(4)

SRL-0018-TM

AR-005-416

AUSTRALIA



**DEPARTMENT OF DEFENCE**

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION
SALISBURY

# SURVEILLANCE RESEARCH LABORATORY

SOUTH AUSTRALIA

**TECHNICAL MEMORANDUM**

**SRL-0018-TM**

## GPS USER EQUIPMENT EVALUATION TECHNIQUES USING A ROTOR MOUNTED ANTENNA



J.S. GUBBAY

Technical Memoranda are of a tentative nature, representing the views of the author(s), and do not necessarily carry the authority of the Laboratory.

Approved for Public Release



COPY No.

AR-005-416

DEPARTMENT OF DEFENCE

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION

SURVEILLANCE RESEARCH LABORATORY

TECHNICAL MEMORANDUM

SRL-0018-TM

# GPS USER EQUIPMENT EVALUATION TECHNIQUE USING A ROTOR MOUNTED ANTENNA

J.S. Gubbay

S U M M A R Y

The accuracy of the NAVSTAR Global Positioning System (GPS) permits evaluation of dynamic performance of user equipments by mounting the antenna on a rotor of practical dimension.

The reported diameter of the circular path described by the antenna phase centre will depend on Kalman filter characteristics and will tend to increase with rotor speed. GPS system noise was observed to obey Rayleigh statistics through measurement delay intervals up to one minute. This characteristic of system noise and the development of symmetry techniques permits delayed difference measurement of reported diameter of antenna path to an accuracy of better than 0.5 m over 30 min. This method of Kalman error measurement provides a means for establishing a benchmark for integration filter design software simulation.

POSTAL ADDRESS: Director, Surveillance Research Laboratory,
PO Box 1650, Salisbury, South Australia, 5108.

TABLE OF CONTENTS



LIST OF FIGURES

## 1. REQUIREMENT

The RAAF has selected the NAVSTAR/Global Positioning System (GPS) as the prime external navigation system. Joint Project Brief (JPB) 5195 defines the schedule for ADF acquisition of GPS. User Equipments (UEs) will be selected for purchase over three phases of UE acquisiton. Planned date of delivery of Phase I UEs is late 1990. Joint Project Brief (JPB) 5195 also provides for the acquisition of seven R&D UEs to be delivered to Microwave Radar Division (MRD) for preliminary performance evaluation mid 1989.

Performance evaluation of high dynamic GPS UEs requires the measurement of error in reported position in order to qualify UEs against US Department of Defense specification of error limits for defined dynamic conditions. In addition to the assessment of static errors therefore, it is necessary to determine both velocity dependent position errors and acceleration dependent position errors. Flight trials using kinetheodolite ground truth are expensive, dependent on cloud conditions, limit acceleration to values well below specification and the processing of results takes several months. Alternative means for preliminary evaluation of GPS UE dynamic error are required to enable relatively inexpensive techniques to be employed and to allow rapid reporting of results.

Electromagnetics Group has developed and employed a technique to measure static errors(ref.1) and velocity dependent position errors(ref.2). This report examines a technique for the evaluation of dynamic errors, including acceleration dependent position errors.

In addition to the measurement of error in reported position, it would be very useful to derive the UE senescent error ie the time between UE data acquisition and position reporting. Kalman filters for the integration of the GPS UE with other navigation aids, namely INS and Tacterm Units, are to be designed at the Aeronautical Research Laboratory (ARL). Senescent time for each navigation aid must be known. It may be possible to further develop the technique discussed here to provide a measure of senescent time.

## 2. TECHNIQUE

Differential measurement of position implies simultaneous measurement of position at two or more locations. For external navigation systems such as GPS, the error in differential position may be attributed to differences in the propagation path and to user equipment errors. Thus system errors common to each location may be ignored.

Previous work(ref.3) and recent measurements have confirmed that the 95% differential horizontal accuracy For GPS is about 5 m for stationary conditions.

