cmc electronics

USER'S MANUAL

ALLSTAR

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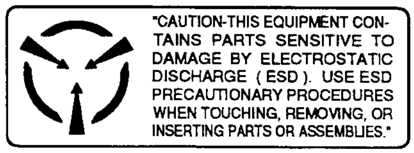
FORWARD

ELECTROSTATIC DISCHARGE

This equipment contains components which are sensitive to damage by electrostatic discharge (ESD).

Modules containing components sensitive to ESD are identified on the module by a label bearing the following marking.



When these modules have to be replaced and returned for service the following precautions should be observed:

1. Handle the modules as little as possible. Do not touch the leads, pin or tracks while handling.

2. Keep spare modules in the ESD protective packing until ready for use.

3. Discharge static before handling modules (removal or replacement) by touching a grounded metallic surface such as rack or cabinet hardware. Use of wrist strap grounded through a one megohm resistor is preferred when handling modules. (This ground should be the same as the equipment ground).

4. Do not slide static-sensitive modules over any surface.

5. Clothing must not come in contact with components or assemblies. Short sleeves are preferred; if long sleeves are worn then should be rolled up.

6. Package parts properly for storage or transportation. Modules which are removed from the equipment should be placed into ESD protective packing immediately. Do not place any paper, card or other plastic inside the ESD protective packing.

7. When packing these modules for storage or transportation, keep them in the bag. Fold over and seal the mouth of the bag to keep out any static generating packing material (eg, foamed polystyrene). Pack around the bag firmly to prevent motion which could generate static.

WARRANTY

In the case of any ESD sensitive module bearing the marking described above which is received by CMC Electronics Inc. not in ESD protective packing, other than the initially reported fault, all warranty, present or future, is voided for failure related to ESD sensitive components.

GLOSSARY OF TERMS

ASCII - A 7 bit wide serial code describing numbers, upper and lower case alpha characters, special and non-printing characters.

Address field - for sentences in the NMEA standard, the fixed length field following the beginning sentence delimiter "$" (HEX 24). For NMEA approved sentences, composed of a two character talker identifier and a three character sentence formatter. For proprietary sentences, composed of the character "P" (HEX 50) followed by a three character manufacturer identification code.

Almanac - a set of orbit parameters that allows calculation of approximate GPS satellite positions and velocities. The almanac is used by a GPS receiver to determine satellite visibility and as an aid during acquisition of GPS satellite signals.

Attenuation - reduction of signal strength.

Azimuth - the horizontal direction of a celestial point from a terrestrial point, expressed as the angular distance from 000° (reference) clockwise through 360°. The reference point is generally True North, but may be Magnetic North, or Relative (ship's head).

Bearing - the horizontal direction of one terrestrial point from another terrestrial point, expressed as the angular distance from a reference direction, usually measured from 000° at the reference direction clockwise through 360°. The reference point may be True North, Magnetic North, or Relative (ship's head).

Carrier - the steady transmitted RF signal whose amplitude, frequency, or phase may be modulated to carry information.

Checksum - by NMEA standard, a validity check performed on the data contained in the sentences, calculated by the talker, appended to the message, then recalculated by the listener for comparison to determine if the message was received correctly. Required for some sentences, optional for all others.

Circular Error Probable (CEP) - the radius of a circle, centered at the user's true location, that contains 50 percent of the individual position measurements made using a particular navigation system.

Coarse Acquisition (C/A) Code - a spread spectrum direct sequence code that is used primarily by commercial GPS receivers to determine the range to the transmitting GPS satellite. Uses a chip rate of 1.023 MHz.

Communication protocol - a method established for message transfer between a talker and a listener which includes the message format and the sequence in which the messages are to be transferred. Also includes the signalling requirements such a baud rate, stop bits, parity, and bits per character.

Control segment - the Master Control Station and the globally dispersed Monitor Stations used to manage the GPS satellites, determine their precise orbital parameters, and synchronize their clocks.

Course - the horizontal direction in which a vessel is to be steered or is being steered; the direction of travel through the air or water. Expressed as angular distance from reference North (either true, magnetic, compass, or grid), usually 000° (north), clockwise through 360°. Strictly, the term applies to direction through the air or water, not the direction intended to be made good over the ground (see *track*). Differs from heading.

Cycle slip - an error in the continuous count of carrier phase cycles.

Dead Reckoning (DR) - the process of determining a vessel's approximate position by applying from its last known position a vector or a series of consecutive vectors representing the run that has since been made, using only the courses being steered, and the distance run as determined by log, engine rpm, or calculations from speed measurements.

Destination - the immediate geographic point of interest to which a vessel is navigating. It may be the next waypoint along a route of waypoints or the final destination of a voyage.

Differential GPS (DGPS) - a technique to improve GPS accuracy that uses pseudorange errors measured at a known location to improve the measurements made by other GPS receivers within the same general geographic area.

Dilution of Precision (DOP) - A numerical value expressing the confidence factor of the position solution based on current satellite geometry. The lower the value, the greater the confidence in the solution. DOP can be expressed in the following forms:

GDOP	-	all parameters are uncertain (latitude, longitude, height, clock offset)
PDOP	-	3D parameters are uncertain (latitude, longitude, height)
HTDOP	-	2D parameters and time are uncertain (latitude, longitude, time)
HDOP	-	2D parameters are uncertain (latitude, longitude)
VDOP	-	height is uncertain
TDOP	-	clock offset is uncertain

Doppler - the change in frequency of sound, light or other wave caused by movement of its source relative to the observer.

Doppler aiding - a signal processing strategy, which uses a measured Doppler shift to help a receiver smoothly track the GPS signal, to allow more precise velocity and position measurement.

Earth-Centered-Earth-Fixed (ECEF) -a right-hand Cartesian coordinate system with its origin located at the center of the Earth. The coordinate system used by GPS to describe three-dimensional location.
ECEF - Earth-Centered-Earth-Fixed coordinates are centered on the WGS-84 reference ellipsoid, have the "Z" axis aligned with the Earth's spin axis, the "X" axis through the intersection of the Prime Meridian and the Equator and the "Y" axis is rotated 90 degrees East of the "X" axis about the "Z" axis.

Ephemeris - a set of satellite orbit parameters that is used by a GPS receiver to calculate precise GPS satellite positions and velocities. The ephemeris is used in the determination of the navigation solution and is updated periodically by the satellite to maintain the accuracy of GPS receivers.

Field - a character or string of characters immediately preceded by a field delimiter.

Fixed field -a field in which the number of characters is fixed. For data fields, such fields are shown in the sentence definitions with no decimal point. Other fields which fall into this category are the address field and the checksum field (if present).

Flash ROM - Programmable read-only memory.

GDOP - Geometric Dilution of Precision - A numerical value expressing the confidence factor of the position solution based on current satellite geometry. Assumes that 3D position (latitude, longitude, height) and receiver clock offset (time) are variables in the solution. The lower the GDOP value, the greater the confidence in the solution.

Geodetic datum - the reference ellipsoid surface that defines the coordinate system.

Geoid - the figure of the earth considered as a sea level surface extended continuously through the continents. The actual geoid is an equipotential surface coincident with mean sea level to which at every point the plumb line (direction in which gravity acts) is perpendicular.

Geostationary - a satellite orbit along the equator that results in a constant fixed position over a particular reference point on the earth's surface. (GPS satellites are not geostationary.)

Global Positioning System (GPS) - full name NAVSTAR Global Positioning System, a space-based radio positioning system which provides suitably equipped users with accurate position, velocity and time data. When fully operational, GPS will provide this data free of direct user charge worldwide, continuously, and under all weather conditions. The GPS constellation will consist of 24 orbiting satellites, four equally spaced around each of six different orbital planes. The system is being developed by the Department of Defense under U.S. Air Force management.

Great circle - the shortest distance between any two points along the surface of a sphere or ellipsoid, and therefore the shortest navigation distance between any two points on the Earth. Also called Geodesic Line.

HDOP - Horizontal Dilution of Precision - A numerical value expressing the confidence factor of the horizontal position solution based on current satellite geometry. Makes no constraint assumptions about time, and about height only if the FIX HEIGHT command has been invoked. The lower the HDOP value, the greater the confidence in the solution.

HTDOP - Horizontal position and Time Dilution of Precision - A numerical value expressing the confidence factor of the position solution based on current satellite geometry. Assumes height is known if the FIX HEIGHT command has been invoked. If not, it will give the normalized precision of the horizontal and time parameters given that nothing has been constrained. The lower the HTDOP value, the greater the confidence factor.

Heading - the direction in which a vessel points or heads at any instant, expressed in degrees 000° clockwise through 360° and may be referenced to True North, Magnetic North, or Grid North. The heading of a vessel is also called the ship's head. Heading is a constantly changing value as the vessel oscillates or yaws across the course due to the effects of the air or sea, cross currents, and steering errors.

L1 frequency - the 1575.42 MHz GPS carrier frequency which contains the coarse acquisition (C/A) code, as well as encrypted P-code, and navigation messages used by commercial GPS receivers.

L2 frequency - a secondary GPS carrier, containing only encrypted P-code, used primarily to calculate signal delays caused by the ionosphere. The L2 frequency is 1227.60 MHz.

Magnetic bearing - bearing relative to magnetic north; compass bearing corrected for deviation.

Magnetic heading - heading relative to magnetic north.

Magnetic variation - the angle between the magnetic and geographic meridians at any place, expressed in degrees and minutes east or west to indicate the direction of magnetic north from true north.

Mask angle - the minimum GPS satellite elevation angle permitted by a particular GPS receiver design. Satellites below this angle will not be used in position solution.

Measurement error variance - the square of the standard deviation of a measurement quantity. The standard deviation is representative of the error typically expected in a measured value of that quantity.

Multipath errors - GPS positioning errors caused by the interaction of the GPS satellite signal and its reflections.

Nanosecond - 1×10^{-9} second.

Nautical mile - any of various units of distance for sea and air navigation; in the U.S. since 1959, an international unit of linear measure equal to 1 minute of arc of a great circle of the Earth, 1,852 metres (6,076 feet).

Null field - by NMEA standard, indicates that data is not available for the field. Indicated by two ASCII commas, i.e., “*” (HEX 2C2C), or, for the last data field in a sentence, one comma followed by either the checksum delimiter "“”"(HEX 2A) or the sentence delimiters <CR><LF> (HEX 0D0A). [Note: the ASCII Null character (HEX 00) is <u>not</u> to be used for null fields.]

Obscuration - term used to describe periods of time when a GPS receiver's line-of-sight to GPS satellites is blocked by natural or man-made objects.

Origin waypoint - the starting point of the present navigation leg, expressed in latitude and longitude.

P-Code (precise or protected) - a spread spectrum direct sequence code that is used primarily by military GPS receivers to determine the range to the transmitting GPS satellite. Uses a chipping rate of 10.23 MHz.

PDOP - Position Dilution of Precision - A numerical value expressing the confidence factor of the position solution based on current satellite geometry. 3D position (latitude, longitude, height) is unknown. The lower the PDOP value, the greater the confidence factor.

PRN - Pseudo-Random Noise number - the identify of the GPS satellites as determined by a GPS receiver. Since all GPS satellites must transmit on the same frequency, they are distinguished by their pseudo-random noise codes.

Parallel receiver -a receiver that monitors four or more satellites simultaneously with independent channels.

Precise Positioning Service (PPS) - the GPS positioning, velocity, and time service which will be available on a continuous, worldwide basis to users authorized by the U.S. Department of Defense (typically using P-Code).

Pseudolite - an Earth-based transmitter designed to mimic a satellite. May be used to transmit differential corrections.

Pseudorange - the calculated range from the GPS receiver to the satellite determined by taking the difference between the measured satellite transmit time and the receiver time of measurement, and multiplying by the speed of light. This measurement generally contains a large receiver clock offset error.

Receiver channels - a GPS receiver specification which indicates the number of independent hardware signal processing channels included in the receiver design.

Relative bearing - bearing relative to heading or to the vessel.

Residual - in the context of measurements, the residual is the misclosure between the calculated measurements, using the position solution and actual measurements.

Route - a planned course of travel, usually composed of more than one navigation leg.

Satellite elevation - the angle of the satellite above the horizon.

Selected waypoint - the waypoint currently selected to be the point toward which the vessel is travelling. Also called **"to" waypoint, destination** or **destination waypoint**.

Selective Availability (SA) - the method used by the United States Department of Defense to control access to the full accuracy achievable by civilian GPS equipment (generally by introducing timing and ephemeris errors).

Sequential receiver - a GPS receiver in which the number of satellite signals to be tracked exceeds the number of available hardware channels. Sequential receivers periodically reassign hardware channels to particular satellite signals in a predetermined sequence.

Spherical Error Probable (SEP) - the radius of a sphere, centered at the user's true location, that contains 50 percent of the individual three-dimensional position measurements made using a particular navigation system.

Spheroid - sometimes known as ellipsoid; a perfect mathematical figure which very closely approximates the geoid. Used as a surface of reference for geodetic surveys. The geoid, affected by local gravity disturbances, is irregular.

Standard Positioning Service (SPS) - a positioning service made available by the United States Department of Defense which will be available to all GPS civilian users on a continuous, worldwide basis (typically using C/A code)

SV - Space Vehicle ID, sometimes used as SVID; also used interchangeably with Pseudo-Random Noise Number (PRN).

TDOP - Time Dilution of Precision - A numerical value expressing the confidence factor of the position solution based on current satellite geometry. The lower the TDOP value, the greater the confidence factor.

Three-dimensional coverage (hours) - the number of hours-per-day when four or more satellites are available with acceptable positioning geometry. Four visible satellites are required to determine location and altitude.

Three-dimensional (3D) navigation - navigation mode in which altitude and horizontal position are determined from satellite range measurements.

Time-To-First-Fix (TTFF) - the actual time required by a GPS receiver to achieve a position solution. This specification will vary with the operating state of the receiver, the length of time since the last position fix, the location of the last fix, and the specific receiver design.

Track made good - the single resultant direction from a point of departure to a point of arrival or subsequent position at any given time; may be considered synonymous with Course Made Good.

True bearing - bearing relative to true north; compass bearing corrected for compass error.

True heading - heading relative to true north.

Two-dimensional coverage (hours) - the number of hours-per-day with three or more satellites visible. Three visible satellites can be used to determine location if the GPS receiver is designed to accept an external altitude input.

Two-dimensional (2D) navigation - navigation mode in which a fixed value of altitude is used for one or more position calculations while horizontal (2D) position can vary freely based on satellite range measurements.

Undulation - the distance of the geoid above (positive) or below (negative) the mathematical reference ellipsoid (spheriod). Also known as geoidal separation, geoidal undulation, geoidal height.

Universal Time Coordinated (UTC) - this time system uses the second-defined true angular rotation of the Earth measured as if the Earth rotated about its Conventional Terrestrial Pole. However, UTC is adjusted only in increments of one second. The time zone of UTC is that of Greenwich Mean Time (GMT).

Update rate - the GPS receiver specification which indicates the solution rate provided by the receiver when operating normally.

VDOP - Vertical Dilution of Precision - A numerical value expressing the confidence factor of the position solution based on current satellite geometry. The lower the VDOP value, the greater the confidence factor.

Variable field - by NMEA standards, a data field which may or may not contain a decimal point and which may vary in precision following the decimal point depending on the requirements and the accuracy of the measuring device.

WGS-84 - World Geodetic System 1984 is an ellipsoid designed to fit the shape of the entire Earth as well as possible with a single ellipsoid. It is often used as a reference on a worldwide basis, while other ellipsoids are used locally to provide a better fit to the Earth in a local region. GPS uses the center of the WGS-84 ellipsoid as the center of the GPS ECEF reference frame.

Waypoint - a reference point on a track.

