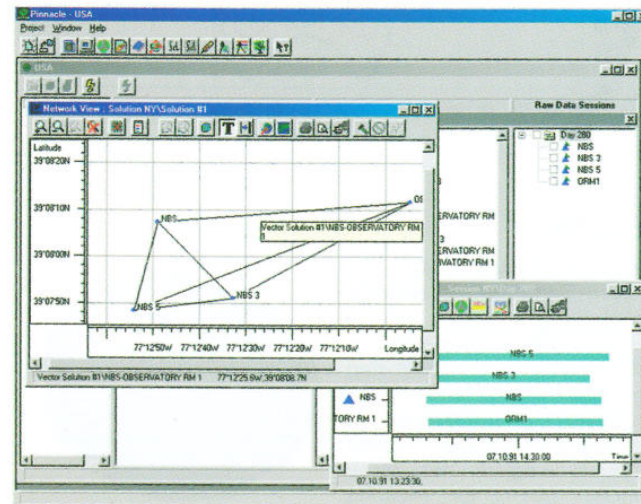


"Project USA" is active. The panels show (from left to right)

- Hierarchical data organization within the project. Subproject "NY" is opened.
- "Subnet #1" consists of 4 points and 6 vectors used to obtain adjusted coordinates of the points.

- "Solution #1" consists of 6 vectors that are computed based on 4 occupations. Session "Day 280" contains raw data for 4 occupations.

Network View Window/ Occupation View Window



PC-CDU

PC-CDU software shows the receiver's state, parameters of locked satellites and controls the operation of the receiver and data collection.



It allows the following:

- Download files from a receiver via serial or parallel port.
- Activation and stop of collecting data into a receiver internal file.
- Log data into files on a PC in the real-time mode.
- Configure a receiver for further control using only MINTER (recording interval, elevation mask, satellite systems to use, file names etc.). It is also able to configure radio modems connected to the receiver.
- Set various parameters for data collection controlled by PC-CDU (recording interval, elevation mask, and satellites to use, site name, and antenna height).
- ... and more.

PC-CDU may work in the client-server mode via Internet, providing full control over a remote receiver.

Specifying GPS Receiver Requirements... 20 Years Later

GPS is almost 20 years old... and many believe that understanding receiver specifications (from different manufacturers) along with defining true requirements (from some RFPs) is as perplexing as it has ever been.

Most importantly, beyond and behind the numbers, it appears that the significance of various spec items for different applications have not been clearly understood or stated; thus confusion over specs and puzzlement over poor RFPs.

Below, we present a generic model for specifying a GPS system for precise applications and attempt to clarify the significance of each item. For this article, by "GPS" we mean GPS and GLONASS, except when indicated otherwise.

In general, a high precision GPS system must be able to:

- Track GPS signals and measure data.
- Record the measured data for post processing or transmit them to another receiver via radio modem for real time solutions (DGPS or RTK).
- Accept user commands and display results via a Control/Display Unit (CDU).

The system could also include accessories such as batteries, interconnect cables, and carrying case.

Next we will provide a model for specifications and try to explain the technical aspects of each component. Please note that the numbers in [] are nominal and should be replaced with actual requirements as necessary.

Specifications

1. GPS Signals

1.1. The receiver must be able to track and measure all signals from each GPS satellite: C/A-L1 code and carrier, P-L1 code and carrier, P-L2 code and carrier.

Significance: Only carrier phase can provide millimeter level accuracy; code phase alone can only give meter-level accuracy. L1+L2 removes the effects of the ionosphere; L1 alone does not. In short baselines, where effects of the ionosphere are insignificant, each L1+L2 signal is equivalent to having 1.5 single-frequency signals, thus providing faster and more reliable results. In general, L1+L2 is required when most accurate results are desired.

1.2. The receiver must be able to track satellite signals down to [20] dB*Hz.

Significance: Under heavy foliage or when satellite signals pass through light trees, the signal strength is greatly diminished. The receivers that have better sensitivity can track signals more reliably under such adverse conditions. If you don't foresee such an application, you may want to increase the number to 30 dB*Hz.

1.3. The receiver must be able to mitigate the effects of multipath by signal processing. Carrier multipath error should be less than [1] mm for multipath distances >30 m. Code multipath error should be less than [1] m for multipath distances >30m.

Significance: Multipath reduces accuracy, reliability and the speed of obtaining results. If you leave the specification at: "The receiver must be able to mitigate the effects of multipath", everyone may meet, or may say that they meet this requirement. It needs to be quantified.

1.4. The receiver must have an in-band interference suppression of at least [50] dB.

Significance: Signals from other sources can disturb the operation of a GPS receiver when they fall within the GPS band. Also note that sometimes terms such as "interference rejection" or "interference suppression" are used, which omit the "in-band" qualifier. They usually refer to "out-of-band" interference rejection that all GPS receivers commonly have.