In order to evaluate the velocity dependent position error attributable to a single GPS UE, the UE may make mirroring runs at constant velocity through the same surveyed position(ref.2) and the respective observed error vectors differenced, in order to remove the system component of error. This technique however incurs a delay between the position measurements for opposing runs.

The term 'delayed difference' is applied in place of 'differential' where measurements compared are not simultaneous. The delay interval between corresponding measurements will introduce some measure of system error depending on system noise behaviour.

GPS system noise statistics were observed over a series of measurements taken over two hours on different days. It was found that system noise closely followed the Rayleigh random walk distribution for delay intervals through to one minute, the maximum interval studied (paragraph 3.1). This implies that the system component of position error varies as the square root of the value of the delay interval between measurements(ref.4).

High dynamic GPS UEs report position at one second intervals. If the epoch is made to coincide with the extreme east and west positions of antenna traverse, the reported difference in the position of these two points will increase with rotor speed. The motion described involves time derivatives of position beyond acceleration so that a 5, 8 or 11 state Kalman filter will not fully model this motion (see figure 1). Consequently, the reported antenna positions will tend to lie on a circle larger than the physical circle described by the antenna phase centre.

The rotor arm may be controlled so that arrival of the antenna phase centre at the east and west extremities of travel coincides with GPS epoch time and the reported diameter of the circle in the east west direction may be measured. The spectrum of allowed values of rotor speed for measurement of diameter in any direction is given by the relation below.

Allowed values of w revolutions per second that will permit 'Delayed Difference' measurement of diameter may be expressed as follows

$$w = \frac{2n+1}{2m} \text{ rev/s}$$

where n, m are positive integers of any value, with the exclusion of m=0. The relation simply states that within the second or multiple second reporting interval, the antenna must describe an odd number of semicircles or any other even division of a circle.

$$\Omega = \frac{\text{any odd number x 60}}{\text{any even number}} \text{ rev/min}$$

eg for Ω rev/min = 10

| | n | m |
|---|---|---|
| | - | - |
| | 0 | 3 |
| or | 1 | 9 |
| etc | | |

and for Ω rev/min = 1

| n | m |
|---|---|
| - | - |
| 0 | 30 |

It may be shown for instance that to achieve diameter measurement, 9 rev/min is an allowed value of Ω whereas 4 rev/min and 8 rev/min are disallowed values of Ω.

The reported diameter will tend to exceed the diameter of the physical trajectory of the antenna phase centre and is dependent on various parameters as follows:

In general,

(i) the greater the number of states of the Kalman filter, the smaller the error vector and thus the smaller the reported diameter;

(ii) the greater the senescent time, the greater the error vector;

(iii) the error vector increases with rotor speed;

(iv) the statistical spread of the value of the error vector increases with delay interval between measurements being differenced. Results of a study described in paragraph 3.1 show that the increase in spread with delay interval obeys Rayleigh statistics for random walk distribution, for delay intervals up to 60 s. Ultimately, the statistical spread in the error vector ceases to increase with delay and the statistical noise then follows a normal distribution.

Parameters (i) and (ii) are fixed for any UE. Parameters (iii) and (iv) may be controlled within limits by varying rotor speed and length of arm. Increasing rotor speed will increase the value of the Kalman error vector and in general will decrease the delay interval incurred in delay difference measurement of diameter, thus reducing statistical spread of the error vector.

It was necessary to determine the nature and extent of delayed difference measurement statistics and to assess whether a rotor could be designed to determine the Kalman Filter/Senescent Time induced error vector of a candidate GPS UE without placing severe mechancial stress on the rotor system.

## 3. FEASIBILITY STUDIES

### 3.1 Statistical noise measurements

In January 1988, a GPS UE of commercial design (SPS only) became available for the investigation of delayed difference statistics.

For a stationary UE and PDOP values around 3.0, the progress of reported position was studied for various delay intervals and found to obey Rayleigh statistics over the delay interval range selected ie 1 s to 60 s. It is likely that the smaller component of error due to the UE follows a normal distribution while the dominant error, due to the GPS space segment and to the propagation media, describes a smaller proportion of its ambit within the reporting interval of 1 s.