GLOSSARY OF ACRONYMS

1PPS	One Pulse Per Second
2D	Two Dimensional
3D	Three Dimensional
A/D	Analog-to-Digital
ASCII	American Standard Code for Information Interchange
BIT	Built-In Test
bps	Bits per Second
C/A Code	Coarse/Acquisition Code
CEP	Circular Error Probable
CMC	CMC Electronics Inc.
CPU	Central Processing Unit
CR	Carriage Return
CRC	Cyclic Redundancy Check
CTS	Clear To Send
dB	Decibel
DGNSS	Differential Global Navigation Satellite System
DGPS	Differential Global Positioning System
DOP	Dilution Of Precision
DSP	Digital Signal Processor
DSR	Data Set Ready
DTR	Data Terminal Ready
ECEF	Earth-Centered-Earth-Fixed
ESD	Electrostatic Discharge
FOM	Figure of Merit
GDOP	Geometric Dilution Of Precision
GMT	Greenwich Mean Time
GND	Ground
GPS	Global Positioning System
HDOP	Horizontal Dilution Of Precision
hex	Hexadecimal
HTDOP	Horizontal position and Time Dilution Of Precision
Hz	Hertz
IC	Integrated Circuit
IF	Intermediate Frequency
I/O	Input/Output
IODE	Issue of Data (Ephemeris)
IRQ	Interrupt Request

LF	Line Feed
LHCP	Left Hand Circular Polarization
LNA	Low Noise Amplifier
LO	Local Oscillator
lsb	Least significant bit
msb	Most significant bit
msec	millisecond
MSL	Mean sea level
MTBF	Mean Time Between Failures
N.mi.	Nautical mile
NCO	Numerically Controlled Oscillator
NMEA	National Marine Electronics Association
nsec	nanosecond
OCXO	Oven Controlled Crystal Oscillator
OEM	Original Equipment Manufacturer
PC	Personal Computer
PCB	Printed Circuit Board
P Code	Precise Code
PDOP	Position Dilution Of Precision
PLL	Phase Lock Loop
PPS	Precise Positioning Service or Pulse Per Second
PRN	Pseudo-Random Noise number
PVT	Position Velocity Time
RAM	Random Access Memory
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
ROM	Read Only Memory
RTC	Real-Time Clock
RTCA	Radio Technical Commission for Aviation Services
RTCM	Radio Technical Commission for Maritime Services
RTK	Real Time Kinematic
RTS	Request To Send
RXD	Received Data
SA	Selective Availability
SEP	Spherical Error Probable
SNR	Signal-to-Noise Ratio
SPS	Standard Positioning Service
SRAM	Static Random Access Memory
SV	Space Vehicle

TCXO	Temperature Compensated Crystal Oscillator
TDOP	Time Dilution Of Precision
TTFF	Time-To-First-Fix
TXD	Transmitted Data
UART	Universal Asynchronous Receiver Transmitter
UDRE	User Differential Range Error
UTC	Universal Time Coordinated
VDOP	Vertical Dilution of Precision
VSWR	Voltage Standing Wave Ratio
WGS	World Geodetic System
wpt	Waypoint
XTE	Crosstrack Error

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SECTION I

INTRODUCTION

PURPOSE OF THE MANUAL

This user manual defines the design, operational characteristics, physical, interface, functional and performance requirements for the receiver along with the installation and operation procedures.

SYSTEM OVERVIEW

The receiver is a Global Positioning System (GPS) Standard Positioning Service (SPS) single board twelve-channel code differential receiver for embedding in Original Equipment Manufacturer (OEM) consumer market navigation systems.

Code Differential GPS (Code DGPS) is the regular Global Positioning System (GPS) with an additional correction (differential) signal added. This correction signal improves the accuracy of GPS and can be broadcast over any authorized communication channel.

The GPS determined position of a base station is computed and compared to its surveyed geodetic position. The differential information is transmitted to user receivers by radio or other means. These differences can then be matched up with GPS measurements from the roving GPS receiver, and used to remove the systematic (correctable) error factors.

A DGPS system therefore consists of at least two units: a base station and one or several roving units. The base station broadcasts its differential data and the roving units receive it through a data port, directly connected to a radio receiver. The roving units can then display velocity, time and other information as needed for their marine, terrestrial, or aeronautical applications.

The receiver with a separate GPS antenna, decodes the GPS satellites RF signal and interfaces with a host system to provide three dimensional user position and velocity, time and other status information at a maximum rate of once per second. It decodes differential corrections from the transmitting base station as well. The receiver uses WGS-84 as its geographic reference.

The receiver has 12 independent parallel channels each capable of simultaneously tracking a GPS satellite signal. The receiver makes provisions for external initialization of data to support faster GPS signal acquisition. Figure 1-1 illustrates the receiver single board.

Figure 1-1. Receiver Single Board

The main features are listed as follows:

- Decodes differential corrections encoded in the RTCM message format.
- Twelve channel correlator for all-in-view satellite tracking.
- Single chip RF Front End.
- Supports active and passive antennas.
- Single 5V input operation.
- Complete GPS receiver and navigator on a single compact board.
- Operation under standard temperature range (-30°C to +75°C). Optional extended temperature range (-40°C to +85°C).
- 1 PPS Output aligned on GPS Time ± 200 ns
- 1,2,5 or 10 Hz Measurement Output Aligned on GPS Time
- Support for 62 predefined datums.
- Upgradeable software (stored in Flash memory) via the RS-232 serial port.
- Code and Carrier tracking of L1 GPS frequency for increased accuracy.
- Retention of satellite almanac and ephemeris data in non-volatile memory for rapid time-to-first-fix (TTFF) after power interruption.
- Very fast signal reacquisition due to signal masking (obstruction or vehicle attitude).
- Two serial input/output data ports. One for host communication, the second one for differential data output. Both can be used for the maintenance (reprogramming) mode.
- On-board rechargeable lithium battery (optional).

Custom Application Optional Features:

- Spare CPU time.
- Third serial input/output data port.
- Memory expansion: FLASH, EEPROM and SRAM memories.
- 2 Hz and 5 Hz PVT Output (Optional)

The receiver is available in 3 formats:

- as an OEM board
- within the Development Kit
- within the STARBOX casing

The Development Kit is an equipment set permitting easy evaluation of the receiver. A full description of this kit is provided in Appendix A.

The STARBOX casing is a special packaging of the receiver. A full description of the STARBOX is provided in Appendix B.

RELATED PUBLICATIONS

The related publications are listed in Figure 1-2.

PUBLICATION NAME	PUBLICATION NAME
[1] ICD-GPS-200 Rev. B	NAVSTAR GPS Space Segment/Navigation Interface
[2] RTCM-104 version 2.1 January 1994	Recommended Standards for Differential NAVSTAR GPS Radio Technical Commission for Maritime Services
[3] SAE J1211	Recommended Environmental Practices for Electronic Equipment Design
[4] NMEA-0183 Rev 2.20	National Marine Electronics Association Standard for Interfacing
[5] STARVIEW User's Manual	#1205-GEN-0101

Figure 1-2. Related Publications

EQUIPMENT IDENTIFICATION

Using the DGPS base station receiver requires specific hardware equipment. The nomenclature and part number or model for the required equipment are listed in Figure 1-3.

EQUIPMENT NOMENCLATURE	PART NUMBER OR RECOMMENDED MODEL
GPS Receiver	220-600944-00X
GPS Antenna	Active Geodetic Antenna between +12dB and +36dB [1]
DPGS Receiving Antenna	Any UHF antenna
Receiving Modem	GLB Model SN2RX96-450

[1] Refer to Appendix D, or contact CMC for our list of antennas (sold separately).

Figure 1-3. Equipment Identification

SYSTEM ARCHITECTURE

Figure 1-4 below depicts the block diagram of the receiver assembly.

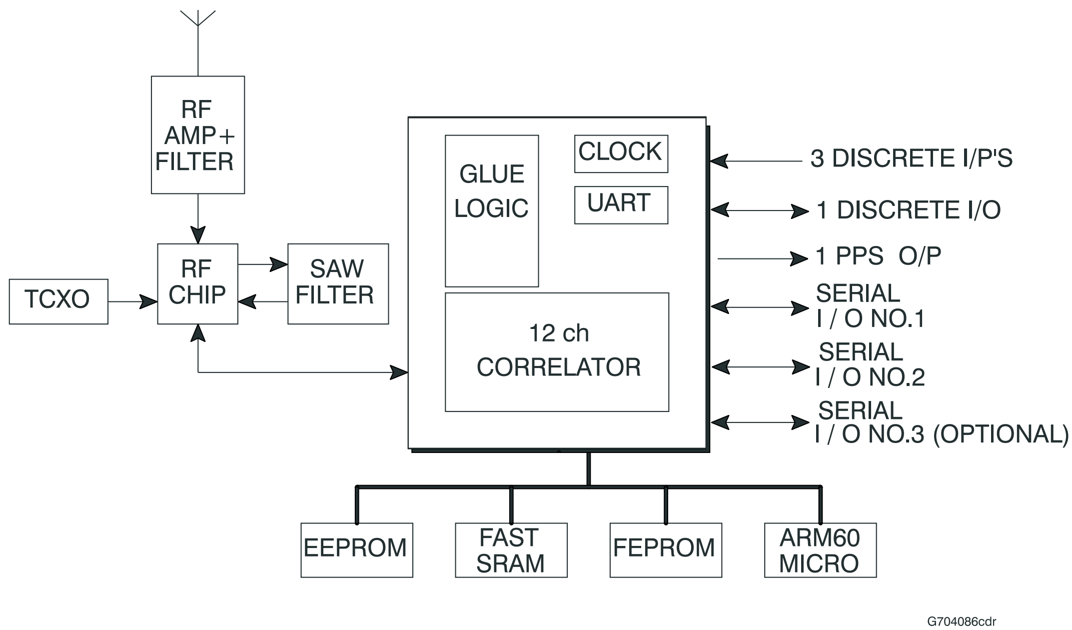

Figure 1-4. Receiver Block Diagram

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SECTION II

RECEIVER SPECIFICATIONS

NAVIGATION PERFORMANCE

The position and velocity outputs meet the accuracies defined in Figure 2-1 under the dynamic conditions of 500 m/s and linear acceleration of up to ±4.0g. Specified accuracies are achieved with a 95% probability.

NAVIGATION ACCURACIES	SA INACTIVE	SA ACTIVE	DGPS	RTK (optional)
Receiver Performance 2 SIGMA (95%)				
Horizontal Position	30 meters	100 meters	2 meters	0.2 meters
Ground Speed*	0.13 m/s	0.3 m/s	0.05 m/s	0.05 m/s
Track Angle True**	1.0 deg	3.0 deg	0.1 deg	0.1 deg
Vertical Speed	0.16 m/s	0.6 m/s	0.1 m/s	0.1 m/s
Altitude	40 meters	160 meters	5 meters	0.2 meters
N-S Velocity*	0.1088 m/s	0.21 m/s	0.035 m/s	0.035 m/s
E-W Velocity*	0.1088 m/s	0.21 m/s	0.035 m/s	0.035 m/s
Time***	1 usec	1 usec	1 usec	1 usec

* Velocity accuracies are for straight and level motion during zero acceleration. Dynamic errors due to jerk of 2 m/s^3 results in a maximum additive error of 4.2 m/s.
** For a ground speed of 20 km/hour or greater.
*** At the rising edge of Time Mark output.

Figure 2-1. Position and Velocity Outputs

The accuracies are met for the following conditions:

HDOP = 1.5
VDOP = 2.0
TDOP = 0.8

A. FIGURE OF MERIT

The receiver provides an estimated accuracy level. The accuracy level estimate is provided in the horizontal and vertical Figure of Merit (FOM). The FOM reflects a 95% confidence level for the position solution accuracy estimate. The FOM accounts for all major sources of errors in the pseudo ranges of the satellites used in the position solution. The error sources which are included are selective availability, ionospheric and tropospheric errors, satellite position errors based on transmitted user range error and thermal noise.

B. TIME-TO-FIRST-FIX (TTFF)

The receiver shall enter Navigation mode and provide valid outputs in less than 50 seconds (95%) after completion of the self-test and all of the following initialization criteria being met:

1. Valid time (±10 minutes) and position data (±100 km) from actual position.

2. Valid almanac data (less than one year old).

3. Elevation of at least 4 satellites greater than 5° above horizon.

4. HDOP < 6.

   The time allowed for self-test and device initialization is less than 5 seconds.

   In the case where the following additional conditions are met, the TTFF is reduced to less than 30 seconds (95%):

5. The unit was in SRAM Keep-Alive mode before nominal power was re-applied.

6. The last navigation fix occurred within the last 2 hours.

7. Valid ephemeris data (age of less than 4 hours) for at least 5 satellites.

With no initialization, the time from power application to valid navigation output is less than 3 minutes typically (less than 10 minutes, 95%).

RECEIVER PERFORMANCE

The receiver meets the performance requirements defined below under conditions of vehicle operating speeds of up to 514 m/s (limited by Canadian & US Export Laws), acceleration of up to ±4.0g, jerk of up to 2 m/s^3, specified temperature range (as specified herein) and minimum carrier-to-noise ratios (as specified herein).

1. GPS Signals

   The receiver is meant to operate using the L1 GPS signal as described in Reference [1].

2. Reacquisition

   Reacquisition is defined as resumption of tracking and measurement processing.

   There is no disruption of navigation data output when a satellite signal is lost, for reasons other than a receiver power interrupt, for a period of less than or equal to 200 milliseconds.

   When a satellite signal is lost, for reasons other than a receiver power interrupt, for a period greater than 200 milliseconds but less than 5 seconds, the receiver reacquires the satellite signal within 0.3 seconds after the satellite visibility has been restored.

When a satellite signal has been lost due to signal masking, the signal is typically reacquired within 2-3 seconds after the satellite signal meets the minimum input levels. The vehicle dynamics during the masking period are assumed to be less than or equal to 0.5g acceleration and 100 m/s velocity.

When total signal masking occurs, navigation will resume within 3-5 seconds of a Navigation mode criteria being met.

3. Measurement Rate

The receiver is capable of 10 measurements per satellite per second. A complete navigation solution is computed every second (2 per second if in 2Hz PVT mode or 5 per second if in 5Hz PVT mode) whenever a sufficient set of measurements is acquired.

4. Operational Signal Level Input

The receiver will operate with a signal level input from -165 dBW to -120 dBW.

5. RF Input Impedance

The impedance is 50 ohms with VSWR of 2.0 : 1 or better.

6. Receiver Noise Figure

The receiver has the following noise figure characteristics:

Typical:	3.8 dB
Maximum:	4.8 dB

in the temperature range of -40°C to +85°C and supply voltage range 5V ± 5%.

7. Acquisition Sensitivity

The receiver is capable of acquiring satellite signals with a minimum input carrier-to-noise density ratio (C/N_0) to the correlator of 34 dB-Hz.

8. Tracking Sensitivity

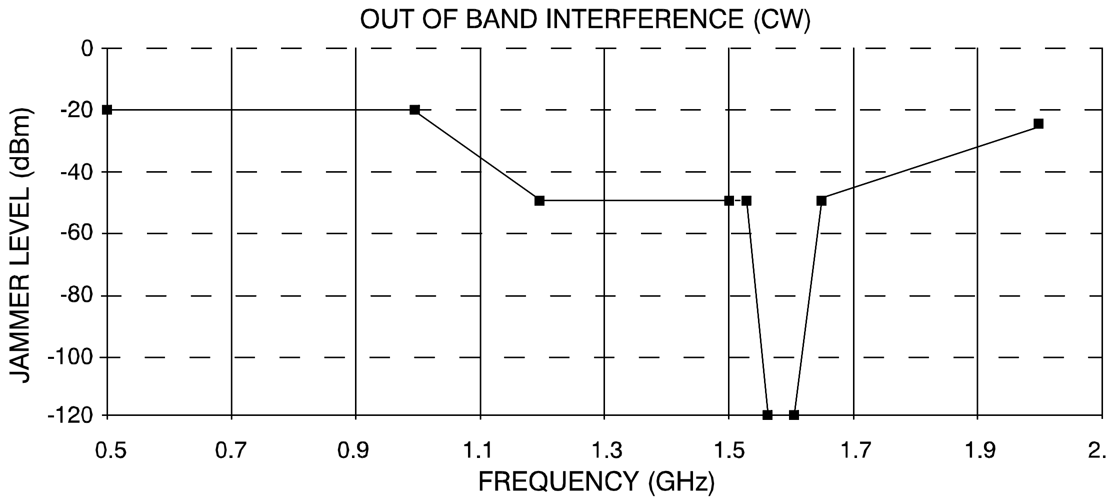
Once a signal has been acquired, the receiver is capable of tracking satellite signals with a minimum input carrier-to-noise density ratio (C/N_0) to the correlator of 31 dB-Hz.