1.5. The receiver must have enough channels to track all visible satellites at any given time. GPS-only systems require 12 and GPS+GLONASS systems need 20 dual frequency channels.

Significance: The accuracy, reliability and speed of obtaining results increases with the number of satellites. With 5 satellites one may need to stay at a position for hours to obtain sufficient results while with 10 satellites seconds could be enough. Large number of satellites (greater than 9) are especially helpful in RTK applications.

2. Antenna

2.1. The phase center of the antenna element must have a horizontal symmetry of better than [2] mm.

Significance: What you actually compute with GPS is the location of the electronic center of the antenna. If the electronic center changes with the orientation of the antenna, it will cause an error in the computed position. For an antenna to have such characteristics, we believe it must have no less than a four-feed network and to our knowledge no other technique exists today.

2.2. The antenna element must be mounted on a choke ring with a down/up ratio of better than [-35] dB at Zenith for L1 and L2.

Significance: Multipath from surfaces below the antenna plane (land, water, etc.) can often be mitigated only by a choke ring. Please note that our single-depth antenna has down/up ratios of -28 dB and -32 dB respectively for L1 and L2; but our dual-depth antenna has down/up ratios of -40 dB and -35 dB for L1 and L2.

3. External Signals

3.1. The receiver must have a [1] PPS timing signal synchronized to GPS (or others).

Significance: Applications such as timing, photogrammetry, or any others that require this pulse.

3.2. The receiver must have an Event Marker with the accuracy of [25] nanoseconds.

Significance: If you have photogrammetry or similar applications, then you need an event marker accurate enough for your requirement.

3.3. The receiver should provide a frequency output of [20 MHz] locked to GPS.

Significance: If you have timing applications you need the frequency output. 20 MHz is commonly used.

3.4 The receiver must accept external frequencies of [5, 10 or 20] MHz.

Significance: For use in monitoring stations.

4. Data Recording

4.1. The system must have [16] megabytes of internal data storage.

Significance: You need memory to store data for post processing. A complete satellite data (section 1.1.) on each epoch takes about 100 bytes of data. Multiply this by the number of satellites at each epoch (take 10 for an average number) and then by the number of epochs during your

What power amplifier do you need at the RTK base?

The range of RTK depends on the amplification power available at the base. In spread spectrum radios we have 50mW of embedded power (no external box) sufficient for transmission range of up to 1.5 km. The external 1W (maximum allowable) extends the range to 20 kilometers.

Long range transmission is the most difficult and troublesome part of RTK. You will have much less of a headache if you can manage your RTK jobs with as short of lines as possible. In moving the rover from point to point, you can select some of the points that you survey as your "next" base and move the base to this new point to keep the distances short. We call this "hop-along RTK". In cases when this cannot be done, powerful amplifiers are necessary at the base or deployment of repeaters is necessary.

UHF has much lower baud rate but has transmission range of up to 30 kilometers, given enough amplification and proper set up of the antenna.

For the UHF power amplifier we have the options of 2W, 15W, and 35W from Pacific Crest.

What type of antenna do you need for the radio modem for base and rover?

Antenna type and positioning of the antenna in proper location can significantly impact the performance of the radio modem, hence the performance of the RTK. Analyzing the "antenna pattern" is helpful for selecting a good location for the antenna.

Typically the longer the antenna, the better transmission and reception characteristics it has. The antenna performance is characterized by its "gain".

For our Spread Spectrum radio modem we offer the following antenna choices:

- Internal radio antenna in Odyssey with gain of 2 dB.
- External short antenna with gain of 3 dB.
- External Whip antenna with gain of 6 dB. In the United States, this antenna is not authorized for use in conjunction with the one-Watt transmitter amplifier.

For UHF we have the Whip antenna which has 6 dB of gain.

What hand held controller do you need?

We offer a wide range of controllers. You can select from the simplest to the most elaborate depending on your application. Selecting an "appropriate" controller is a crucial decision for trouble free operation. As a general rule, limit your fieldwork to an absolute minimum. A sophisticated controller can be a powerful tool when you need it, and it can be a source of trouble when it is overkill.

We offer the following interfaces with the receiver:

MINTER: This interface is standard in all of our receivers. It can be used for static, kinematic, and stop and go survey application. It is based on two keys and two LEDs and very simple to use, yet very powerful.

It can perform the following task:

- turn the receiver on and off;
- start/stop data recording;
- change the mode from static to kinematic (stop and go);
- show the proper operation of the receiver;
- number of GPS and GLONASS satellites tracked;

- show signal strength on GPS and GLONASS satellites;
- proper tuning and operation of the receiver;
- cycle slips in the last 15 minutes.