Two hours of data on reported position was logged for the stationary UE. The reported change in position for various fixed intervals through two hour periods was analysed. As the value of the fixed interval increased through the range 1 s, 2 s, 5 s, 10 s, 20 s, 30 s, 45 s, 60 s, it was found that the mean change of reported position over time interval for the respective values of fixed interval closely obeyed Rayleigh statistics, ie mean change in reported position increased with the root of the number of steps (interval seconds) through the range(ref.4). For the sample studied the following relation was obtained

Mean change in reported position = $0.708\ s^{\frac{1}{2}}$ m (figure 3)

where s is the number of interval seconds.

This result indicates that if an antenna were to alternate between two positions, say every 9 s, the mean value of error in delayed difference position would be 2.1 m.

This value will vary with the geometrical disposition of GPS satellites. With the exclusion of Satellite PRN 8 which is operating on a crystal controlled frequency standard, the error observed should be largely independent of the satellite constellation selected.

Because the error is commensurate with the least digit of measurement, the distribution of error about the true value of reported position difference will depart from symmetry as the true value differs from integer values of the least digit.

The least digit of the UE readout may represent 0.1 arc s equivalent to 3 m in latitude or 2.5 m in longitude at the latitude of Salisbury, South Australia, or represent 0.001 arc min, equivalent to 1.8 m in latitude or 1.5 m in longitude at the latitude of Salisbury. Consequently, if a GPS UE antenna is mounted on say a 10 m rotating arm, the least digit readout for longitude (and latitude) will cycle through several integers.

In figure 2, the position of the antenna on the rotor arm is adjusted so that the reported East-West diameter of antenna travel is equal to an integral number of position displacement units. Thus as migration of the clocks in the satellite constellation cause the East-West displacement grid to drift, the distribution of reported East-West displacement remains equally distributed about an integral value.

In order to study the dependence of distribution asymmetry on departure of delayed difference in reported position from least digit integer value, the antenna was stepped along an East-West line a distance equivalent to one least digit unit and then a second least digit unit. The time interval for each step was 20 s. The antenna was then stepped back to the original position at a stepping rate of 20 s.

It was thus possible to obtain the error distribution for a reported delayed difference measurement of one least digit unit (ie the actual measurement unit) for time intervals of 20 s and 60 s and of two measurement units for a time interval of 40 s. These distributions appeared to be symmetrical about values of one and two measurement units respectively. The experiment was repeated across a North-South diameter with a similar result. The experiment was then repeated adding a further step of 50 cm and 100 cm to examine whether departure from integer steps would result in significant asymmetry in the distribution of reported position about the true value. The object of the experiments was to estimate the size of the sample population which would provide a 90% probability of detecting a change of 50 cm in reported position. Sample size for the East-West experiment and the North-South experiments were each limited to 34. However it is very unlikely that the marked asymmetry that resulted in each case for the 50 cm and 100 cm displacements could be attributed entirely to the effect of a small sample. The results suggest that a sample population in the region of 300 is required to achieve 90% to 95% probability of detecting an error in the delayed difference position of 0.5 m. For a rotor rotation rate of 9 rev/min, this would take nearly 34 min.

Detection threshold would decrease as the inverse of square root of rotor speed. Furthermore the radial error in reported position in general increases with rotor speed.

The analysis of position data was one of the projects carried out by S. Braidwood, an EPIC program student from the Physics Department of the University of Adelaide, during his attachment to Electromagnetics Group(ref.4).

3.2 Software simulation for prediction of the error vector

CAST NAVSIM software at the Aeronautical Research Laboratory may be used to predict the error vector for a specified GPS user equipment in a defined dynamic environment.