9. Input Burn-Out Protection

The receiver is capable of withstanding a signal level not exceeding +15 dBm at L1+/- 50 MHz without damage.

10. Out of Band CW Signal Rejection

The receiver, in a suitable system configuration, is capable of continuous operation under interference conditions specified in Figure 2-2.



G704081CDR

Frequency	Power	Frequency	Power
0.500	-20.0	1.560	-120.0
1.000	-20.0	1.590	-120.0
1.200	-50.0	1.625	-50.0
1.525	-50.0	2.000	-25.0

Tabular values of Figure 4.1

Figure 2-2. Out of Band Interference (CW)

PHYSICAL CHARACTERISTICS

This section applies to the OEM board version of the receiver.

For details on the physical characteristics of the Development Kit version of the receiver, please refer to Appendix A.

For details on the physical characteristics of the STARBOX version of the receiver, please refer to Appendix B.

A. OUTLINE AND FORM FACTOR

Figure 2-3 shows the OEM board outline.

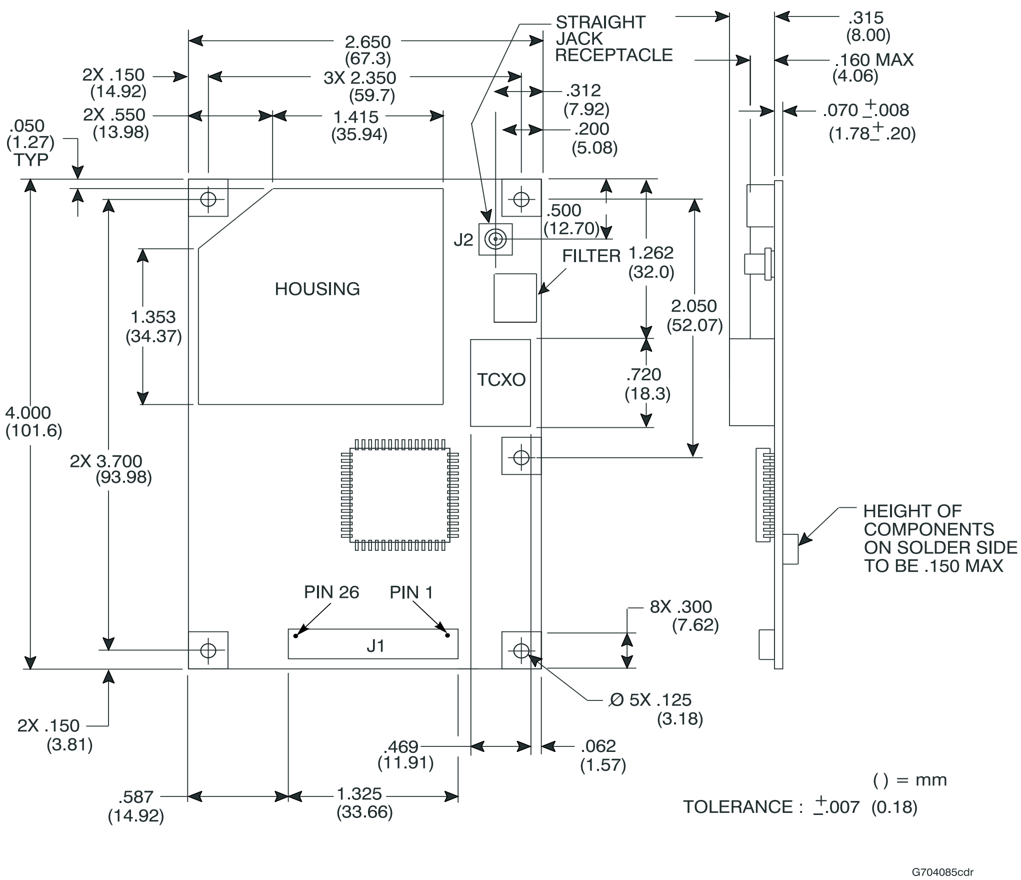


Figure 2-3. Receiver OEM Board Outline Drawing
(VAR -XX1)

Figure 2-4 shows the receiver OEM board outline for:

VAR-XX2 : right angle connector
VAR-XX3 : straight header connector on top side
VAR-XX0 : straight header connector on bottom side

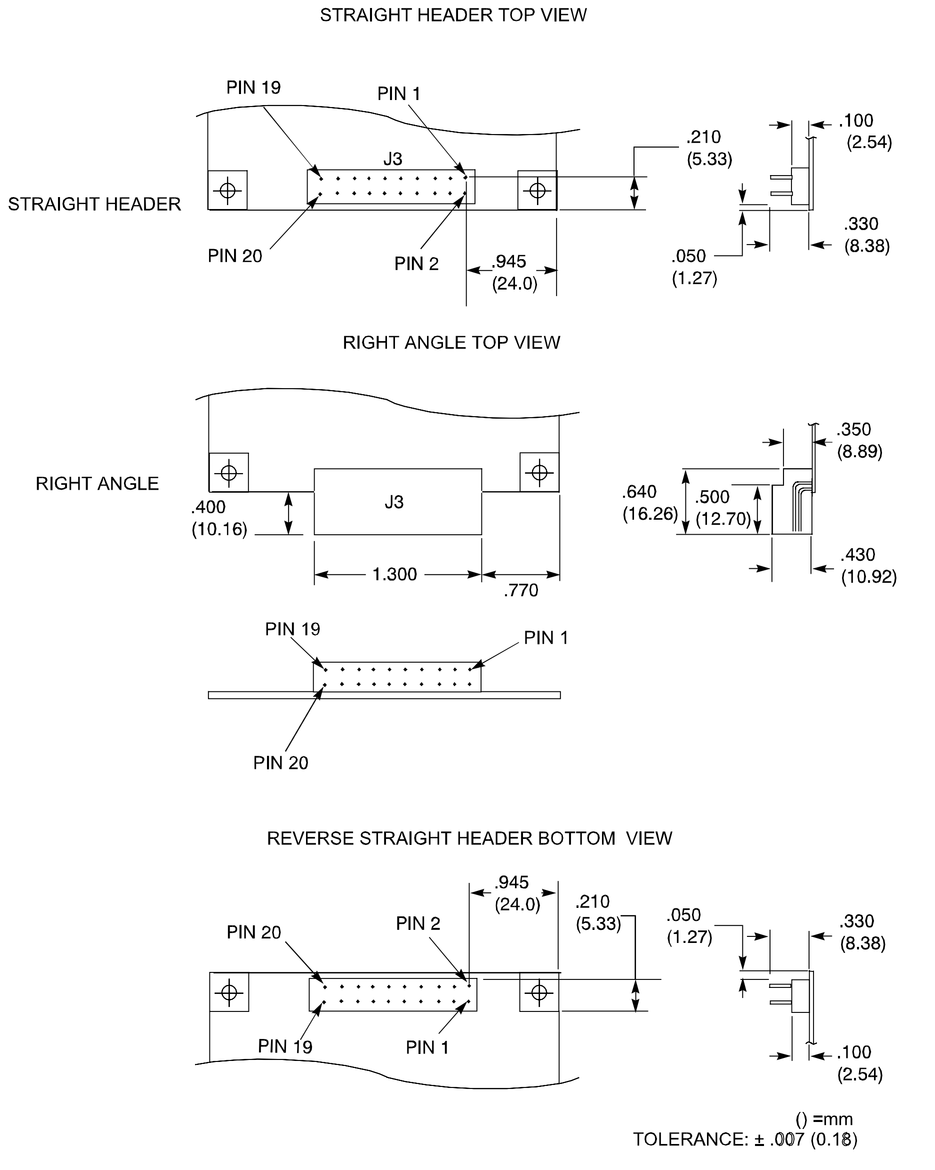


Figure 2-4. Receiver OEM Board Outline Drawing
(Var: -XX2, -XX3, -XX0)

B. PACKAGING DESCRIPTION

The receiver assembly consists of one PCB, containing a shielded RF, digital and I/O sections located on both sides of the PCB and a surface mount connector. The receiver does not require heat-sinking to a metal case.

Mechanical packaging of the receiver is designed to allow for mounting within various different configurations of OEM units.

1. Weight Limits

The receiver weight limit is 1.76 ounces (50 grams) maximum.

2. Size

The receiver size is:

Height (total including components) 0.55 in. (1.4 cm)
Length 4.00 in. (10.2 cm)
Width 2.65 in. (6.7 cm)

See Figures 2-3 and 2-4 for outline drawings.

RELIABILITY

A design goal of 55,000 hours MTBF for a Ground Fix environment is pursued through a robust design, when the receiver is installed in an OEM unit, offering reasonable environmental protection. The high reliability is ensured through concurrent engineering practices, covering all aspects of the electrical and mechanical design. Attention is paid to all features that affect the producibility, testability and maintainability of the assembly.

The MTBF calculation uses to the maximum extent possible models derived from past experience (service and test), which also account for failures due to causes other than piece-parts. When such data is not available, the analysis procedure of MIL-HDBK-217F is used, assuming a 40°C ambient temperature inside the host unit.

ENVIRONMENTAL AND EMC REQUIREMENTS

The receiver operates within the performance requirements specified herein during and/or after exposure to the following environmental and electrical conditions. The receiver meets all specified requirements and provides performance and reliability under any natural combination of the service conditions outlined in Figure 2-4.

It shall be understood that in normal operation the environmental and EMC tests shall be performed with the receiver installed within the host unit. When in a unit the following environmental requirements of Figure 2-4 shall be met.

The basic version of the receiver dissipates 1.2W typical. The receiver relies on convection and radiation for heat dissipation. If the host unit's internal temperature is greater than the maximum operating temperature, thermal management shall provide for heat sinking of the RF shield to the host unit chassis.

Operating Temperature	**-30°C to +75°C (Optional -40° C to +85°C)**
Storage Temperature	-55°C to +100°C (Version without battery)
Temperature Variation	4°C per minute
Humidity	Relative Humidity up to 95%, non-condensing
Altitude	-1,000 feet to 60,000 feet (18 000 m)
Vibration operational	See SAE curve Figure 2-6
Shock	20g peak, 5 milliseconds duration (3 axes)
Dynamics	Velocity : 514 m/s
	Acceleration : 4g
	Jerk : 2 m/s^3

Figure 2-5. Environmental Categories

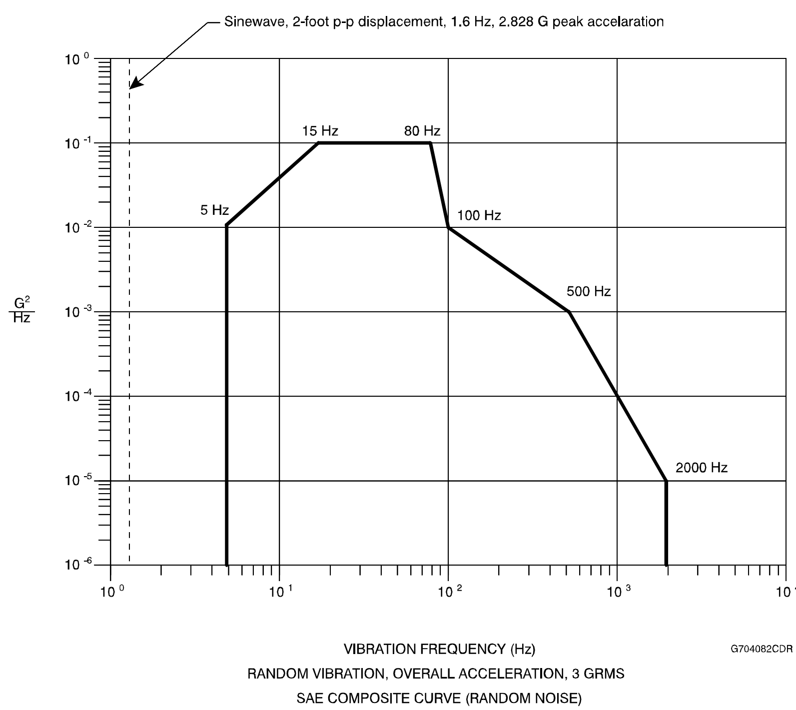


Figure 2-6. SAE Composite Curve (Random Vibration)

DESIGN AND CONSTRUCTION

A. Materials, Processes and Parts

The selection of parts and materials is based on commercial parts suitable for automotive and airborne applications. Standard parts and materials are procured to supplier's catalog number. All parts and materials are subject to CMC incoming inspection for conformance to requirements. Non-standard parts are also subject to CMC incoming inspection and documented on a CMC Source Control Drawing which include as a minimum the following:

- Electrical and mechanical characteristics
- Environmental and Quality Assurance requirements
- Workmanship requirements
- Marking requirements

Manufacturing processes used are selected for their full compliance to airborne requirements and are under statistical process control. All manufacturing processes are fully documented.

B. Equipment Markings

The receiver part number shall be 220-600944-XXX. The last 3 digits shall be used to identify specific variations.

1. S/W Part Number

The S/W part number appears on a label on top of the FEPROM. The host shall get access to the latest S/W part number on the serial interface port.

2. Modification

A modification record numbered from 1 through 5 shall be etched on the PCB close to the H/W part number. This modification number shall be used primarily for H/W changes.

3. Electrostatic Discharge Protection

The receiver shall be identified with a "Caution" Label. The receiver can withstand an electrostatic discharge level of 2kV from 100pF through 1.5kΩ between any two pins in either polarity (Mil. Std.883 human body model).

C. Built-In Test (BIT) Requirements

The receiver performs self-tests and generates status information to provide an indication of the operational readiness and facilitate maintenance actions.

Failure indication is transmitted on the primary serial output bus via the self-test result (message ID #51). 90% of all receiver failure modes are detected and annunciated or have no effect on receiver outputs.

D. Interchangeability

Interchangeability of the receiver with any other receiver bearing the same part number shall not necessitate readjustments of any component in order to meet the performance requirements.

HARDWARE INTERFACE

This section applies to the OEM board version of the receiver.

For details on the hardware interface of the Development Kit version of the receiver, please refer to Appendix A.

For details on the hardware interface of the STARBOX version of the receiver, please refer to Appendix B.

A. Connectors and Connector Pins Assignment

1. Pin Assignment

   Refer to Appendix C for the pin assignment.

2. General

   The receiver has two standard connectors. J1 is a 26 pin connector for general input/output interfaces and power input and J2 MCX type RF connector.

   VAR -XX1 1mm Flexible Printed Circuit, 26 pin ZIF connector J1

   The receiver is also available in different variations:

   VAR-XX2 with a 0.100 x 0.100, 20 pin (2x10) Right Angle Shrouded Header with detent windows J3 instead of the ZIF connector J1.

   VAR -XX3 with a 0.100 x 0.100, 20 pin (2x10) Straight Header J3 instead of the ZIF connector J1 on the TOP side.

   VAR -XX0 with a 0.100 x 0.100, 20 pin (2x10) Straight Header J3 instead of the ZIF connector J1 on the BOTTOM side.

   See Appendix C for more details.

3. J1 Interface and Power Connector

The J1 Interface Connector is a 1mm Flexible Printed Circuit, 26 pin, AMP 2-487952-6 or ELCO 00-6200-026-032-800. Following is the list of possible mating Flat Flexible Cable and connector manufacturers:

a) AXON' CABLE (cable)
390 E. HIGGINS Road
ELK GROVE VILLAGE,IL 6000
TEL: (708) - 806 - 6629

b) MIRACO (mating and connector)
9 PITTSBURG Av.
P.O. BOX 1163
NASHUA, NH 03061-1163
TEL: (603) - 882 - 6887

c) ELCO USA (connector)
3250 KELLER Street, Unit One
SANTA CLARA, CA 95054
TEL: (408) - 499 - 1861

4. J2 RF Input Connect

The J2 RF input connector is an MCX Sub-miniature Snap-On Connector straight jack receptacle. The following is the list of possible mating connectors compatible with RG316 cable type:

Right angle: OMNI SPECTRA, 5807-5001-09 or SUHNER, 16 MCX-50-2-5C/111 or RADIALL, R113182.