CDU-1

This controller can perform all display control functions. It does not perform any geodetic functions in the field.

CDU-2

This is the Psion Series-5 with excellent pen-based graphic capabilities. The unit is relatively inexpensive but is not suitable for harsh environment.

TDS

We are proud to be able to interface our products with the world famous and legendary product of Tripod Data Systems corporation. They use Husky hand held computers, another legendary name in geodesy and GIS.

Do you need Post Processing Software?

Select Pinnacle, the first and the only plan-and-execute post processing software. You can download the manuals from the Download Area of this website.

Do you need automatic receiver control and data collection software?

Select PC-CDU MS.

Do you need any extra cables?

Each receiver comes with one serial port and one power cable.

Each external antenna comes with a 3-meter antenna cable.

The Parallel port option comes with one parallel cable.

Each additional serial port option comes with a serial cable.

The external frequency option comes with the required cable.

The frequency output option comes with the required cable.

Each radio receiver and transmitter comes with its own cable.

If you need additional cables, you can select from the list of cables.

Do you need any accessories?

Except for the cables mentioned above, none of the items specified in the accessory section comes standard with any products. For example, no battery or charger comes with any product. Also the CDU-1 is not a standard part of Odyssey. It must be ordered separately.

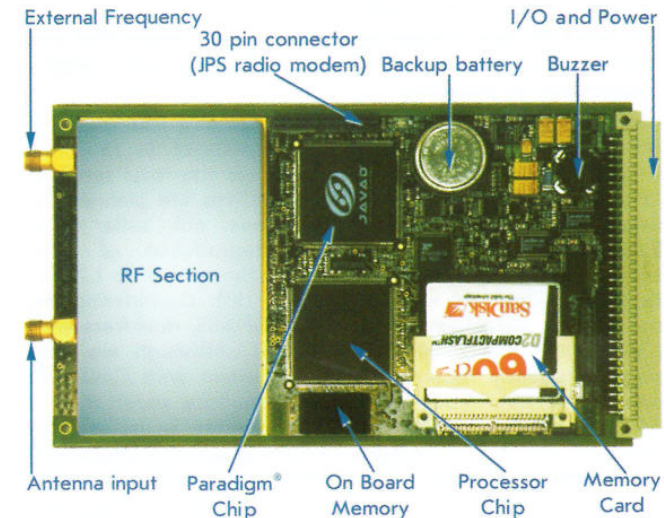
Prices

When you select all the advanced options that we offer, the price of the system may be higher than of our competitors. But you are getting the most advanced system that is at least two years ahead of all others. The advanced features pay for themselves after few times of usage. For example, imagine the saving that you will have with In-Band Interference Rejection when you can continue your work when all other receivers fail to operate in a jammed environment.

OEM

JPSEuro, our Eurocard compatible board, is based on the same technology and features as in *Odyssey*, *Legacy*, and *Regency* electronics.

JPSEuro is password upgradeable from GPS L1 to GPS+GLONASS L1+L2. It provides the highest quality code and carrier data both on C/A and P codes of L1 and L2.



Features

- 40 channels of L1, or 20 channels of L1+L2, GPS or GPS+GLONASS.
- Cinderella Option.
- Up to 60 dB of "IN-BAND" interference suppression.
- Up to 112 megabytes of on-board data storage (removable compact flash).
- IEEE-1284 compliant ECP Parallel port with more than 500 Kbytes per second data transfer rate. This reduced the download time and data latency by a factor of 50 comparing with the fastest serial ports.
- Four 115K-baud serial ports.
- No need for regulated voltage supply. JPSEuro on-board power supply accepts any unregulated DC voltage from 4.75 to 28 volts. No need for a power supply board.
- Direct connection with our GPS-coupled spread spectrum radio.
- 3.3 watt power consumption even when all features are active.

Cinderella Option, Pay-Per-Use/Password Upgradeable

Cinderella Option automatically turns your receiver into a dual frequency GPS+GLONASS for 24 hours every other Tuesday starting at GPS midnight.

Cinderella Option provides you with all the necessary hardware and software for your receiver to be Password Upgradeable (PU) to the highest level of GPS+GLONASS L1+L2 and most of other options. If you need additional features or need to upgrade your receivers to higher models (L1+L2 or GPS+GLONASS) you just pay the price difference and we will give you a password to make the features operational.

Cinderella Option also enables you to participate in the Pay-Per-Use (PPU) program. With PPU program you can buy the minimum system (for example GPS L1) and then pay for other features and options (for example, RTK with GPS+GLONASS L1+L2) as you use them. The usage of features during the *Cinderella* days is not counted as PPU time and are free as part of the *Cinderella* Option.

At any time you can buy the features that you have rented and credit the remaining PPU time towards the purchase of the features.