A request to simulate the rotor motion for four combinations of rotor speed and length of rotor arm was addressed to Flight Management Group at Systems Studies Division ARL. Four combinations were selected to provide comparison benchmarks as well as to bracket the limits on rotor speed and length of arm set by physical constraints and GPS reporting rate. Figure 4 shows a simulation of the physical track obtained for a rotor arm of 10 m rotating at 10 rev/min, using Navsim software. Work is in process to produce a plot of the corresponding behaviour of the error value for a specified GPS UE.

## 4. DESIGN CONSIDERATIONS

Feasibility studies thus show that a GPS UE antenna mounted on a rotor arm of 10 m length and rotating at speeds from 0.5 rev/min to 30 rev/min would provide a useful tool for the assessment of the operation of the Kalman filter. The capability to provide confirmation of simulation studies conducted at ARL for benchmark conditions would assist in qualifying Kalman filter operation of the Phase III UEs and the R&D UEs to be acquired by the ADF mid-1989 and qualify the integration filter design software prior to the work at ARL on the design of GPS/INS/Tacterm integration filters.

Rotor control should be designed so that rotor phase does not vary by more than about 1° from the chosen point of traverse at reporting epoch, over a period of 100 min. Gusty conditions therefore may limit the operation of the rotor. A limit of 0.5° of variation from the chosen point is preferred. It would be desirable to vary the direction of the diameter observed by the delay difference method to allow further development of the rotor technique for more detailed assessment of Kalman filter characteristics.

Discussions have taken place with the School of Electrical Engineering at the South Australian Institute of Technology on the design of the rotor control and the phase reporting system. The design specifications were accepted as feasible for operation except in gusting or strong wind.

## 5. MEASUREMENT PROCEDURE

An antenna, connected via low loss cable through a rotating joint to a GPS UE should be mounted on a rotor arm, of the order of 10 m from the centre of rotation, so that the diameter of the circle it describes is within 4 cm of an integral number of measurement units (see figure 2). An appropriate value for rotor speed, within the range 0.5 rev/min to to 30 rev/min, should be selected.

The rotor should be controlled to ensure that the rotor arm is within about half a degree of the east west (or north south) line at the position reporting epoch. These positions are logged and sequential pairs are differenced. The differences constitute a sample population of delayed difference measurements at the selected fixed interval. The operation should continue until a total of about 300 samples is obtained.

The distribution of delayed difference measurement of reported position in the east west direction should be examined to establish whether it has a high degree of symmetry. If it exhibits asymmetry, the antenna position should be adjusted and the procedure repeated until the distribution is highly symmetrical about a value equal to an integral number of least digit units (see figure 2). This value is then compared with the physical diameter of antenna traverse to obtain twice the value of the east west component of radial error.

The distribution of delayed difference measurement of the north south component of the same reported positions is also examined to establish departure from symmetry. The phase of rotation of the rotor arm at position reporting epoch is adjusted away from the east west line and the procedure repeated until the distribution is closely symmetrical about a value equal to an integral number of least digit units in the north south direction. This value is then compared with the north south component of physical separation of the antenna positions at position reporting epoch to obtain twice the value of the north south component of radial error.

The data should be logged and analysed while the rotor is in operation so that the degree of symmetry of the respective sample populations can be viewed throughout the data capture process.

The radial error vector for a benchmark position should be compared with the value of the radial error vector using NAVSIM simulation software at Systems Division ARL and the values obtained using the Satellite Simulator Test Bed developed by CAST and incorporating the NAVSIM simulation package.

By repeating the procedure for a number of different rotor speeds and relating the dependence of the resulting error vector on rotor speed process noise and to the number of states of the Kalman filter/predictor, it may be possible to extend the technique to obtain a measure of senescent time

## 6. RECOMMENDATIONS

It is recommended that a rotor be constructed in order to develop and to employ a technique for the assessment of UE performance under non-linear dynamic conditions.

Techniques for measurement of velocity dependent position error can detect time like errors in positon. This may occur where UE post processing increases accuracy in static position by using less sophisticated running average techniques. Switch settings broaden the digital filter for higher dynamic states. Time like errors may indicate the absence of an effective velocity based predictor. A procedure for the measurement of velocity dependent position error has been usefully applied by the Radio Navigation Team in Electromagnetics Group for performance tests on a number of UEs of different manufacture.