Straight: OMNI SPECTRA, 5831-5001-10 or SUHNER, 11MCX-50-2-10C or RADIALL, R113082.

OMNI SPECTRA (M/A COM)
100 Chelmsford St.
P.O. Box 3295
Lowell, MA 01853-9910
TEL : 1-800-366-2266

HUBER & SUHNER
One Allen Martin Drive
P.O. Box 400
Essex, VT 05451
TEL : 1-802-878-0555

RADIALL
150 Long Beach Blvd.
Stratford, CT 06497
TEL : 1-203-386-1030

5. J3 Interface and Power Connector

The J3 Interface and Power connector is a 0.100 x 0.100, 20 Pin Header (3 examples of manufacturer's part numbers):

AMP	1-103783-0
BERG	67996-120
SAMTEC	TSW-1-10-07-S-D

or a 0.100 x 0.100, 20 pin Right Angle Shrouded Header with detent windows (1 example of manufacturer's part number : connector and mating):

Connector:	AMP	102570-8
Mating:	AMP	87835-4

NOTE: Internal row contains the odd pin number (1-19)
External row contains the even pin number (2-20)

B. Power Input

The receiver shall operate from regulated DC power supplies as specified in Figure 2-7.

PIN NO.	FUNCTION (NOTE 1)	VOLTAGE	STANDBY CURRENT (TYP) mA (NOTE 4)	ACTIVE CURRENT (TYP) mA	ACTIVE CURRENT (MAX) mA	RIPPLE MAX. (NOTE 2)
J1-21	+5V Digital	5V +10%/-5%	18	70	130	100 mV
J1-26	+5V RF (Note 1)	5V ±5%	15	75	110	50 mV
J1-15	VDD (Note 3)	5V +10%/ -5%	0.180	90	170	100 mV
	VDD (Note 5)	2.6V	0.030			

Note:

1. To avoid CMOS latch-up condition, the maximum ΔV (including ripple) between the +5V Digital, +5V RF and VDD shall be <0.5 V.

2. Ripple specification is defined for frequencies up to 100 kHz.

Figure 2-7. Power Input (Sheet 1 of 2)

3. If the application doesn't request the SRAM Keep-Alive Mode (see para 3.1.1), this pin must be connected to J1-21 (+5V Digital).

   Typically, the data will stay valid for VDD down to 2.6V but it is not guaranteed for all variations when VDD < 4.5Volts. Only for variations (contact CMC for more information) having Low voltage data retention SRAM, the data will be keep valid down to 2.6Volts.
   The time source will be kept valid for VDD down to 2.6 Volts for any variations.

4. The Standby Current is measured when the Power Control Input is LO or when the +5V Digital is below the 4.5V threshold.

5. VDD current in SRAM Keep Alive Mode.

Figure 2-7. Power Input (Sheet 2 of 2)

1. Power Control Input

   The receiver possesses its own circuitry to perform a proper power-down and power-up sequence in order to preserve the non-volatile data in SRAM. The Power Control input allows also the possibility to generate a master reset (Standby Mode) to the receiver without removing the power.

   A low voltage input will cause a master reset.

   Refer to Appendix C for the electrical characteristics.

2. Preamplifier Power Pass-Through (Antenna Supply)

   The preamp signal is available on the I/O connector for the host to provide power to the antenna preamplifier via the centre conductor of the RF cable J2. The receiver is capable of handling voltages in the range of +5V to + 16V.

   Note: Maximum current is 100 mA on J2.

3. RF Input

   The receiver will receive the GPS signal from the antenna amplifier on one RF input connector, J2. The RF input port impedance is 50 Ohms nominal with a maximum return loss of -10 dB over the frequency range of 1575.42 ± 3 MHz. The nominal source impedance presented by the antenna shall be 50 Ohms with a maximum return loss of -10 dB.

4. Discrete Inputs

   For normal operation, all discrete inputs can be left opened. See Appendix C for the electrical characteristics.

a. DISC_IP_1

The discrete input Discrete #1 is used to control the reprogramming of the Operational software. Refer to Appendix F for details on the programming mode procedure.

b. DISC_IP_2 , DISC_IP_3 and DISC_IO_1

These 2 discrete inputs and the configurable discrete I/O signal are general purpose default condition inputs. (DISC_IO_1 can be configured as a discrete output signal for custom applications).

Note: Not all signals are available depending on the type of connector selected. (see Appendix C)

TIME MARK OUTPUT 1 PPS

The Time Mark discrete output interface is implemented using a standard TTL Logic output type. Clamping diodes are provided to Vcc and Ground, and the output is current limited using a series resistor. The time mark is a 1 Hz signal with its rising edge corresponding to the time when the navigation outputs are valid. (see Figure 2-7 for Time Mark waveform).

The Time Mark Output has 2 operating modes: Aligned on GPS Time or Free-Running.

In Aligned on GPS Time mode, the Time Mark Output and GPS measurements will be aligned on GPS time at ± 200ns typically. With respect to Figure 2-8, Tb is 1.01 s ± 0.01 ms. To allow the synchronization on GPS Time, a maximum delay of 5 seconds can be added to the TTFF. See Binary message ID #20 and #103 for more information.

In Free-Running mode the Time Mark won't be aligned and the TTFF is according to the specification. With respect to Figure 2-7, Tb is 1.01 ms ± 0.01 ms and occurs once each second approximately (999.999ms+/- receiver clock drift) with the rising edge (0 to 1 transition) corresponding to the receiver epoch (1 Hz).

In 2 Hz PVT mode, the Time Mark will be output once per second. In Time Alignment mode, the Time Mark will be synchronized to the Seconds boundary of the GPS Time.

The Time Mark Output can also be configured as a standard discrete output fully controlled by the software for customized versions. See Appendix C for the electrical characteristics.

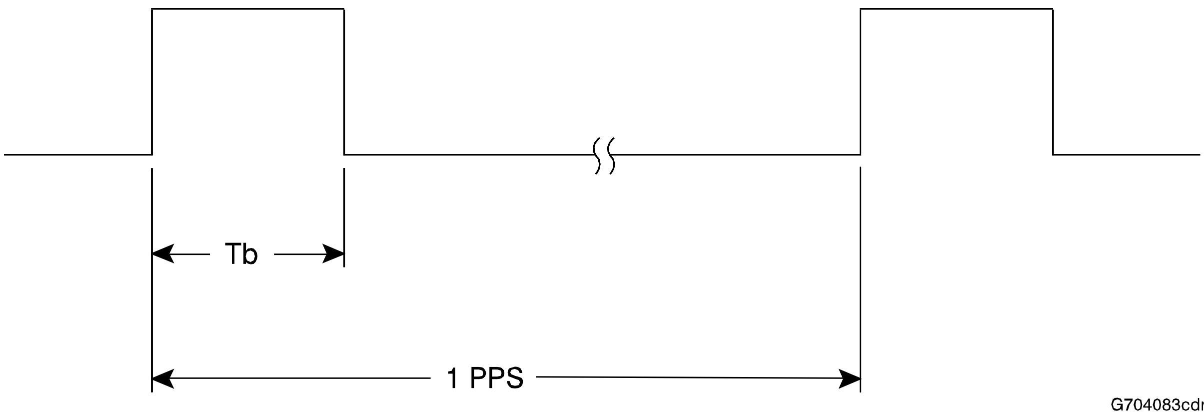


Figure 2-8. Time Mark Waveform

The timing relationship for the GPS Time Mark output from the receiver is defined in Figure 2-9. The Navigation Data message ID #20 defines the UTC time of the epoch. The rising edge of the Time Mark is accurate to within 1 μsec of UTC.

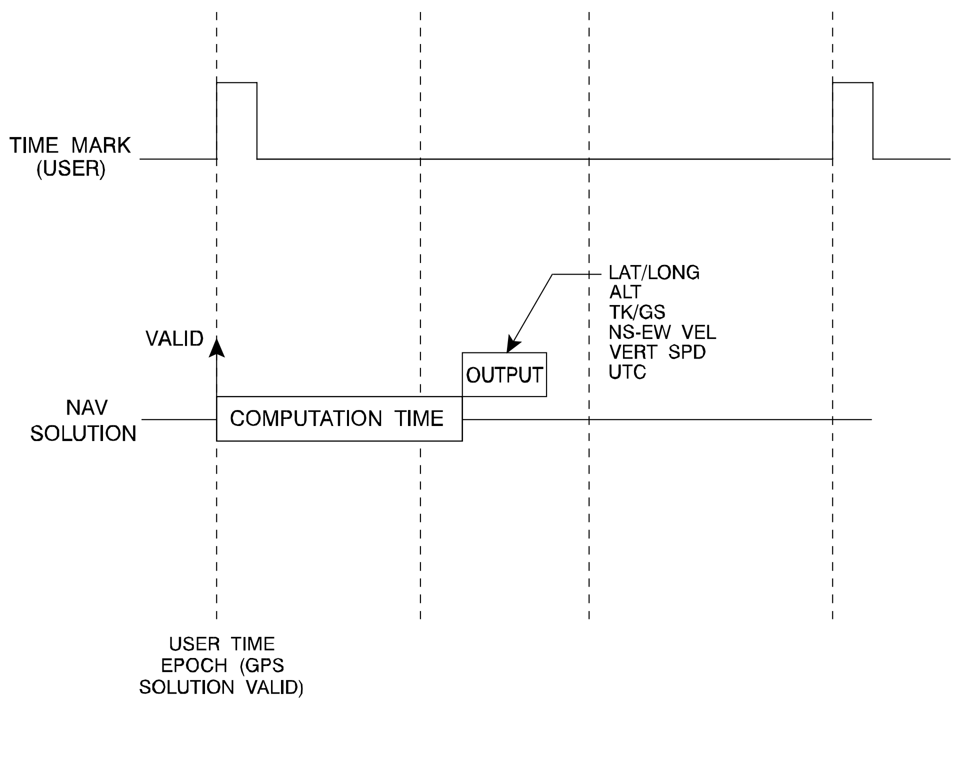


Figure 2-9. GPS Timing Relationships

SERIAL DATA INTERFACE

The receiver includes 2 standard serial input/output interface ports and one optional port. The ports are designated the Primary Port and the Auxiliary Port. Both ports operate independently with baud rates adjustable from 300 to 38.4 K baud.

The Primary Port supports data input (for receiver configuration and control) and data output (navigation results, receiver status etc.).

The Auxiliary Port supports data input (roving unit mode) or output (base station mode) for differential correction data adhering to Ref [2].

Both ports can be used for S/W reprogramming (refer to Appendix F).
Refer to Appendix C for the electrical characteristics.

A. Primary Port

The Primary Port supports communication via the Binary protocol. Through specific Binary messages, the primary port is re-configurable to communicate with a PC-based Monitor named StarView (for extensive monitoring of SV tracking, measurements and navigation status).

The default baud rate is 9600 but can be reconfigured (see Binary message ID #110). If no default message list has been stored in NVM, the receiver will output the Binary message ID #20 at a rate of once per second after each power up.

B. Auxiliary Port

The auxiliary port input is used to receive (roving unit mode) or transmit (base station mode) RTCM differential messages (Ref [2]). The default baud rate is 9600 and can be modified via the Binary Set DGPS Configuration message ID #83.

The new configuration will be stored in NVM.

The output port is used to transmit RTCM differential message when the receiver is acting as a base station.

NON-VOLATILE MEMORY DATA

The receiver stores in NVM different types of information used to accelerate the TTFF and to configure the I/O; refer to Figure 2-10 for a partial list of data stored in NVM.

PARAMETER	NOTES
ALMANAC	The most recent one
LAST POSITION	Position in NVM is updated at different rates depending on the application. The last known position is always kept in battery back-up SRAM.
DGPS CONFIGURATION	
RS232 CONFIGURATION	Contains the following configuration information : 1. Mode of operation 2. Baud Rate: 300 to 38400 3. Default Binary message list 4. Time Alignment Mode State 5. Mask Angle 6. Used Datum
BASE STATION PARAMETERS	Position and message rates (base station configuration only)

Figure 2-10. Non-Volatile Memory Data

SECTION III - INSTALLATION AND VERIFICATION

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SECTION III

INSTALLATION AND VERIFICATION

This section covers the installation and verification of the receiver. Sold separately, the StarView Graphical User Interface running on a PC allows the user to control the receiver and to display its outputs. Details on StarView are provided in Ref. [5].

EQUIPMENT REQUIRED

Refer to Figure A-1 in Appendix A for a description of the equipment required for the receiver to operate.

ELECTROSTATIC DISCHARGE WARINESS

Refer to the electrostatic discharge notice in the preliminary pages of this manual.

EQUIPMENT INTERCONNECTION

As aforementioned, the receiver can be provided either as an OEM board, within a STARBOX unit or within a Development Kit. The interconnection of the OEM board format is guided by its physical and electrical specifications detailed in the previous section. A complete description of the Development Kit is provided in Appendix A and a complete description of the STARBOX is provided in Appendix B.

The receiver includes two serial communication ports: COM1 and COM2. Serial communication with the receiver must be performed on COM1. The I/O protocol is discussed in a subsequent section. The minimal baud rate is 19200. The other serial port, COM2, is used for the differential link, and its minimal baud rate stands at 9600.

INSTALLATION CONSIDERATIONS

All formats of the receiver are not waterproof, therefore they must be mounted in a dry location. They should also be located where it's convenient for cables to run to the power source, display device, and antenna. Drip loops should also be formed to prevent moisture from running down the cables and into the receiver.

The receiver should be mounted several feet away from radio transmission equipment.

A. ANTENNA LOCATION

1. The antenna must be mounted high enough to provide an unobstructed view of the sky in all directions. The receiver uses satellites that can be as low as 5° above the horizon, so nothing should block it from the sky. Ensure that the bottom of the antenna is at least 5 inches above the surface it's mounted on. The antenna should also be mounted below the radiation plane of INMARSAT or radar antennas, and away from any other high-power transmitting antennas.

2. Care should be taken as well to avoid coiling the antenna cable around the mounting base and pinching the antenna cable in window or door jambs.

B. BASE STATION LOCATION

1. It is imperative that the base station be located on a site that is above all obscuring elements on the surrounding terrain in order to have all satellites above the horizon visible at the base station's antenna. The intent is to have all satellites that are visible at the roving user's antenna to be visible at the base station as well.

2. As well, multipath interference must be minimized as much as possible. Multipath is defined as the interaction of the GPS satellite signal and its reflections; this causes errors mainly on the GPS code, but not so much on the GPS carrier. Even though the receiver uses carrier phase measurements, it can revert to code differential GPS operation if carrier phase differential GPS cannot be performed. Hence, the base station's antenna must be far from any reflecting elements.

3. The position of the base station's antenna must be surveyed using appropriate surveying equipment. This position must then be programmed in the base station using the message ID #80. Any error in the base station's position will be reflected in the roving user's computed position.

C. DATA LINK

1. The data link must operate at a minimal rate of 9600 bauds.

2. The required power level depends on the distance separating the base station and the roving units.

D. BASE STATION AND ROVING UNITS SEPARATION

The operational range of carrier-phase differential measurements is limited to about 20 km, after which significant accuracy degradation could occur. If your application requires greater separations, your own base station network must be established.

CHOICE OF A WIRELESS DGPS DATA LINK

The choice of wireless link is a key part of any DGPS system. The functionality and reliability of the link can have a significant effect on the success of the DGPS system. The key functional parameters affecting the performance and cost of DGPS wireless links are:

- Range
- One-way versus two-way data capability
- Latency and rate of data transmission
- Radio Frequency
- Frequency Selector
- Interference Rejection
- Wide area Differential network capability

For narrow-band communication, typical frequencies of operation are in the 150 MHz or 450 MHz bands. Data rates range from 9600 to 19.2 kbps. RF transmit power ranges from 2 W to 30 W.

For spread-spectrum links, 900 MHz or 2.4 GHz is typical. Data rates range from 19.2 to 115 kbps. Power is 1 W or less. These are typically short range (<5mi.) links for portable or mobile operation.

A. Range

Exact range of a wireless radio link is difficult to calculate without a detailed engineering analysis. Reasonable approximations are possible however. Range is primarily affected by the combination of the following factors:

- Terrain
- Transmit power and receiver sensitivity
- Transmitter and receiver antenna gain.