With *Cinderella* Option (that includes PU/PPU program) you get the following benefits:

- You minimize the initial investment and will have the most sophisticated hardware and software ready when you need them.
- You can test the features like L1+L2 and GPS+GLONASS in your actual jobs and then buy them when you are convinced that they are more cost effective than L1-only and they provide much better results faster.
- You never have to worry about the need for another equipment whatever your survey jobs will end up to be.

The purchase price of any feature is the difference between the price of that feature and what you have already purchased. For example if you have already purchased a GPS L1 *Legacy* and *LegAnt* for \$4,750 and you need to upgrade them to GPS L1+L2 that costs \$9,500, you pay the price difference of \$4,750. The same price difference will be the basis for PPU calculation if you decide to rent the L2 feature rather than buying it.

- Daily cost is 1/120 of the purchase price of the feature.
- Weekly cost is 1/30 of the purchase price of the feature.
- Monthly cost is 1/10 of the purchase price of the feature.
- We also charge \$200 for each PPU/PU transaction order.

If you decide to upgrade your receiver within three months of purchase, we fully credit you the price that you paid for the *Cinderella* Option towards the purchase of upgrades.

And note that with all the above options, you are purchasing the superior technology of JPS and the advanced features that nobody else can offer.

We reserve the right to change, modify or terminate the PPU/PU program at any time.

World Class Manufacturing



JPS products are manufactured under ISO-9002 certified processes in the high technology manufacturing plant of the SMT Center Inc. (SMTc) in San Jose, California.

SMTc (<http://www.smtc.com>) provides a high quality manufacturing process to JPS, in production scheduling, material planning and procurement, assembly and testing operations. Final products are then delivered to JPS or shipped directly to JPS customers by SMTc.



Amongst the best-of-the-breed in electronics manufacturing, SMTc manufactures high-volume products for prominent companies in personal computers, networking, office automation, telecommunications and industrial instrumentation applications. Our turnkey manufacturing alliance takes advantage of SMTc's global

resources and world-class operations, ensuring the highest quality of finished products to JPS customers.



SMTc is headquartered in Toronto, Canada with its world wide high technology manufacturing sites located in Toronto, Charlotte (North Carolina), Austin (Texas), San Jose (California), Ireland and China.

How to Configure a GPS System for Your Application

To select an efficient system tailored to your needs, please answer the following questions, write down your selections.

What performance do you need?

GPS L1 (G), GPS+GLONASS L1 (GG), GPS L1+L2 (GD) or GPS+GLONASS L1+L2 (GGD)

The heart of your system depends on the signals that you receive. This selection is like selecting the engine performance of your car.

Having more satellites improves the reliability and speed of obtaining accurate data. GPS (G) consists of 24 satellites. GPS+GLONASS (GG) currently increases the total satellites to about 40 and more GLONASS satellites are planned for launch. Furthermore, GLONASS does not suffer from Selective Availability (intentional degradation of orbit accuracy) and Anti Spoof (encrypting the access to L2 that degrades signal strength by over 10 dB). Considering the operational advantages of GPS+GLONASS dual-frequency (GGD), it is the most cost effective. Although we offer single frequency receivers, we offer them with Cinderella option that turns your GPS single frequency receiver to a GGD receiver every other Tuesday for full 24 hours. You can then see the advantages of L1+L2 and the benefits of more satellites. When you are convinced of the benefits, you can permanently activate all features by password entry.

Dual Frequency eliminates the effect of the ionosphere in long baselines. In short baselines (<10km) each dual frequency satellite counts as 1.5 satellites.

If you have selected less than GGD, do you want The Cinderella Option?

Remember the Cinderella option turns your receiver into a GGD every other Tuesday for 24 hours. Furthermore, with the purchase of the Cinderella option, all hardware are included in the receiver, with the hope that you may want to pay for and upgrade your receiver to a higher level with the purchase of the password. The only exception to this is the Spread Spectrum radio, the third and fourth serial ports, the parallel port and the external frequency input.

Select antenna ground plane: Flat Ground Plane, Single-Depth Choke Ring, Dual-Depth Choke Ring.

Choke ring ground plane significantly reduces the ground multipath. Dual-depth choke ring maximizes the multipath mitigation for L1 and L2 separately. The choke ring ground plane is larger than the flat ground plane.

Do you want an antenna to be integrated with the receiver?

The advantage of having an antenna and a ground plane in a single box is operational simplicity and fewer cables. Some people prefer to have the antenna separate in dynamic applications. In static applications, like monitoring stations or machine control, it is also preferred to have the antenna separate from the electronics. This is only a matter of operational choice. The performance is exactly the same.