The Rotor Assessment Test-bed (RAT) should be used in conjuction with the Constant Velocity Optical Recording (CVOR) technique in UE field trials to screen UEs that do not warrant kinetheodolite trials at the Woomera

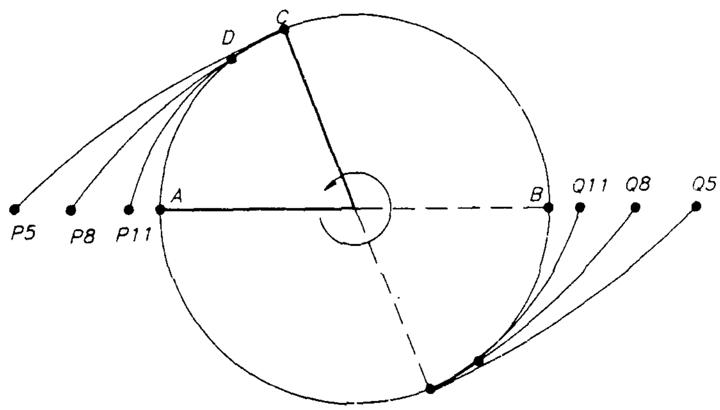
Instrumented Range. The latter option should be reserved for final field assessment of the dynamic performance of qualified GPS UEs.

The South Australian Institute of Technology School of Electrical Engineering can provide the necessary expertise for the design of rotor control systems. Funds should be made available to employ this expertise.

REFERENCES


| No. | Author | Title |
|---|---|---|
| 1 | Gubbay, J.S. | "Scientific Investigation of GPS Differential Navigation Techniques". Air Task Plan 85/090 Final Report January 1987 |
| 2 | Silby, J.H. | "ERL Report of Defence Trial 6/440". August 1987 |
| 3 | Stolz, A. and Masters, E.G. | "Global Positioning System Navigation Errors". Report on work carried out at the University of NSW under Research Agreement, using differential GPS position data collected by Radio Group September 1986 |
| 4 | Braidwood, S. | "Statistical Analysis of Data acquired from a GPS Receiver". Report on work carried out by University of Adelaide EPIC program student on delayed difference position data collected by Electromagnetics Group File: Z6156/5/4 April 1988 |

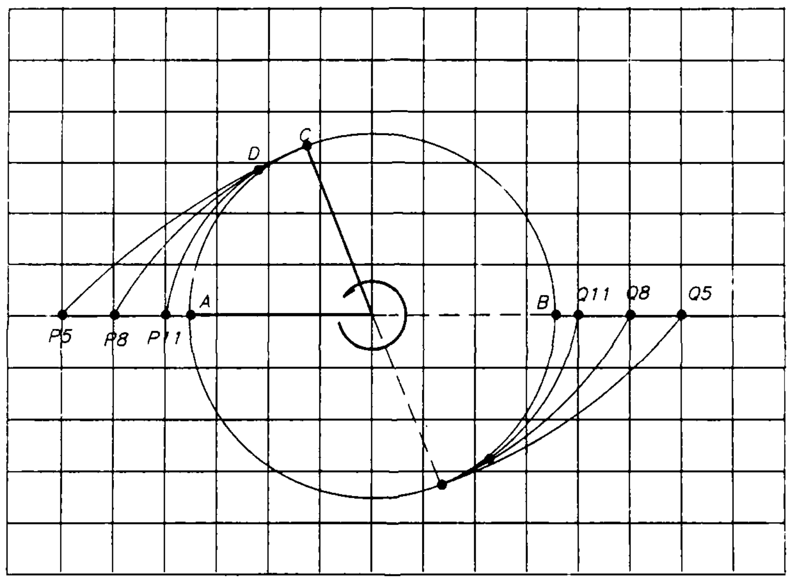
Schematic of error in reported position of GPS antenna mounted on a rotor, induced by predictor.