The simplest calculation of range assumes the earth is smooth and spherical. This is the starting point for all range calculations and establishes the minimum height requirements for the antennas. The calculation establishes range by line of sight. The range in miles is given by.

$$\text{Range} = \sqrt{(2*H_t)} + \sqrt{(2 * H_r)}$$

where H_t is the height of the transmit antenna in feet and H_r is the height of the receive antenna in feet. Given 8 feet height for the receive antenna and 25 feet height for the transmit antenna, the range is 11 miles. Note that if the transmit antenna or receive antenna are on hilltops, the height of the hill above the highest terrain between TX and RX should be included in the height of the antenna.

B. Terrain

Terrain is the greatest contributor to short range (<100 miles) communication. Terrain includes the shadowing or blocking effect of hills and valleys as well as buildings and foliage. Dense foliage can easily shorten a smooth earth range calculation of 10 miles to 2 or 3 miles. Foliage can often be overcome by brute RF transmit power or excellent receiver sensitivity.

C. Transmit Power and Receive Sensitivity

Transmit power and receiver sensitivity can be traded off against each other in cases where you are not competing with another user on the same frequency. Having a receiver sensitivity of say 6 dB better than a competing receiver makes your transmitter look 6 dB (4x) more powerful. This translates to more range and a more reliable link. Alternately, having a sensitive receiver can significantly lower the cost of the transmitter by allowing a lower power model. Having a lower power transmitter can increase battery life or reduce battery weight in portable applications.

D. Antenna Gain

Antenna gain increases the effective radiated power of a transmitter and the effective sensitivity of a receiver. A 5 W transmitter with a 6 dB (4x dipole) gain antenna looks like a 20 W transmitter when compared to the same unit on a simple vertical whip with a ground plane. A receiver with a 6 dB antenna sees a 5 W transmitter as if it has raised its power to 20W. With a 6 dB antenna on both transmit and receive, the 5 W transmitter performs like an 80 W transmitter in the case of 0 dB antennas on both ends.

E. One Way vs. Two Way Link

In many applications such as DGPS, it is only important to send a message one way. In this case the wireless link can be made less expensive by using transmit only and receive only radios. This can also reduce the cost, size and weight of the link. Two way is useful in applications such as tracking, AVL and dispatch where the data must be sent back to the base.

In two way applications that have high update rates and/or a large number of users, key performance items to look for are over-the-air data rate and data turnaround time. See Latency and Rate of Data Transmission below.

F. Latency and Rate Of Data Transmission

Latency and rate of data transmission can have a significant effect on the number of users that can be supported on a single radio channel as well as the time it takes to get an update to the base. Latency is affected by the data rate at the serial ports of all the equipment in the link as well as the over the air data rate. The higher the data rates, the lower the latency or age of DGPS corrections. The higher the data rate, the higher the number of updates or DGPS corrections per second.

G. The Radio Frequency Used

The radio frequency can have some effect on the link results. Low frequencies tend to propagate better over terrain and higher frequencies tend to be more line of sight. For a given amount of antenna gain, higher frequency antennas are smaller in direct proportion to the frequency difference. The higher gain antennas also tend to be less expensive at higher frequencies due to their smaller size.

It should be noted that at the higher frequencies (above 400 MHz), transmission line loss must be considered. A run of 50 feet using an inappropriate cable can easily lead to a loss of half of your transmit power or more. The same applies to the receive side of the link in terms of loss of effective receiver sensitivity.

H. Frequency Selector

Many DGPS links in North America are operated on a small group of itinerant frequencies. These frequencies can become congested in urban areas. Most radios are synthesized and can be programmed to operate at a specific frequency or set of frequencies if equipped with a selector switch. Having the selector switch under field conditions can greatly simplify changing frequencies in the case of interference from other users on a frequency. Having a larger number of positions on the selector switch can give a greater choice of alternate frequencies.

I. Interference Rejection

Common forms of interference are:

- Co-channel
- Image channel
- Intermodulation
- Adjacent channel.

Co-channel interference is when someone is operating on the same channel as your wireless link. The simplest ways to eliminate this are to relocate to a different channel or to use more power than the competitor. Note that using more power means that your receiver must see you base station at a higher power level than the competing station.

Image channels are channels that are separated from your channel by 2x the first intermediate frequency (I.F.) of your receiver. A common I.F. is 21.4 MHz. With poor image rejection, a channel that is 42.8 MHz away from your channel can strongly interfere with your desired signal. An external preselector can minimize this problem. Some radios are available with high selectivity preselectors already built in and thus minimize the tangle of extra cables and bulk of the external unit.

Intermodulation (IM) interference is a complex process where two channels mix to generate a signal that is on your channel. This mixing can take place in the DGPS wireless link receiver. Some types of IM can be reduced by having a good preselector on the receiver front end thereby attenuating one or both of the offending signals. Close in frequencies simply require a good IM performance specification. Look for an IM specification in excess of 60 dB.

Adjacent channel interference typically occurs when there is a strong signal in the next adjacent channel and you are near the limit of range of your system. Look for specifications in excess of 65 dB.

J. Network Capability

In some cases, a DGPS reference station with single transmitter cannot cover enough area without the logistical difficulty of frequently moving the station. A wider area can be covered using a singe reference station with multiple transmitters. The Network uses the first transmitter to send the DGPS correction and it is in turn repeated by one or more distant transmitters.

To set up a DGPS network with several repeaters requires the wireless link to have a network protocol capability. Protocols such as AX.25 or the more powerful MX.25 support powerful features such as multi hop digipeting (digital repeating) and time slotted digipeting. Systems have been set up that cover more than 30,000 square miles using a single DGPS reference station. Systems can even include mobile, marine or airborne repeaters without a degradation of DGPS accuracy.

K. Wireless DGPS Link Options

Many companies provide DGPS link products that may be used in the field with our products.

Features may include:

- Multiple channel selector switch.
- High receiver sensitivity.
- Built in preselector for image interference rejection.
- Powerful AX.25 and MX.25 protocol for repeating or network coverage.
- High speed 9600 bps operation.
- Fast turnaround time for Tracking and AVL.
- Rugged water resistant packaging.
- 5 W and 25 W transmitters.

SECTION IV - OPERATION

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SECTION IV

OPERATION

RECEIVER STATES

A. NON-OPERATIONAL STATES

The receiver has two non-operating modes, OFF mode and SRAM Keep-Alive mode. The maintenance of the DC power on the SRAM will determine which of the two non-operating modes will be automatically entered during the power down sequence.

1. OFF Mode

   In OFF mode only the data contained in the NVM is retained for use when power is re-applied. Refer to the NVM Data section details on retained data.

2. SRAM Keep-Alive Mode

   In SRAM Keep-Alive mode specific data contained in the SRAM is retained to reduce the time-to-first-fix when power is re-applied. Data retained in SRAM mainly consists of valid satellite ephemeris data not older than 3 hours.

B. OPERATIONAL STATES

1. The receiver has 6 operating modes: Self-Test, Initialization, Acquisition, Navigation, Dead-Reckoning and Fault. The receiver switches between modes automatically as shown in Figure 4-1. The receiver reports on its host port the current operating and navigation modes.

2. Self-Test Mode

   The receiver enters Self-Test mode upon request from an external source (Binary message ID #51). The time duration spent in the Self-Test mode is no more than 15 seconds. On self-test completion, the receiver reports the BIT results on its host port through the Binary message ID #51. Self-Test mode exits to either Initialization or Fault mode.

3. Initialization Mode

   Upon power-up, the receiver enters Initialization mode. During this mode hardware is initialized prior to Acquisition mode entry. The Initialization mode is also initiated upon completion of the Self-Test mode, but exits always to the Acquisition mode.

   Depending on the previous non-operating state (OFF or SRAM Keep Alive Mode) the receiver will retrieve data only from the NVM (cold start) or from both NVM and the SRAM (warm start). Integrity checking is done on all data retrieved from the non-operating state.

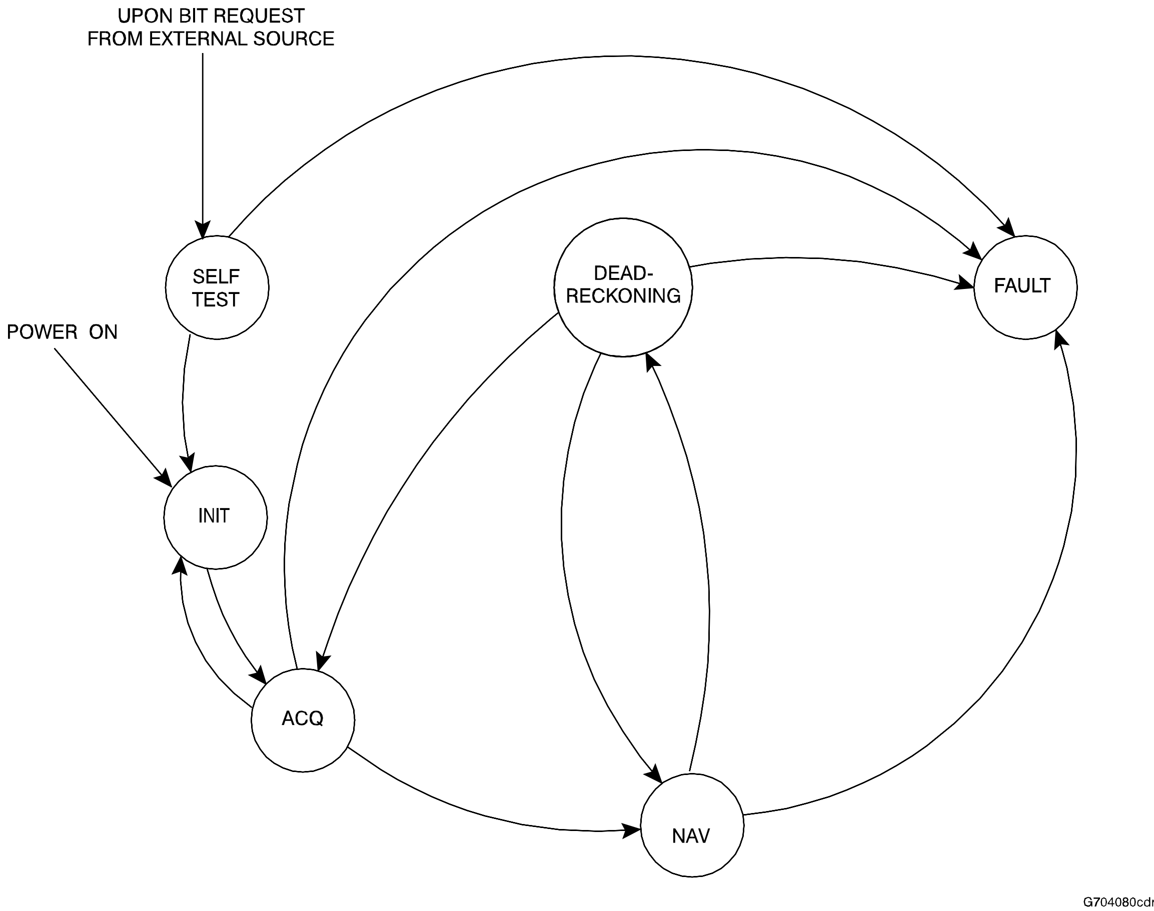

Figure 4-1. Receiver Operating Modes

During initialization, the receiver retrieves the last received valid almanac data and last user position from NVM, gets the current time from the low-power time source and predicts which satellites are currently visible. This list of visible satellites is then used in Acquisition mode to program the 12 parallel correlator channels.

4. Acquisition Mode

The receiver is in Acquisition mode when insufficient satellite data is available to produce an initial navigation solution. Acquisition mode is entered from Initialization, or Dead-Reckoning mode, and exits to Navigation or Fault mode.

To acquire signals from the GPS satellites, the receiver uses:

a. Almanac data which describes the satellite orbits.

b. Time, which in conjunction with almanac data is used to estimate the present position of satellites in their orbits.

c. The approximate location of the receiver so a prediction can be made as to which satellites are visible.

The receiver then collects ephemeris data by decoding the satellite down-link data message. After each satellite in view is acquired, its measurement data set is produced. When a sufficient number of satellites are being tracked, position, velocity and time can be computed and Navigation mode entered.

If the receiver cannot perform an acquisition due to an absence of valid almanac data or user position and/or time it initiates a "Search the Sky" acquisition. The receiver attempts to acquire all satellites in the GPS constellation. Once a satellite has been acquired, ephemeris data is decoded from the satellite down-link message. After sufficient satellites have been acquired, the receiver enters Navigation mode. In "Search the Sky", the TTFF is typically less than 3 minutes.

5. Navigation Mode

The receiver is in Navigation mode whenever sufficient satellite information and measurement data is available to produce a GPS fix. Navigation Mode is entered from Acquisition or Dead-Reckoning mode, and exits to Dead-Reckoning or Fault mode.

In Navigation mode, a receiver configured as a roving unit operates in 2 sub-modes: Differential and Stand-Alone Nav. Sub-mode transition occurs automatically depending on satellite data availability. A receiver which is configured as a base station unit will operate in Base Station Navigation mode only. The receiver reports its current navigation sub-mode on its host port.

a. Differential (Roving Unit Only)

The receiver operates in Differential mode when data from at least 4 satellites with adequate geometry and differential corrections and/or measurements exists to compute position, velocity and time outputs. This is the preferred navigation mode. Differential data is supplied to the receiver via the differential input port. Differential data can be received only on the auxiliary serial data port.

b. Stand-Alone Nav (Roving Unit Only)

The receiver operates in Stand-Alone Nav mode when data from at least 4 satellites with adequate geometry, but no differential corrections or measurements, exists to compute position, velocity and time outputs. This is the preferred navigation mode when insufficient differential data is available to generate a differential GPS fix.

c. Base Station Nav (Base Station Unit Only)

The receiver operates in Base Station Nav mode once the time has been initialized and at least 4 satellites with adequate geometry can be used for navigation purposes. Once in this mode, only a change of configuration (rover mode requested) or a reset will cause the unit to leave this navigation mode. In this mode, the unit will have the ability to transmit the DGPS messages which are requested and allowed once its position is initialized. (Refer to the Configurable Parameters section for position initialization details.)

7. Dead-Reckoning Mode

The receiver enters Dead-Reckoning mode when it cannot remain in a Navigation. The speed and direction is assumed constant to allow the receiver to provide an estimated position.

8. Fault Mode

The receiver enters Fault mode during the period of the time in which the receiver outputs are affected by one or more critical system faults. This mode supersedes all others and remains active until the next power-down/power-up cycle. Fault mode is entered from any other mode except Initialization.

C. DATUM SUPPORT

The receiver has the ability to provide its position in one of the 62 predefined datums. The list of all the supported datum is provided in Appendix E. Moreover, the receiver can also support two user-defined datum. These have to be defined, prior to their use, using binary message ID #88. Afterwards the desired datum, whether it is user-defined or predefined, can be selected using Binary message ID #88.

POWER-UP INFORMATION

At power up, the receiver sends two categories of factory information data to the main port (COM1) at 9600 bauds. The categories of information, Boot and Operational information, can be displayed on a dummy terminal.

A. BOOT INFORMATION

The Boot information contains the following factory data:

ALLSTAR
V4
G : XXXXXXXXXX
169-613914-007 : Boot S/W Part Number
D0
PCPB: XXXXXXXXXX

GO : Go in Operational Mode

B. Operational Information

The Operational information contains both the factory and the current operating mode information. The current operating mode baud rate is output twice. This is useful when the operating baud rate is not 9600.

Example :

<Part Nb:169-614110-XXX[1], CB=0x0000003F[2] SHP
Go to Binary @ 19200 baud.
In Binary @ 19200 baud[3].
I>[3]

Note 1: Operational S/W Part Number
Note 2: Power-up BIT result.
Note 3: Line transmitted at the Configured Baud Rate

DATA REQUESTS

Data may be requested for output by the receiver for display or logging purposes. The list of data request commands and data messages is detailed in the following section.

CONFIGURABLE PARAMETERS

Several parameters of the receiver and the base station are configurable and therefore, must be defined by the user prior to operation.