Based on decisions so far a receiver type can be selected:

Ground\Plane	Integrated	Select
Flat	no	Legacy + LegAnt
Flat	yes	Odyssey
Choke Ring-1 or -2	no	Legacy + RegAnt-1 or -2
Choke Ring-1 or -2	yes	Regency-1, or -2

For each selection you can use suffix G, GG, GD, or GGD depending on the first question.

How much internal storage capacity you need?

If you need to record data for post processing, you need internal data storage capacity in the receiver. Storage capacity depends on how many hours of data storage; how fast you want to record data; and the signals that you record (G, GG, GD, or GGD).

Do you want Advanced Multipath reduction?

Multipath is the most significant error source. Some multipath reduction techniques come as standard.

Do you want In-Band Interference Rejection?

In-band interference can destroy your day's work. The major costs on a project are logistics - avoid reoccupying sites.

Do you need a parallel port?

It will take you more than two hours to download 76 megabytes of data (typical of photogrammetry applications) via (even fast) serial ports. With our parallel port this time is reduced to about two minutes. Some suggest the use of removable PCMCIA cards. These cards are not suited for repeated removal. Eventually the pins in the receiver will bend and render the receiver useless. Access to the receiver to remove the card also exposes the electronics to an undesirable environment.

Do you need a third serial port?

We have two serial ports as standard. Some applications may require an additional port.

Do you need a fourth serial port?

In standard configurations we install a second power connector instead of serial port D. If we need a fourth serial port, we can replace the second external power input with serial port D. This will leave you with only one external power connector.

Do you need external frequency input?

With this option you can feed the receiver with a great number of external frequency sources. This is used in applications such as monitoring stations.

Do you need precise output frequency?

With this option the internal 20 MHz oscillator of the receiver is locked to GPS or GLONASS satellites and provides the same long term stability as the timing system that is used in master control segments of GPS or GLONASS. This is used for timing applications.

Do you need event markers?

Our receivers can come with two event markers. They are typically used in photogrammetry and machine control applications. The input pins are located in the same connectors as serial ports A and B.

Do you need programmable timing signals?

We provide two timing signals that are synchronized with GPS, GLONASS, or UTC standards. Their period and offsets are programmable.

How fast do you need data?

We can provide data up to 20 times per second. The delivery of the data depends on the communication media and the amount of data (G, GG, GD, or GGD).

Do you need RTCM D-GPS? How fast?

We provide the RTCM corrections at the Update Rate speed. The delivery depends on the communication channel.

Do you need RTK? How fast?

How is it possible for the base to send RTK data to the rover only once per second but rover compute RTK solutions 20 times per second? The answer is that the rover can extrapolate (estimate, to speak loosely) the RTK data that it receives from the base and use it for one second until it gets refreshed again. Of course the less the extrapolation time, the more accurate is the result. If the base can transmit RTK data two times per second, then the extrapolation time is reduced by half.

The speed of the radio link is the limiting factor for sending the RTK data from the base to the rover. In fact, quality of the radio and the reliable radio link is absolutely crucial for successful RTK.

In this step select the speed of RTK that you need, but should be aware that RTK data is sent from base at the speed that the radio link permits and the solutions in between are somewhat based on the "extrapolation" of base data.

If you need RTK, what type of radio do you need?

You have the following choices:

Spread Spectrum radio modem with Frequency Hopping and Direct modes. We offer them in two frequencies of:

915Mhz
2.4 GHz

UHF (Made by Pacific Crest): We offer them with a choice of frequencies:

410-430MHz
430-450MHz
450-470MHz

VHF (Made by Pacific Crest): We offer them with the following frequencies:

150-173MHz

Spread Spectrum is the most advanced and most reliable radio modem for RTK and D-GPS applications.

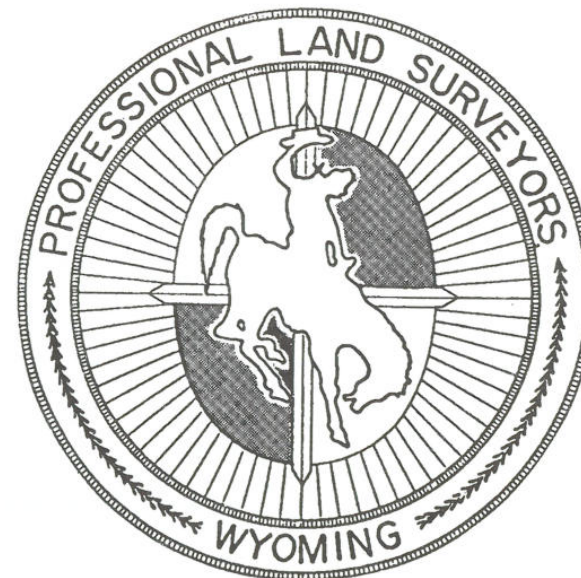
We have integrated both Frequency Hoping and Direct modes of Spread Spectrum modems in our electronics. You can select one or both. They have baud rates of 32K and 64K sufficient to transmit full GGD RTK data from base to rover several times per second.