C DATA CAPTURE
D POSITION DETERMINED
A POSITION REPORTING EPOCH
P POSITION PREDICTED FOR REPORTING EPOCH
: SUBSCRIPT REFERS
5–, 8–, OR 11– STATE KALMAN FILTER
AB ACTUAL DIAMETER OF CIRCULAR PATH
PQ REPORTED DIAMETER OF CIRCULAR PATH
CA SENESCENT TIME

Figure 1. Rotor induced Kalman filter error in reported position

Grid of GPS User Equipment unit readout value superimposed over trajectory of rotating antenna. The antenna has been placed on the rotating arm so that the reported East–West position difference is equal to an integral value of the East–West readout unit.




C DATA CAPTURE
D POSITION DETERMINED
A POSITION REPORTING EPOCH
P POSITION PREDICTED FOR REPORTING EPOCH
: SUBSCRIPT REFERS
5–, 8–, OR 11– STATE KALMAN FILTER
AB ACTUAL DIAMETER OF CIRCULAR PATH
PQ REPORTED DIAMETER OF CIRCULAR PATH
CA SENESCENT TIME

Figure 2. Grid representing measurement resolution superimposed on figure 1

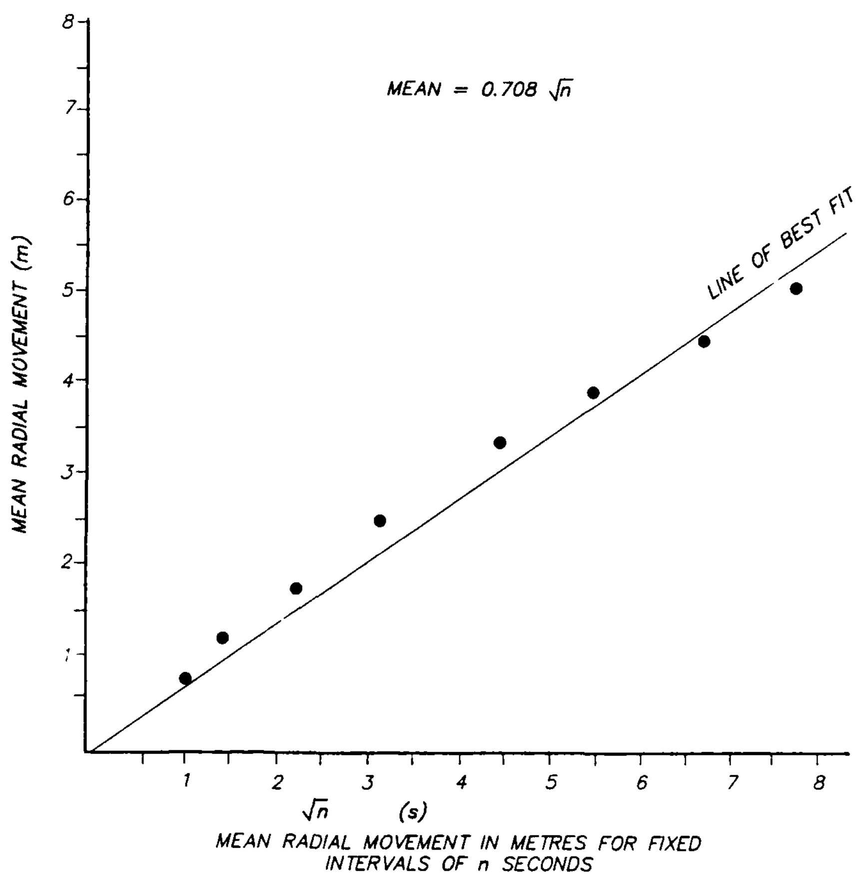
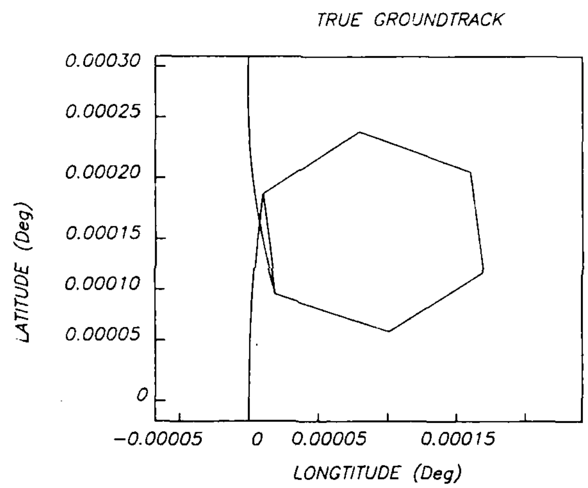