A. MASK ANGLE

The mask angle is defined as the minimum satellite elevation angle (in degrees) above which any given satellite must be in order for it to be used in the GPS position solution. Low satellites usually do not yield accurate measurements due to weak signal reception and possible multipath. Typical mask angle values range from 5°-10°, depending on the receiver's location. This value is programmable via command message #81.

B. GPS ANTENNA POSITION

For the base station, it is imperative to program the surveyed position of the GPS antenna. This can be done using either the X-Y-Z coordinates in meters within the WGS-84 reference frame, or latitude and longitude in degrees as well as height in meters.

This can be achieved via message ID #80.

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SECTION V

SERIAL DATA INTERFACE

BINARY SERIAL DATA COMMUNICATION PROTOCOL

The purpose of this section is to define a serial data transfer protocol for the RT•STAR. The serial data is transmitted in variable size message blocks, where the message block header defines the contents and size of all message blocks bearing this ID.

For discussion purpose, the transmitter is the controlling Host CPU, and the receiver is the GPS Receiver. Prior to entering the protocol, both the transmitter and receiver must be set up to the same baud rate and data setting. Upon entering the protocol, the transmitter and receiver wait for the possible transmission of message blocks.

A. PHYSICAL LINK LAYER

The electrical signals used are those for RS-232 communication port. Only the Receive and Transmit lines are required. The serial port is asynchronous and should be set up with 1 start bit, 8 data bits, no parity bit, and one stop bit. A default baud rate of 9600 is used. Both transmitter and receiver are operating at the same rate and can be reprogrammed (see msg ID #110).

B. DATA LINK LAYER

1. Bit Ordering

The ordering of data within message blocks is such that the least significant bit (LSB) is the first bit received, moreover the most significant bit (MSB) is the last bit in the sequence.

	MSB							LSB
Order	7	6	5	4	3	2	1	0

This ordering is applied to all data formats, which include integer values, fixed point values, floating point values, and character strings.

2. Message Block Structure

All communication is done using message blocks. Each message block consists of a header and possibly data. The data portion of the block is of variable length depending on the message ID. The header has a fixed length of 4 bytes, consisting of a Start-of-Header character (SOH), Block ID, Block ID Complement and Message Data length. Each block has a truncated 16-bit word containing the Checksum associated with the complete content of the block. It is appended at the end of the Data portion of the block.

The Message Block structure is as follows:

byte 1 [SOH]
byte 2 [ID #]

byte 3 [Cmpl ID #]
byte 4 [Msg Data Length]
byte 5 [Data Word 1] LSB
byte 6 [Data Word 1] MSB
.. ..
[Checksum] LSB
[Checksum] MSB

where:

SOH

Start of header character (decimal 1).

ID #

Byte containing the Block ID numeric value. The block ID number field is used uniquely to identify the format of the data portion of the block. Since only 7 bits are needed for the ID, the higher bit is used to identify if the message is sent in one shot or continuous mode. This prevents an unnecessary increase in overhead by eliminating any extra bytes in the protocol. e.g. ID# 23 with ID=17 for one shot (ID=MSG/0x7F) or ID=97 for continuous (ID=MSG/0x80)

Cmpl ID #

1's complement of the ID # field. This can be calculated as Cmpl Block # = 255 - (Block #) or using XOR as Cmpl Block # = (Block #) XOR 255. This field, in conjunction with the Start-Of-Header, helps to synchronize the message blocks, since the SOH character can appear within the data, the Cmpl Block # field validates the header contents and thus confirms the start of the block.

Msg Data Length

One byte containing the length of the data part of the message in bytes (excluding header and checksum).

Checksum

This fields contains the checksum value for the complete message blocks transmitted, which includes header and data. The checksum calculations is discussed in more detail below.

3. Message Block Types

a. Host CPU to Receiver Message Types

There are 5 types of messages:

Dummy Message (ID #0):

Reserved

Initiate Link (ID #63):

First message (optional) to be sent by the transmitter upon entering the protocol. Its purpose is to inform the receiver that communication is desired. A password is encoded in the message. If the receiver was already transmitting data, this message will interrupt all output messages and will wait for new data request messages.

Data Request Messages:

Request the receiver to turn on/off the transmission of broadcast data or to transmit data only once. The MSB of the message ID will indicate the type of request with "1" to turn on broadcast, and "0" for once only or to turn off the broadcast.

Command Messages:

Request a particular receiver action other than a data request. The MSB of the msg ID may be used to set the receiver to normal mode (MSB=0) or to special mode (MSB=1).

Data Messages:

Any message containing data to be memorized or processed by the RT•STAR.

b. Receiver to Host CPU Message Types

There are 6 types of messages:
(All data is sent in receiver internal format)

Dummy Message (ID #0):

Reserved

Initiate Link (ID #63):

This is the response to the transmitter initiate link message.

Acknowledge Message (ID #126):

All transmitter messages are acknowledged by the acknowledge message. This message is sent as soon as possible if there is at least one message to acknowledge. The data field of this message contains 5 bytes which encode the IDs of the messages acknowledged (4 messages per time interval and possibly a message from previous time interval that was not completely decoded). So, a maximum of five messages may be acknowledged per message. ID #0 indicates a dummy message and should be discarded by the transmitter; its purpose is only to fill the data field of the acknowledge message block.

Link Overload Error Message (ID #125):

Sent by the receiver only when at least one output message caused an overload of the transmission link. This message is sent at a maximum rate of once per second. This message encodes a bit map of all the message IDs (#1 - #127), therefore indicating which IDs caused the link overload. The request of the message that caused the overload is cancelled to prevent any further overload.

Data Messages:

Messages containing requested data.

Status Messages:

Informs the transmitter on the status of a file transfer performed via a command message. The status is encoded in the MSB of the ID field. If the MSB = 0, the command request is unsuccessful. If the MSB = 1, the command is successfully performed. This message is sent within 1 minute after the command message. (This is currently only use for the almanac

C. INITIATION

Upon receipt of initiate link message block containing a valid password, the receiver sends a message block back to the transmitter with its own password.

This command also cancel all previous data request messages within 2 seconds.

The receiver will respond within 300msec to the initiate link command.

D. DATA TRANSMISSION

In most cases the receiver is given command message blocks for which it must respond with one or several blocks of data. Typically the following sequence of events occurs once the link is initiate.

The transmitter sends one or more message blocks to the receiver while keeping track of all message blocks that need to be acknowledged by the receiver. The receiver searches out each message block sent by the transmitter and then compare its own checksum calculation with the value that was sent by the transmitter. If the values match, the receiver includes that particular ID in the acknowledge message block. If the checksums are different, the receiver will not include the ID. Once all message blocks received during the last time interval scheduled by its executive are decoded a new acknowledge message block is built with all valid ID's received. The acknowledge message will be transmitted in the next available time slot.

For each individual message block transmitted, the transmitter must wait for its corresponding acknowledge or produce a time out error if not acknowledged within 300 ms.

The transmitter may send additional message blocks at any time. All message blocks are treated independently, therefore the transmitter do not need to wait for acknowledge before another message block can be transmitted, except for file transfer command messages, in which case the transmitter must wait for acknowledge message before continuing a file upload.

E. ERROR RECOVERY AND TIMING

Error detection and recovery are incorporated in this protocol. Some of the common error conditions are listed below:

1. Block ID Complement Error

   If the block ID in the header portion does not match the complement block ID number, the block must be discarded. This means that the data received is probably not a block.

2. Checksum Error

   For the RT•STAR, if the calculated checksum value on receipt of a block does not match the value in the block, the block must be discarded and this message block's ID is not indicated in the acknowledge message block sent to the transmitter. For the transmitter, if it detects a checksum error then the block must be discarded and a message block timeout should occur for the corresponding request.

3. Transmit Timeout Errors

   The transmitter should wait up to the message rate for the reception of a data message block. Afterwards, the transmitter should report the error.

4. Frame Synchronization Errors

   Since extraneous characters can be generated when using asynchronous communications, the receiver does not count on receiving valid blocks with no extra characters for each block transmitted. Synchronization is as follows: if the character received when expecting the start of a block is not a SOH, then it ignores the character and continues to search for a SOH. Once a SOH is found, the receiver assumes that the next two bytes are a valid block ID number and complement. If they are complements, then it assumes that the packet has begun and the search for the next SOH starts after the checksum even if the checksum is invalid. If they are not complements, it continues to search for SOH from the location of the block ID.

F. CHECKSUM CALCULATION RULES

The 16-bit checksum is defined as the 16-bit sum of all the unsigned 8-bit bytes starting at the beginning of the header, any overflow or carry to the 16-bit sum is discarded immediately. Therefore, it adds unsigned bytes to produce a 16-bit result. For example, a valid initiate link message can be:

```
SOH,ID#,Compl ID#,Length,U,G,P,S,-,0,0,0,Cksum(LSB),Cksum(MSB).
01, 63, 192, 08, 85, 71, 80, 83, 45, 48, 48, 48, 772   (decimal)
01h,3Fh,C0h,08h,55h,47h,50h,53h,2Dh,30h,30h,30h,04h,03h
(hexadecimal)
```

G. DATA STRUCTURE

This paragraph describes the data representation standards to be used in formulating the contents of data fields. The structures defined are:

1. Character Data
2. Integer Values
3. Fixed Point Values
4. Floating Point Values

Character Data is to be stored in the following order in the Block data field:

5 8	7 0
CHAR 2	CHAR 1
CHAR 4	CHAR 3
CHAR 6	CHAR 5
CHAR 8	CHAR 7

Character Data are unsigned by default.

Integer Values are represented in two's complement form.

Floating Point Values are stored in IEEE format using "little-endian" method to store data types that are larger than one byte. Words are stored in two consecutive bytes with the low-order byte at the lowest address and the high-order byte at the high address. The same convention applies for 32 bit and 64 bit values.

Following is the detail of the floating-point format:

Short Float (32 bits)

MSB (bit 31) = Sign
Bit 30..23 = Exp
Bit 22..00 = Mantissa
2exp(-1*bit22) + 2 exp(-2*bit21).......
Value = Sign * 1.mantissa * 2 exp(EXP-127)

Double Float (64 bits)

MSB (bit 63) = Sign
Bit 62..52 = Exp
Bit 51..00 = Mantissa
2exp(-1*bit51) + 2 exp(-2*bit50).......
Value = Sign * 1.mantissa * 2 exp(EXP-1023)

For example, message ID #6, bytes 11..14 (SNR value)(short Float)

byte 11 : 85
byte 12 : AC
byte 13 : 41
byte 14 : 42
short float = 4241AC85
Sign = +
EXP = 132
mantissa = 0.5130773782
value = 48.4

H. MESSAGE STRUCTURE

All the messages have the following form:

```
byte 1:           SOH
byte 2:           ID # (See Note 1)
byte 3:           Cmpl ID
byte 4:           Message Data Length (0..255)
byte 5 ..  n:     n-4 Data bytes
byte n+1 .. n+2:  Checksum
```

NOTE 1: For transmitter messages, MSB = 0 -> one shot or cancel continuous, MSB = 1 -> continuous unless specified otherwise.

BINARY PROTOCOL INPUT MESSAGES

A. MESSAGE SUMMARY

ID	DEFINITION	MESSAGE TYPE	# BYTES
6	Current channel assignment data request	DR	6
20	Navigation data request (user coordinates)	DR	6
21	Navigation data request (GPS coordinates)	DR	6
22	Ephemeris (ICD-GPS-200 format) request	DR	6
23	Measurement block data request	DR	7
33	Satellite visibility data and status request	DR	6
43	DGPS Configuration request	DR	6
45	Hardware/Software identification	DR	6
47	Base Station Status request (optional)	DR	6
48	Differential Message Status request	DR	6
49	Receiver Status request	DR	6
50	Satellite health summary request	DR	6
51	Initiated BIT request	DR	7
63	Initiate link	PM	14
64	Set Channel deselection	CM	16
65	Raw DGPS Data Request (optional)	CM	6
77	Update almanac	CM	6
78	Common almanac data transfer	CM	21
79	Specific almanac data transfer	DM	79
80	Set User's Position/Operating Mode	CM	38
81	Set Mask angle	CM	18
82	Transmit DGPS data message	CM	Note #1
83	Set DGPS Configuration	CM	27
84	Set tropo model use	CM	14
85	Set Beacon Receiver Status	CM/DR	11
86	Set Mean Sea Level model use	CM	14
88	Select/Define datum to use	CM	38
90	Set SV deselection	CM	18
91	Differential Message Configuration (optional)	CM	8
95	Track SV request	CM	19
99	Erase NVM	CM	14
103	Set Date,Time & GPS Time Alignment Mode	CM	21
105	Set default Binary message list	CM	30
110	Configure Main Port Mode	CM	7
112	Switch to Reprogramming Mode	CM	7

LEGEND: CM : Command Message
DR : Data Request
PM : Protocol Message

Note 1: Variable length (6 - 94 bytes)

B. MESSAGE CONTENT

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
6 Current channel assignment data request		This request will cause the GPS receiver to send both messages ID #6 and 7. No data bytes.	N/A	N/A
20 Navigation data request (User coordinates)		No data bytes.	N/A	N/A
21 Navigation data request		No data bytes.	N/A	N/A
22 Ephemeris (ICD-GPS-200 format) request		Each time a new request is sent, the GPS receiver will transmit a complete set of all ephemeris and SV clock data currently acquired. In a case of broadcast mode, the GPS receiver will transmit a complete set and then transmit only on new ephemeris reception. No data bytes.	N/A	N/A
23 Measurement block data request	 5	Request measurement block data for all tracked SV's. The GPS receiver will respond by sending message ID 23 every 100 msec (if requested at 10 Hz). bits 0..1 : Transmission Rate 0 : 1 Hz 1 : 2 Hz 2 : 5 Hz 3 : 10 Hz 2..7: Reserved (shall be 0)		
33 Satellite visibility data and status request		No data bytes	N/A	N/A
43 DGPS Configuration request		No data bytes	N/A	N/A
45 Software Identification request		No data bytes.	N/A	N/A
47 Base Station Status request		No data bytes.	N/A	N/A
48 Differential Message Status request		No data bytes.	N/A	N/A
49 Receiver Status request		No data bytes.	N/A	N/A
50 Satellite health summary request		No data bytes.	N/A	N/A

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
51 Initiated BIT request	5	0 = PowerUp BIT Results 1 = Initiate a Customer BIT 2-255 = Reserved	N/A	N/A
63 Initiate Link		This request will cancel all previous data request messages within 2 seconds.		
	5..12	Password (UGPS-000), in ASCII format, U character first	N/A	char [8]
64 Set Channel deselection		Set deselection criteria for all 12 channels if password valid. The channels to be deselected should be indicated in a bit map form. 1 in the bit map specifies that the corresponding channel shall be deselected.		
	5..12	Password (UGPS-000), in ASCII format, U character first	N/A	char [8]
	13	bit map (bit 0 -> ch #1, bit 7 -> ch #8)	N/A	N/A
	14	bit map (bit 0 -> ch #9, bit 3 -> ch #12)	N/A	N/A
65 Raw DGPS Data Request		No data bytes		
77 Update almanac		Force the decoding of a new almanac from SV subframe 4&5 data. No data bytes.	N/A	N/A
78 Common almanac data transfer		Command message that initiates a transmitter to GPS receiver data transfer if the password is valid. The data field of the message is composed of a list of available SV# (4 byte bit map) and the almanac data common to all SVs and almanac week. This message is sent ahead of the specific almanac data transfer message (ID #79 defined below).		
	5..12	Password (UGPS-000), in ASCII format, U character first	N/A	char [8]
	13	bit map (bit 0 -> SV #1, bit 7 -> SV #8)	N/A	N/A
	14	bit map (bit 0 -> SV #9, bit 7 -> SV #16)	N/A	N/A
	15	bit map (bit 0 -> SV #17, bit 7 -> SV #24)	N/A	N/A
	16	bit map (bit 0 -> SV #25, bit 7 -> SV #32)	N/A	N/A
		Almanac data which is common to all SVs are the week number and the reference time detailed below.		
	17..18	Almanac Week range: 0 .. 65535	weeks	word
	19	toa range: 0 .. 147 resolution: 602112 / 4096	seconds	unsigned char