The embedded amplifier has 50 mW of power, which is sufficient for up to 1.5 Km of range. The external 1W amplifier extends this range to about 20 Km in open areas.

If neither one of the 915 Mhz nor the 2.4 Ghz Sp. Sp. is allowed in your country, you need range of beyond 20 Km, or you are working in areas with obstructions your choice is UHF or VHF radio modem. The choice between UHF and VHF depends on licensing requirements in your area and what frequencies are already being used.

The UHF radio modems typically comes with 9.6K or 19.2K baud rates, which are enough to transmit RTK corrections one or two times per second. Rovers that provide up to 20 times per second of RTK solutions "extrapolate" the RTK data that is received from base every second. With Sp. Sp. radios, the rover can receive data about 6 times faster and extrapolate six times less.

Professional Land Surveyor
AND
YOU



*HOW the PROFESSIONAL
LAND SURVEYOR
SERVES
THE PUBLIC*

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*Progressing from
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% Lines & Points
P.O. Box 904
Casper, Wyoming 82601

WHAT INFORMATION DOES THE LAND SURVEYOR NEED FROM YOU?

Land description of the property (Lot, Block and Subdivision Name, aliquot Part description, or deed recording data).

The exact purpose of the survey.

A copy of the plat or plans showing the boundaries.

All available information regarding disputes over corner locations or boundaries.

All information you may have about the location of your boundary lines or corners.

HOW MUCH WILL A SURVEY COST?

Surveyors' fees like those of other professionals, are dependent on the type of service required, which in turn determines the level of effort and the number of personnel and type of equipment necessary. The following factors help determine the final cost of a survey.

- Information available
- Research required
- Clarity (or vagueness) of the legal land description
- Amount of land involved
- Number of property corners
- Improvements such as houses, outbuildings, fences, etc.
- Terrain
- Vegetation
- Accessibility
- Boundary disputes
- Personnel and equipment required
- Surveyor's familiarity with the area

These variables make it difficult to determine exact fees, but based on general experience in the area and the type of work required, the Surveyor can usually furnish an estimate of the costs. Surveyors familiar with an area or locale are usually more efficient than those who are not.

INTRODUCTION

Most people may require the services of a professional land surveyor only once during their lifetime. You may be unaware of how to select a professional land surveyor to best serve you.

The Professional Land Surveyors of Wyoming have prepared this booklet to help answer the questions that are most commonly asked and to assist you in selecting a land surveyor to best fit your requirements and needs.

A professional land surveyor has met the stringent requirements of the State Board of Registration for Professional Engineers and Professional Land Surveyors for the State of Wyoming before receiving a license to practice surveying in this state. This consists of an internship under the tutelage of a licensed professional and educational requirements as set forth by the board. Experience, education and knowledge of good surveying practices enable the surveyor that you select to best satisfy your needs and requirements on the type of project you need to have performed.

This should help you in your selection of a professional land surveyor to fit your needs.

The professional land surveyor is usually proficient in all types of surveying, but usually specializes in one specific branch or type of surveying. Some surveyors are better equipped, have more personnel and are better suited to perform large scale surveys, while others are more experienced in water rights applications. The profession has many general practitioners and many specialists. The choice should be determined by procuring the professional most suited to



WHEN DO I NEED A PROFESSIONAL LAND SURVEYOR?

BEFORE a title to land is transferred.

WHEN buying land to protect the investment being made.

WHEN selling land to insure that you are conveying title to the land that you intend to sell.

BEFORE land is subdivided.

WHEN platting lands into lots and blocks or tracts for residential, commercial, industrial use, etc.

FOR the conveyance of these individual parcels.

WHEN the land is to be divided by deed, will or court decree.

BEFORE the development of property by the construction of buildings, fences, roads or other improvements.

WHEN the possibility of a boundary dispute exists.

WHEN a lending agency or mortgage company requires a survey.

WHEN a parcel is conveyed from a larger tract of land, and the parcel in question has not been surveyed.

WHEN searching for the property corners of your land to assure that there are no encroachments or to satisfy your own curiosity and locate the boundaries of your land ownership.

HOW CAN YOU OBTAIN THE SERVICES OF A PROFESSIONAL LAND SURVEYOR

Only a professional land surveyor licensed by the State Board of Registration is legally permitted to perform land surveying in the State of Wyoming

Ask someone who has employed a professional land surveyor.