Figure 3. Interval range for which Rayleigh statistics describes GPS system noise

Ground track for a NAVSTAR GPS User Equipment antenna mounted on a rotor. Simulation carried out at ARL using CAST NAVISM simulation package. For segment between 11s and 29s, rotor speed=10rpm; rotor arm=10m. (Courtesy of Dr R. Miller)




| | | |
|---|---|---|
| .00 | CRUISE | 5.00sec |
| 5.00 | CHG.SPD | 10.47m/s |
| 7.05 | TURN.R | 3600.00deg |
| 68.17 | CHG.SPD | .00m/s |
| 70.21 | CRUISE | 10.00sec |

Figure 4. Simulated track of rotor mounted antenna using NAVSIM software (courtesy of Dr R. Miller, ARL)

DISTRIBUTION

| | Copy No. |
|---|---|
| DEPARTMENT OF DEFENCE | |
| Defence Science and Technology Organisation | |
| Chief Defence Scientist | 1 |
| First Assistant Secretary Science Policy (FASSP) | 1 |
| First Assistant Secretary Science Corporate Management (FASSCM) | 1 |
| Counsellor, Defence Science, London | Cnt Sht Only |
| Counsellor, Defence Science, Washington | Cnt Sht Only |
| Surveillance Research Laboratory | |
| Director, Surveillance Research Laboratory | 2 |
| Chief, Microwave Radar Division | 3 |
| Senior Principal Research Scientist, Microwave Radar Division | 4 |
| Head, Radar Techniques Group | 5 |
| Head, Microwave Radar Systems Group | 6 |
| Head, Radar Signal Processing Group | 7 |
| Head, Microwave Radar Engineering Group | 8 |
| Mr W. Dickson, Head, Electronic Warfare Techniques | 9 |
| Dr R. Miller, Flight Management Group, Aeronautical Research Laboratory | 10 |
| Navy Office | |
| Navy Scientific Adviser | Cnt Sht Only |
| Army Office | |
| Scientific Advisor - Army | 11 |
| Director General, Army Development (NSO), Russell Offices for ABCA Standardisation Officers | |
| UK ABCA representative, Canberra | 12 |
| US ABCA representative, Canberra | 13 |
| Canada ABCA representative, Canberra | 14 |
| NZ ABCA representative, Canberra | 15 |

| | |
|---|---|
| Air Office | |
| Air Force Scientific Adviser | 16 |
| Joint Intelligence Organisation (DSTI) | 17 |
| Libraries and Information Services | |
| Librarian, Technical Reports Centre, Defence Central Library, Campbell Park | 18 |
| Document Exchange Centre Defence Information Services Branch for: | |
| Microfiche copying | 19 |
| United Kingdom, Defence Research Information Centre | 20 - 21 |
| United States, Defense Technical Information Center | 22 - 23 |
| Canada, Director, Scientific Information Services | 24 |
| New Zealand, Ministry of Defence | 25 |
| National Library of Australia | 26 |
| Main Library, Defence Science and Technology Organisation Salisbury | 27 - 28 |
| Library, Aeronautical Research Laboratories | 29 |
| Library, Materials Research Laboratories | 30 |
| Librarian, DSD, Melbourne | 31 |
| ACADEMIC INSTITUTIONS | |
| Dr Kurt Kubik, Queensland Institute of Technology | 32 |
| Dr R. Freeman, Queensland Institute of Technology | 33 |
| UNITED KINGDOM | |
| British Library, Lending Division, Boston Spa, Yorks | 34 |
| UNITED STATES OF AMERICA | |
| Commanding Officer, ONSOD, Room 4309, 2100 Second Street SW Washington, DC 20593 | 35 |
| Author | 36 |
| Spares | 37 - 42 |