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
79 Specific almanac data transfer		Transmitter to GPS receiver data transfer of SV specific almanac data (using YUMA almanac format). The first data byte shall be the SV#. A complete series of these messages is sent in increasing SV# order, from 1 to 32, for the SV's specified in the common almanac SV bit map data message. It is very important to note that each specific data message must be acknowledged (through message ID #126) before sending the next specific data message. If the GPS receiver does not receive all the SV specific almanac data messages specified in the common message within 55 seconds then a timeout error occurs. The GPS receiver shall then disregard all the data currently received and send an unsuccessful status message to the transmitter. The transmitter shall resend common message first, and then all the data messages. The GPS receiver ALWAYS sends back an almanac reception status message after the full almanac upload is successful or not successful. The transmitter must wait for this status message (or must wait for occurrence of a 60 seconds timeout period) before requesting any other almanac upload. Otherwise, the previous almanac upload will abort and the new almanac upload request is ignored.		
		Almanac data which is specific to each SV are detailed below.		
	5	SV # and type bit 0 .. 5: SV #, bit 6 .. 7: = 00 -> GLONASS, = 01 -> GPS, = 10 -> GIC Almanac Parameters	N/A	N/A
	6..13	Coarse_af0 clock aging parameter range: -(2.0^10) - 2.0^(-20) .. (2.0^10 - 1.0) - 2.0^(-20) resolution: 2.0^(-20)	seconds	long float
	14..21	Coarse_af1 clock aging parameter range: -(2.0^10) - 2.0^(-38) .. (2.0^10 - 1.0) - 2.0^(-38) resolution: 2.0^(-38)	seconds per second	double precision
	22.29	Coarse_M0 mean anomoly of ref. time range: -(2.0^23) - 2.0^(-23) - PI .. (2.0^23 - 1.0) - 2.0^(-23) - PI resolution: 2.0^(-23) - PI	radians	long float

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
79 (Cont'd)	30..37	Coarse_W argument of perigee range: -(2.0^23) - 2.0^(-23) - PI .. (2.0^23 - 1.0) - 2.0^(-23) - PI resolution: 2.0^(-23) - PI	radians	long float
	38..45	Coarse_Omega_0 right ascension range: -(2.0^23) - 2.0^(-23) - PI .. (2.0^23 - 1.0) - 2.0^(-23) - PI resolution: 2.0^(-23) - PI	radians	long float
	46..53	Coarse_Root_A semi major axis range: 2525.0 .. (2.0^24 - 1.0) - 2.0^(-11) resolution: 2.0^(-11)	$(meters)^{1/2}$	long float
	54..61	Coarse_Omega_Dot rate of right ascension range: -(2.0^15) - 2.0^(-38) - PI .. (2.0^15 - 1.0) - 2.0^(-38) - PI resolution: 2.0^(-38) - PI	radians per second	long float
	62..69	Coarse_Del_i angle of inclination (to .3 pi) range: -(2.0^15) - 2.0^(-19) - PI .. (2.0^15 - 1.0) - 2.0^(-19) - PI resolution: 2.0^(-19) - PI	radians	long float
	70..77	Coarse_e eccentricity range: 0 .. 0.03 resolution: 2.0^(-21)		long float
80 Set Operating Mode				
	5-12	Password (UGPS-**XXX**), in ASCII format, U character first.	N/A	char[8]
		where **XXX**: **000** - Set User Position (AllStar compatible - - see below) **R00** - Force to Rover Mode (position not saved) **GSP** - Get Survey Position **BYY** - Set Base Position and Base Information **SYY** - Force to Survey Mode where **YY**: bytes 11..12 (Station ID and Station Health) bits 0..9 : Station ID (10 bits: 1-1023) bits 10..12 : Station Health(as per RTCM) bits 13..15 : **Reserved**		
	13-20	Interpreted field		
		[**000 BYY**] Altitude Ellipsoid	meters	double
		[**SYY**] Survey time [0.0..48.0]	hours	double
		[**R00 GSP**] Don't Care		
	21-28	Interpreted field		
		[**000 BYY**] Latitude	radians	double
		[**SYY R00 GSP**] Don't Care		

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
80 (Cont'd)	29-36	Interpreted field [**000 BYY**] Longitude [**SYY R00 GSP**] Don't Care	 radians	 double
		- PREVIOUS ALLSTAR VERSIONS		
	13..20 21..28 29..36	MSL Altitude Latitude Range: -P1/2 .. P1/2 Longitude Range: -P1 .. P1	meters radians radians	long float long float long float
81 Set Mask angle	5..8 9..16	Mask angle (0 .. π/2) Reserved The value will be stored in NVM.	radians N/A	short float N/A
82 Transmit DGPS data message		byte 5..msg data length: RTCM Raw Data. Each byte is in a 6 out of 8 format as specified in section 4.0 and 5.0 of Ref [2].	N/A	N/A
83 Set DGPS Configuration	5 6 7 8 9..16 17 18..25	bit 0: Enable (0=OFF, 1-On) bit 1-3: Should be 1 bits 4-6: Should be 0 bit 7: Port (0=Main, 1=Dedicated) Differential Coast Time Reserved Auxiliary Port Baud Rate (1=300, ... 32=9600, ... 64=19200) Message Retransmission (Bitmap: bit0 = msg type1, bit63 = msg type 64)) bits 0-6: Reserved bit 7: Reserved Reserved	N/A seconds N/A 300 bauds N/A N/A N/A	N/A unsigned char N/A N/A N/A N/A N/A
84 Set Tropo model use	 5..12	Use tropospheric Model correction if password is valid. (MSB of ID# byte : 0 : correction is applied; 1 : correction is not applied) Password (UGPS-000), in ASCII format, U character first	 N/A	 N/A
85 Set Beacon Receiver parameters	5 6-7	Reserved Frequency range:0, 2835 to 3250 (283.5KHz to 325.0 KHz) 0 sets the Frequency Beacon Receiver board in automatic mode	N/A 100 Hz	N/A unsigned word

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
85 (Cont'd)	8	Bit Rate 0: automatic mode D4(hex) : 25 bps D5(hex) : 50 bps D6(hex) : 100 bps D7(hex) : 200 bps	N/A	N/A
	9	Interval for sending report (msg #85) 0 will stop the transmission of msg ID #85	sec	unsigned char
86 Set Mean Sea Level model use		Use MSL model if password is valid. (MSB of ID# byte : 0 : model is used; 1: model is not used)		
	5..12	Password (UGPS-000), in ASCII format, U character first	N/A	N/A
88 Select/Define datum		Select the datum used to report the position and define user-defined datum.		
	5	Function 0 : Select datum 1 : Define a user-defined datum 2 : Select and define a user-defined datum	N/A	N/A
	6	datum number (from 0 to 63, see Supported Datum List, Appendix TBD)	N/A	N/A
	7,8	dx	Meter	signed short
	9,10	dy	meter	signed short
	11,12	dz	meter	signed short
	13..20	a (semi-major)	meter	long float
	29..36	Reserved Note: The navigation data (user coordinates) message contains the datum currently in use.	N/A	N/A
90 Set SV deselect		Set deselection for all 32 SVs if password valid. The SVs deselect is indicated in a bit map form. 1 in the bit map specifies that the corresponding SV shall be deselected.		
	5..12	Password (UGPS-000), in ASCII format, U character first	N/A	char [8]
	13	bit map (bit 0 → SV #1, bit 7 → SV #8)	N/A	N/A
	14	bit map (bit 0 → SV #9, bit 7 → SV #16)	N/A	N/A
	15	bit map (bit 0 → SV #17, bit 7 → SV #24)	N/A	N/A
	16	bit map (bit 0 → SV #25, bit 7 → SV #32)	N/A	N/A
91 Differential Message Configuration	5	Message type and protocol bits 0..5: 0: Clear All Messages 1-63: Message Type bits 6,7: 00: RTCM 01: Reserved 10: RTCA 11: Reserved	N/A	N/A

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
91 (Cont'd)	6	Rate 0: Stop transmitting 1-255: every xx second(s)	seconds	byte
95 Track SV request		Track SV# on any available channel that is not currently in tracking or has been deselected, starting the search at a given carrier DCO frequency offset (search center frequency). The search window option is specified from 0 to 100 kHz, in 1 kHz increments.		
	5	SV # and type bit 0..5: SV # (1..32) bit 6..7: = 00 -> GLONASS, =01 -> GPS, = 10 -> GIC)	N/A	N/A
	6..7	Search Center Frequency: range: -60 000 .. 60 000	Hz	double word
	10	Search Window Size: range: 0 .. +100	kHz	unsigned char
	11..14	Min C/No range: 0.0 .. 63.0	dB-Hz	short float
	15..16	Doppler Rate	Hz/sec	unsigned 16
	17	Track Command (0 -> automatic mode, 1 -> manual mode)	N/A	N/A
99 Erase Non-Volatile Memory		Erase the data contained in the EEPROM if password is valid.		
	5..10	Password (UGPS-0), in ASCII format, U character first	N/A	N/A
	11-12	Element to erase (00 - 15) in ASCII. Ex. 15 -> 0x31,0x35	N/A	N/A

Characters	Element
00	ALL
01-04	RESERVED
05	ALMANAC
06-08	RESERVED
09	TCXO PARAMETERS
10	IONO & UTC PARAMETERS
11 12	POSITION TIME
13	DGPS CONFIGURATION
14	DEFAULT NMEA MSG LIST
15	RS232 CONFIGURATION

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
103 Set Date Time & GPS Time Alignment Mode		Enter the date and time (UTC). This data is accepted only if a SV is not presently being tracked and if password is valid.	N/A	N/A
	2	bit 7 0-Valid Time, 1-Invalidate the internal time	N/A	N/A
	3	bit 7 1-Valid Time, 0-Invalidate the internal time	N/A	N/A
	5..12	Password, in ASCII format, U character first UGPS-000: the date and time parameter will be applied UGPS-001: the date and time parameter won't be applied but will force the receiver to align its measurements (and TIMEMARK signal) on GPS time after the next power-up. A master reset is requested 10 seconds after the acknowledge of the message ID #103 to ensure the proper operation of the time alignment function. UGPS-002: The date and time parameter won't be applied but will force the receiver to not align its measurements (and TIMEMARK signal) on GPS time.	N/A	char [8]
	13..15	UTC Time resolution: 1 second	HR:MN:SC	byte:byte :byte
	16..19	Data resolution: 1 day	DY:MO:YR	byte:byte :byte
105 Set Default Binary Message List	5	bit 0: Reserved bit 1: Message ID#1 Flag: 0 : won't be transmitted 1 : will be transmitted bit 2: Message ID#2 Flag: 0 : won't be transmitted 1 : will be transmitted bit 3-7: Message ID#3-7 Flags: 0 : won't be transmitted 1 : will be transmitted	N/A	N/A
	6..20	Message ID #8-127 Flags	N/A	N/A
	21..28	Reserved		

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
110 Configure Main Port Mode	5	bits 0-6: Baud Rate (in 300 bauds unit, 1=300, ... 32=9600, ... 64=19200, 65=38400) bit 7: Mode : 1 = Binary, 0 = NMEA	N/A	N/A
112 Switch to Reprogramming Mode	5	Baud Rate (1=300, ... 32=9600, ... 64=19200)	300 bauds	N/A

BINARY PROTOCOL OUTPUT MESSAGES

A. MESSAGE SUMMARY

ID	DEFINITION	MESSAGE TYPE	RATE (SEC)	# BYTES
6	Current channel assignment data (1-6)	UR/FR	1	91
7	Current channel assignment data (7-12)	UR/FR	1	91
20	Navigation data (user coordinates)	UR/FR	1[4]	77
21	Navigation data (GPS coordinates)	UR/FR	1[4]	85
22	Ephemeris (ICD-GPS-200 format) data [2]	UR/FR	1	79
23	Measurement block data [3]	UR/FR	VAR	149
33	Satellite visibility data and status	UR/FR	1[4]	67
43	DGPS Configuration	UR		27
45	Hardware/Software identification request	UR	1	101
47	Base Station Status data (optional)	DR	1	50
48	Differential Message Status request	DR	1	29
49	Receiver Status request	DR	1	12
50	Satellite health summary	UR/FR	30	14
51	Initiated BIT result	UR		40
63	Initiate link	PM	0.1	14
78	Almanac reception status	SM	1	6
83	RTCM data Message Retransmission	DM	0.1	6..94
85	Beacon Receiver Status	SM	VAR	22
125	Link overload error message	PM	1	22
126	Acknowledge message	PM	0.1	11

LEGEND: CM : Command Message
DR : Data Request
PM : Protocol Message

Note for PM and SM: The protocol messages (PM) and status messages (SM) are scheduled to be output once per second or per 100 msec.

- Note 1: Messages 11 to 16 are no longer supported. Customers shall use messages 22 and 23.
- Note 2: Transmitted on first request and then on new ephemeris reception.
- Note 3: Option, Contact Customer Service for more information.
- Note 4: Transmitted twice per second when in 2Hz PVT mode.

B. MESSAGE CONTENT

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
6 Current channel assignment data (1-6)	5	Data set number Channel 1 assignment data	N/A	N/A
	6	SV # and type bit 0 .. 4: SV # (0..31) bit 5 .. 7: Reserved	N/A	N/A
	7..10	Carrier frequency resolution: cycles	cycles	unsigned long
	11..14	SNR	dB-Hz	short float
	15..18	Reserved	N/A	N/A
	19	Status Bit 0-1 encodes tracking state 00 -> not ready 01 -> bits ready 10 -> meas ready 11 -> failed Bit 2-3 encodes allocation state 00 -> idle, 01 -> location, 10 -> tracking Bit 4 encodes channel mode, 1 -> automatic, 0 -> manual	N/A	N/A
	20..33	Channel #2 assignment data	as per ch1	as per ch1
	34..47	Channel #3 assignment data	as per ch1	as per ch1
	48..61	Channel #4 assignment data	as per ch1	as per ch1
	62..75	Channel #5 assignment data	as per ch1	as per ch1
	76..89	Channel #6 assignment data	as per ch1	as per ch1
7 Current Channel Assignment Data (7-12)	5 6..89	Data set number Channel 7-12 assignment data	as per msg ID 6	as per msg ID 6
20 Navigation Data (user coordinates)		The message is output once per second upon reception of a message ID #20 request. The latency on this message is less than 0.5 seconds. The latency defined here refers to the time difference between the time tag of the computed position and the time of transmission of the first message byte. Message Length : 77 bytes		
	5..14	UTC Time units: HR:MN:SC	HR:MN:SC	hour ->, minute -> byte, second -> long float
	5	Time not corrected by UTC parameters (1=True, 0=False)		
	6-7	Reserved		

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
20 (Cont'd)	15..18	Date byte 15, bits 5-7: Reserved	DY:MO:YR	day -> byte, month -> byte, year -> word
	19..26	Latitude range: -P1/2 .. P1/2	radians	long float
	27..34	Longitude range: -P1 .. P1	radians	long float
	35..38	Altitude	meters	short float
	39..42	Ground Speed	meters/ sec	short float
	43..46	Track Angle range: -P1 .. P1	radians	short float
	47..50	Velocity North	meters/ sec	short float
	51..54	Velocity East	meters/ sec	short float
	55..58	Vertical velocity	meters/ sec	short float
	59..62	HFOM	meters	short float
	63..66	VFOM	meters	short float
	67..68	HDOP resolution: 0.1 units	word	N/A
	69..70	VDOP resolution: 0.1 units	word	N/A
	71	bits 0-4: NAV Mode 0 -> Init. Required, 1 -> Initialized, 2 -> Nav 3-D, 3 -> Alt. Hold (2-D), 4 -> Diff. 3-D, 5 -> Diff. 2-D, 6 -> Dead. Reckoning bit 5: Solution Confidence Level 0-> Normal (NAV solution from less than 5 SVs) 1 -> High (NAV solution from at least 5 SVs) bits 6: Reserved bit 7 : GPS Time Alignment mode 1-> Enable 0-> Disable	N/A	N/A
	72	bits 0..3 : Number of SVs used to compute this solution	N/A	N/A
	73	System Mode and Satellite tracking mode (c.f. msg #49, byte 5) bit 7: Reserved	N/A	N/A