FORMAT OF AN IDEAL SECTION

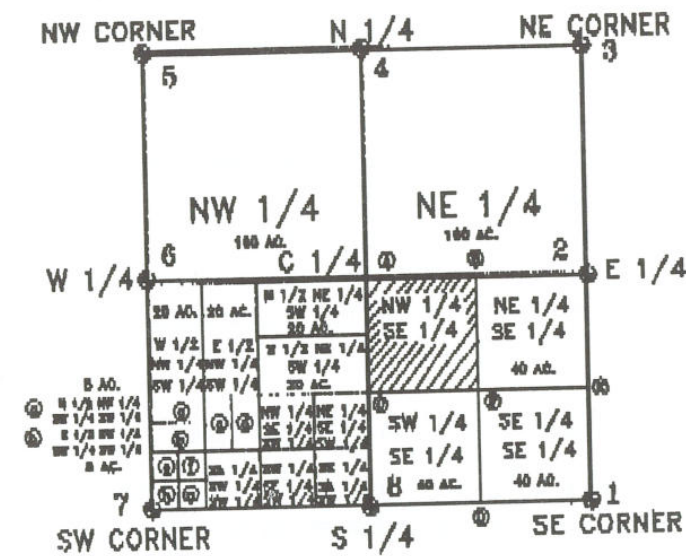


FIGURE (1)

TABLE

① W 1/2 NE 1/4 NW 1/4 SW 1/4 5 AC.	② NE 1/4 SW 1/4 NW 1/4 SW 1/4 2.5 AC.
③ E 1/2 NE 1/4 SW 1/4 SW 1/4 5 AC.	④ SE 1/4 SW 1/4 NW 1/4 SW 1/4 2.5 AC.
⑤ NW 1/4 SW 1/4 NW 1/4 SW 1/4 2.5 AC.	⑥ SW 1/4 SW 1/4 NW 1/4 SW 1/4 2.5 AC.

A TYPICAL SECTION 1 SQUARE MILE

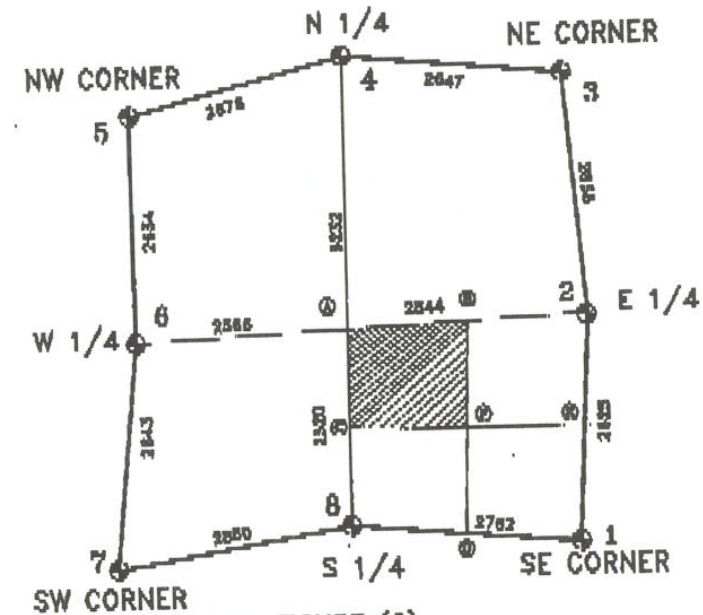


FIGURE (2)

A TYPICAL SECTION (EXAGGERATED)

THIS SYSTEM IS KNOWN AS
THE PUBLIC LAND SURVEY
SYSTEM

(PLSS)

DID YOU KNOW?

That the required procedure to survey a 40 acre tract of such as the NW 1/4 of the SE 1/4 (See fig. 1 page 7) requires a survey of almost the entire section?

The minimum steps that are necessary to survey this parcel are:

- A. Recover the original government corners 1,2,4,6 and 8 (these corners were set by the general land office or BLM, most of these corners were set in the late 1800's or early 1900's).
- B. To establish the center of the section (point A) is at the point of intersection of a straight line between Point 4 and Point 8 & Point 6 & Point 2.
- C. To establish 1/16 corners B, C, D and E; for example: being exactly midway between Point A and Point 2, etc.
- D. To establish the 1/16 corner (F) which is the intersection of a straight line between point B and Point D, and Point C and Point E.

Original surveys and the limitations of the above procedures are required and are necessary to locate the four corners of the NW 1/4 of the SE 1/4. Most sections may have dimensions such as that shown in fig. 2 on page 7 (exaggerated to show that these lines are not necessarily straight or parallel due to difficulties encountered during the original surveys and the limitations of the instrumentation used during these surveys), this shows that the actual distances around a 40 acre 1/4 1/4 will not necessarily be 1320 feet (1/4 mile) nor will the sides be parallel or at right angles to each other.