## DOCUMENT CONTROL DATA SHEET

Security classification of this page : UNCLASSIFIED

**1 DOCUMENT NUMBERS**

| | |
|---|---|
| AR Number : | AR-005-416 |
| Series Number : | SRL-0018-TM |
| Other Numbers : | |

**2 SECURITY CLASSIFICATION**

| | |
|---|---|
| a. Complete Document : | Unclassified |
| b. Title in Isolation : | Unclassified |
| c. Summary in Isolation : | Unclassified |

**3 DOWNGRADING / DELIMITING INSTRUCTIONS**

Limitation to be reviewed in August 1991

**4 TITLE**

GPS USER EQUIPMENT EVALUATION TECHNIQUES USING A ROTOR MOUNTED ANTENNA

**5 PERSONAL AUTHOR (S)**

J.S. Gubbay

**6 DOCUMENT DATE**

August 1988

**7**

| | |
|---|---|
| 7.1 TOTAL NUMBER OF PAGES | 10 |
| 7.2 NUMBER OF REFERENCES | 4 |

**8 8.1 CORPORATE AUTHOR (S)**

Surveillance Research Laboratory

8.2 DOCUMENT SERIES and NUMBER

Technical Memorandum 18

**9 REFERENCE NUMBERS**

| | |
|---|---|
| a. Task : | AIR 87/236 |
| b. Sponsoring Agency : | |

**10 COST CODE**

425

**11 IMPRINT (Publishing organisation)**

Defence Science and Technology Organisation Salisbury

**12 COMPUTER PROGRAM (S)** (Title (s) and language (s))

**13 RELEASE LIMITATIONS (of the document)**

Approved for Public Release.

Security classification of this page : UNCLASSIFIED

Security classification of this page : UNCLASSIFIED

**14 ANNOUNCEMENT LIMITATIONS** (of the information on these pages)

No limitation

**15 DESCRIPTORS**

a. EJC Thesaurus Terms

Global Positioning System
Noise measurement

b. Non - Thesaurus Terms

GPS
NAVSTAR
Dynamic performance evaluation
Delayed difference noise measurement

**16 COSATI CODES**

0076B
0049A

**17 SUMMARY OR ABSTRACT**
(if this is security classified, the announcement of this report will be similarly classified)


The accuracy of the NAVSTAR Global Positioning System (GPS) permits evaluation of dynamic performance of user equipments by mounting the antenna on a rotor of practical dimension.

The reported diameter of the circular path described by the antenna phase centre will depend on Kalman filter characteristics and will tend to increase with rotor speed. GPS system noise was observed to obey Rayleigh statistics through measurement delay intervals up to 1 min. This characteristic of system noise and the development of symmetry techniques permits delayed difference measurement of reported diameter of antenna path to an accuracy of better than 0.5 m over 30 min. This method of Kalman error measurement provides a means for establishing a benchmark for integration filter design software simulation.


Security classification of this page : UNCLASSIFIED

The official documents produced by the Laboratories of the Defence Research Centre Salisbury are issued in one of five categories: Reports, Technical Reports, Technical Memoranda, Manuals and Specifications. The purpose of the latter two categories is self-evident, with the other three categories being used for the following purposes:

| | | |
|---|---|---|
| Reports | : | documents prepared for managerial purposes. |
| Technical Reports | : | records of scientific and technical work of a permanent value intended for other scientists and technologists working in the field. |
| Technical Memoranda | : | intended primarily for disseminating information within the DSTO. They are usually tentative in nature and reflect the personal views of the author. |