TYPICAL TOWNSHIP							
DIVISION INTO SECTIONS							
36 T.14 N. T.13 N.	R.71 W. 31	R.70 W. 32	33	34	35	R.70 W. 36	R.69 W. 31 T.14 N. T.13 N.
1	6	5	4	3	2	1	6
12	7	8	9	10	11	12	7
13	18	17	16	15	14	13	18
24	19	20	21	22	23	24	19
25	30	29	28	27	26	25	30
36 T.13 N.	31	32	33	34	35	36	31 T.13 N.

Choose a reputable surveyor in whose judgment you can place your trust. A professional land surveyor should never be selected by price alone. Competency is the most important aspect in choosing a surveyor. When you are sure that the professional you have chosen has all of the facts and is aware of your requirements, then you should make your selection.

Do not let anyone but a professional land surveyor project or prepare the land description (legal description) of your land.

TYPES OF SURVEYS

LAND OR BOUNDARY SURVEY: A survey for the purpose of locating the boundary lines and property corners of a parcel of land. This type of survey involves field and record research, measurements and computations to establish the corners and boundary lines in conformance with Wyoming State laws. Easements and other features may be located, if specifically requested, with this type of survey.

A survey of a parcel or lot where previous monuments are recovered or new monuments are set to show the boundary lines.

TOPOGRAPHIC SURVEY: A survey locating physical features, both man made and natural, such as buildings, fences, trees, roads, trails, streams and contours showing the slope and relief of the land. These types of maps are utilized by architects and engineers in the designing developments and improvements on these lands.

HYDROGRAPHIC SURVEY: A survey of bodies of water to determine the depth and configuration of the bottom, currents and location of fixed objects for navigation and determining the quantity of said body of water at various water levels.

SUBDIVISION SURVEY: A survey in which a tract of land is divided into smaller parcels, showing monumentation, lots or tracts, streets, rights of ways and easements as required and recorded on a plat or map in conformance with local ordinances and Wyoming State Statutes.

GEODETIC SURVEY: A survey in which the

Geodetic surveys are usually prescribed where the distance or area involved is so great that the desired accuracy and precision can be obtained only by the process of geodetic surveying. In geodetic surveying, prescribed precision and accuracy of results are obtained by the use of special instruments and field methods and equations based on the geometry of a mathematical figure approximating the size and shape of the earth.

MINERAL SURVEY: A survey made to mark and establish the legal boundaries of mineral deposits or ore-bearing formations on public domain, where the boundaries are determined by lines other than the normal subdivision of public lands, showing the location of a mining claim, oil well or other mineral deposit.

CONSTRUCTION LAYOUT SURVEY: To establish the horizontal position, elevation, dimensions and configuration prior to and during construction. The staking line and grade for roads and buildings, fences, utilities etc.

CERTIFICATE OF LOCATION OR MORTGAGE SURVEY: A survey that supplies the lending institution or title insurance companies with information on the location of the buildings, well, septic tank, and other structures on the given parcel or tract of land. This should also show any encroachments and the building setback lines and any setback violations.

ALTA/ACSM SURVEY: An in-depth survey showing all the physical attributes of a given site. This type of survey shows the location of all the buildings, structures, utilities and easements and requires the showing of all monumentation being found and/or set during this survey. This type of survey is to be performed to the specifications as set forth by the American Land Title Association.

WATER RIGHTS SURVEY: A survey performed to fulfill the statutory requirements of the State of Wyoming for the filing of water rights on wells, springs, irrigation ditches, reservoirs and other facilities.

SURVEYING METHODS

Most surveyors utilize electronic distance and angle measuring equipment, as well as the traditional transit or theodolite and tape. Some surveyors may use satellite positioning equipment as a measuring tool. Modern computer systems aid in efficiently gathering measurements and evaluating all collected evidence required to perform the land survey. The professional land surveyor takes pride in being able to use these and other instruments and computers to perform the surveys accurately, efficiently and cost effectively.

SOME COMMON QUESTIONS ASKED ABOUT SURVEYING

Q: Will a land surveyor tell me what I own?

A: No, it is the land owner's responsibility to furnish the surveyor with a land description (Legal Description), current deed and other data that may be required concerning the parcel that is to be surveyed. The surveyor will then locate the property on the ground, marking the corners with physical monuments and provide you with a map of survey showing the results of the said survey. The surveyor will disclose any areas of conflict so the title company and/or attorney can resolve these problems.

Q: How will I be shown what has been surveyed?

A: Corner markers should be set in accordance with the Wyoming State Standards (5/8" x 24" rebar with metallic cap stamped with number of the surveyor). The corners of the parcel can be shown to you if requested.

Q: Should I explain why I want a survey performed?

A: Yes, if the surveyor knows why you want a survey, he can then recommend the type of survey that is required and how much detail should be shown on the map, plat or exhibit, thus saving you the cost of unnecessary work.