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
20 (Cont'd)	72	bits 4..7 : Coordinate system (lowest nibble))	N/A	N/A
	73	bits 4,5: Coordinate system (highest nibble). Datum number = B73 b5,b4, B72 b7,b6,b5,b4 (B=byte, b=bit).	N/A	N/A
	74..75	Reserved		
21 Navigation Data (GPS coordinates)	5..12	GPS Time range: 0.0 .. 604800.0	seconds	long float
	13..14	Week	weeks	word
	15..22	X Position in GPS units	meters	long float
	23..30	Y Position in GPS units	meters	long float
	31..38	Z Position in GPS units	meters	long float
	39..42	X Velocity in GPS units	meters per second	short float
	43..46	Y Velocity in GPS units	meters per second	short float
	47..50	Z Velocity in GPS units	meters per second	short float
	51..58	Clock Bias	micro-seconds	short float
	59..66	Clock Drift	seconds/ second	long float
	67..70	HFOM, see Figure of Merit, Page 2-1	meters	short float
	71..74	VFOM	meters	short float
	75..76	HDOP resolution: 0.1 units	N/A	word
	77..78	VDOP resolution: 0.1 units	N/A	word
	79	NAV Mode (see message #20, byte 71 for the description)	N/A	N/A
	80	bits 0..3 : Nb of SV used to compute this solution bits 4..7 : Reserved	N/A	N/A
	81..83	Reserved	N/A	N/A
22 Ephemeris Data		This message contains ephemeris data for one Satellite. It is transmitted at a rate of one message per second until the ephemeris data list completed, and then it is transmitted only if new ephemeris occurs. The user is directed to Ref [1] for specifics on the format of the ephemeris data.		
	5	bits 0..4 : SV Number bits 5..7 : reserved	N/A	N/A
	6..77	Ephemeris sub-frame 1-3/words 3-10 MSB of byte 6 is the Bit 61 of subframe 1	as per Ref [1]	as per Ref [1]

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
23 Measurement Block Data (1, 2, 5, 10 Hz)	5-6	Reserved	N/A	N/A
	7	Number of measurement blocks (N)	N/A	N/A
	8..15	Predicted GPS Time	seconds	double
	16	bits 0..5 : SV # (0..31) bit 6 : reserved bit 7 : Toggle at each Ephemeris Transmission	N/A	N/A
	17	SNR	0.25 dB/Hz	unsigned char
	18..21	Code Phase range : 0 .. 2095103999	1/1024 half chip	unsigned long
	22..25	Integrated Carrier Phase		
		bit 0-1 : 0 : Ready 1 : Phase Unlock 2 : Cycle Slip Detected 3 : Not Ready	N/A	N/A
		bits 2-11 : Carrier Phase range: 0-1023	1/1024 cycles	N/A
		bits 12-31: Integrated Number of Cycles range: natural roll over	cycles	N/A
	26	Cycle_Slip Counter Increment by 1 every time a cycle slip is detected during a 10ms period range: natural roll over	N/A	unsigned char
		Measurement block #2 . . Measurement block #N	as per meas. block 1	as per meas. block 1
33 Satellite Visibility Data and Status	5	bit 0…3: Total number of Satellites in view bit 4..7: reserved Data transmission of up to 12 satellites in view listed in decreasing elevation order. Satellite visibility data of the 1st SV:	N/A	N/A
	6	Computed data bit map bit 0..4 : SV Number bit 5..6 : SV Status 0 = In View 1 = Tracking 2 = MeasReady 3 = Used by Nav bit 7 : Differential Corrections available	N/A	N/A
	7	Elevation range : -90..90	degree	signed char
	8-9	Azimuth range : 0..360 bits 9-15 : Reserved	degree	word
	10	SNR range : 0..90	dB	byte

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
33 (Cont'd)	11..15	Satellite visibility data of the 2nd SV	as per SV1	as per SV1
	16..20	Satellite visibility data of the 3rd SV	as per SV1	as per SV1
	21..25	Satellite visibility data of the 4th SV	as per SV1	as per SV1
	26..30	Satellite visibility data of the 5th SV	as per SV1	as per SV1
	31..35	Satellite visibility data of the 6th SV	as per SV1	as per SV1
	36..40	Satellite visibility data of the 7th SV	as per SV1	as per SV1
	41..45	Satellite visibility data of the 8th SV	as per SV1	as per SV1
	46..50	Satellite visibility data of the 9th SV	as per SV1	as per SV1
	51..55	Satellite visibility data of the 10th SV	as per SV1	as per SV1
	56..60	Satellite visibility data of the 11th SV	as per SV1	as per SV1
	61..65	Satellite visibility data of the 12th SV	as per SV1	as per SV1
43 DGPS Configuration	5	bit 0 : Enable (0=OFF, 1=On) bits 1-3: Should be 1 bits 4- 6: Should be 0 bit 7 : Port (0=Main, 1=Dedicated)	N/A	N/A
	6	Differential Coast Time	seconds	unsigned char
	7	Reserved	N/A	N/A
	8	Baud Rate (1=300, ... 32=9600, ... 64=19200)	300 bauds	N/A
	9..16	Messages requested for Retransmission (Bitmap: bit0 = 1, bit63 = 64) see message ID #83	N/A	N/A
	17	bits 0-6: Reserved bit 7: Message #5 usage disabled (0=False, 1=True)	N/A	N/A
	18..25	Reserved	N/A	N/A
45 Software Identification Information	5..18	Operational S/W Part number (XXX-XXXXXX-XXX)	N/A	char [14]
	19..36	Reserved ASCII string	N/A	char [18]
	37..50	Boot S/W Part number (xxx-xxxxxx-xxx)	N/A	char [14]
	51..90	Reserved	N/A	N/A
	91..94	Boot Checksum	N/A	N/A
	95..98	Operational Checksum	N/A	N/A
	99	Reserved	N/A	N/A
47 Base Station Status		This message is output once per second upon reception of a message ID #47 request.	N/A	N/A
	5	BaseStatus bits 0-1 : Base Status 0 : Not in Base 1 : Position Not Initialized 2 : Base Initialized 3 : Reserved bits 2-4 : Baud Rate 0-300 1-600 2-1200 3-2400 4-4800 5-9600 6-19200 7-38400 bits 5-7 : Reserved	N/A	N/A

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
47 (Cont'd)	6-13	Time Remaining Survey	hours	double
	14-17	Base Station Position CEP	meters	float
	18-25	Base Station Position Latitude	radians	double
	26-33	Base Station Position Longitude	radians	double
	34-41	Base Station Position Height	meters	double
	42-45	Reserved	N/A	N/A
	46	Number of Differential Message bit 0-4 : Number of Differential Message bit 5-8 : Reserved	N/A	byte
	47-48	byte 1 : Msg Type	N/A	byte
		byte 2 : Programmed Msg Rate Period	sec	byte
48 Differential Message Status		This message is output at a nominal rate of once per second upon reception of a message ID #48 request.		
	5	Station Id # (bits 0..7)	N/A	byte
	6	bit 0-1 : Reserved bit 2-4 : Station Health bit 5-6 : Station Id bit 8-9 bit 7 : Reserved	N/A	byte
	7-14	Msg Type # Received (Bitmap: bit0 = 1, bit63 = 64)	N/A	N/A
	15..16	Receiver Mode Differential data link - Valid Word Count Base Mode Reserved	N/A	N/A
	17..18	Receiver Mode Differential data link - Parity Error Count Base Mode Reserved	N/A	N/A
	19	Reserved	N/A	N/A
	20	Reserved	N/A	N/A
	21	Reserved	N/A	N/A
	22	Reserved	N/A	N/A
	23	Reserved	N/A	N/A
	24	Reserved	N/A	N/A
	25..26	bits 0..12: ZCount of last message 1, 2, 3, 9, or 59 Receiver Mode bits 13..15: DGPS Status 0 -> DGPS Disabled 1 -> Initialization/Synchronization 2 -> Correcting 3 -> Bad GDOP 4 -> Old corrections 5 -> Station unhealthy 6 -> Too few SVs 7 -> Reserved Base Mode Reserved	N/A	N/A
	27..28	Reserved	N/A	N/A

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
49 Receiver status data	5	bits 0-3: System Mode 0 - Self test 1 - Initialization 2 - Acquisition 3 - Navigation 4 - Fault bits 4-5: Reserved bit 6: Satellite tracking mode 0 - All SVs in view (based on current Almanac, position and time) 1 - Sky Search bit 7 : NVM Controller State 0 - Idle (no process in progress) 1 - Busy (Erase and/or Store data process in progress)	N/A	N/A
	6	bit 0 = 0: Tropo model enabled bit 1 = 0: MSL model enabled bits 2..3: Last Power-up Modes 0 - Cold Start (Invalid almanac, time or position) 1 - Initialized Start (Valid almanac, Time and Position) 2 - Warm Start (Valid almanac, Time, Position and Ephemeris) only with Battery Back-up RAM. bit 4: Reserved bits 5..7: Time Source 0 - Initialization required 1 - External 2 - SV without Nav 3 - SV with Nav	N/A	N/A
	7..8	Almanac Week of Collection, unsigned 16	N/A	N/A
	9..10	Week number, unsigned 16	N/A	N/A
	11..14	SV Deselect bitmap, byte 11: bit 0 = SV1, byte 14: bit 7=SV32	N/A	N/A
	15..16	Channel Deselection bitmap, byte 15: bit 0 = Ch1, byte 16: bit 7 - Ch12	N/A	N/A
	17..23	Reserved		
	24..25	Mask Angle (unsigned 16)	0.01 degree	
	26	Discrete Inputs		
	27..28	TCXO Error Estimate, signed 16 (Hz)	Hz	signed char
	29	TCXO Ageing, unsigned char (0.1 ppm)	0.1 ppm	unsigned char
	30..33	Search Noise	dB	short float
	34	Nav Mode (see message #20 byte 71 for description)	N/A	

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
49 (Cont'd)	35..44	Reserved		
50 Satellite Health Summary	5	bit map (bit 0,1 -> SV #1, bit 6,7 -> SV #4)	0 -> healthy, 1 -> unhealthy	N/A
	6	bit map (bit 0,1 -> SV #5, bit 6,7 -> SV #8)	as per byte 5	N/A
	7	bit map (bit 0,1 -> SV #9, bit 6,7 -> SV #12)	as per byte 5	N/A
	8	bit map (bit 0,1 -> SV #13, bit 6,7 -> SV #16)	as per byte 5	N/A
	9	bit map (bit 0,1 -> SV #17, bit 6,7 -> SV #20)	as per byte 5	N/A
	10	bit map (bit 0,1 -> SV #21, bit 6,7 -> SV #24)	as per byte 5	N/A
	11	bit map (bit 0,1 -> SV #25, bit 6,7 -> SV #28)	as per byte 5	N/A
	12	bit map (bit 0,1 -> SV #29, bit 6,7 -> SV #32)	as per byte 5	N/A
51 Initiated BIT Result	5	bit 0-7 : Copy of the Initiated BIT request message byte 1	N/A	N/A
	6	General Results (0=fail, 1=Pass) bit 0 : RAM bit 1 : Flash bit 2 : Eeprom bit 3 : Uart bit 4 : Real Time Clock bit 5 : Correlator & RF bit 6-7 : Reserved	N/A	N/A
	7-9	Reserved	N/A	N/A
	10	Memory Test Results (0=ok, 1=failure) bit 0 : Bad Boot S/W Checksum bit 1 : Bad Operational S/W Checksum bit 2-4: FLASH Error Code if different of 000 : Receiver can not be reprogrammed bit 5-7 : Reserved	N/A	N/A
	11	EEPROM Status bit 0-7 : Number of Usable Pages	N/A	N/A
	12	Primary Port (UART) busy bit 0 : UART not ready or UART busy bit 1 : TX not full flag error bit 2 : No Data received during internal loop tests bit 3 : Framing or Parity error bit 4 : RX not full flag error bit 5 : OVERRUN test failed bit 6-7 : Reserved	N/A	N/A

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
51 (Cont'd)	13	Auxiliary Port (UART) results bit 0 : UART not ready or UART busy bit 1 : TX not full flag error bit 2 : No Data received during internal loop tests bit 3 : Framing or Parity error bit 4 : RX not full flag error bit 5 : OVERRUN test failed bit 6-7 : Reserved	N/A	N/A
	14	RTC results bit 0-2 : RTC warning bit 3-4 : Data Retention register error bit 5-7 : Reserved	N/A	N/A
	15	RF Test Results 0-7 : RF warning code	N/A	N/A
	16	Global Correlator test results #1 bit 0 : Channel 0 error in I&Q test bit 1 : Channel 1 error in I&Q test bit 2 : Channel 2 error in I&Q test bit 3 : Channel 3 error in I&Q test bit 4 : Channel 4 error in I&Q test bit 5 : Channel 5 error in I&Q test bit 6 : Channel 6 error in I&Q test bit 7 : Channel 7 error in I&Q test	N/A	N/A
	17	Global Correlator test results #2 bit 0 : Channel 0 error in I&Q test bit 1 : Channel 1 error in I&Q test bit 2 : Channel 2 error in I&Q test bit 3 : Channel 3 error in I&Q test bit 4 : Channel 4 error in I&Q test bit 5 : Channel 5 error in I&Q test bit 6 : Channel 6 error in I&Q test bit 7 : Channel 7 error in I&Q test	N/A	N/A
	18	Global Correlator test results #3 bit 0 : Channel 9 error in I&Q test bit 1 : Channel 10 error in I&Q test bit 2 : Channel 11 error in I&Q test bit 3 : Channel 12 error in I&Q test bit 4 : Channel 9 error in Measurement test bit 5 : Channel 10 error in Measurement test bit 6 : Channel 11 error in Measurement test bit 7 : Channel 12 error in Measurement test	N/A	N/A
	19-30 31-40	Reserved Reserved		

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
63 Initiate Link	5..12	Password (UGPS-xxx), in ASCII format, U character first	N/A	char [8]
78 Almanac reception status		Informs the transmitter on the complete status of the almanac upload. The MSB of the ID # field encodes the status as follows: 0 = unsuccessful, 1 = unsuccessful. This message is sent once after a new almanac data transfer (which includes one message ID #78 and multiple messages ID #79) to confirm successful almanac upload. No data bytes.	N/A	N/A
83 RTCM data Message retransmission		This message contains one or part of one RTCM message. Message type selected in the Set DGPS Configuration message (ID#83), bytes 9..16 will be retransmitted through this message. Message length is variable and a message can be transmitted up to once every 100 msec. A RTCM message will always start as the first byte of a message and always end as the last byte of a message. Thus, a RTCM message can be output in one or many messages but a message block cannot contain more than one RTCM message. The control byte is used to determine the start and the end of a RTCM message. The sequence number of the control byte can be used to detect the loss of a message block on the transmitter side. It starts at 0 and increments by one for each consecutive message block (0,1,2,3,0,1,2,3,0,1,...).		
	5	Control Byte bits 0..1: Sequence number bit 2: Set if first block of a RTCM message bit 3: Set if last block of a RTCM message bits 4..7: Reserved, must be 0 ,skip the message if not.	N/A	N/A
	6..n+4	Data (Contains a full or part of one message, without parity bits) byte 0 = word 1 bits 1-8 byte 1 = word 1 bits 9-16 byte 2 = word 1 bits 17-24 byte 3 = word 2 bits 1-8	N/A	N/A
85 Beacon Receiver Status	5	Reserved	N/A	N/A
	6-7	Frequency range: 0, 2835 to 3250 (283.5 KHz to 325.0 KHz)	100 Hz	unsigned word

MESSAGE	BYTE	DESCRIPTION	UNIT	TYPE
85 (Cont'd)	8	Bit Rate D4 : 25 bps D5 : 50 bps D6 : 100 bps D7 : 200 bps	N/A	N/A
	9-11	Reserved	N/A	N/A
	12-13	Signal Strength	dB/uV	unsigned word
	14	Signal to Noise	dB	unsigned char
	15-17	Atmospheric impulse count over the last 10 seconds	N/A	N/A
	18	Self Test result (6 bits) 0s means all tests passed bit 0 : Antenna Fault detected bit 1 : Battery Backed RAM Invalid bits 2-5 : reserved	N/A	N/A
	19-20	S/W version	N/A	N/A
125 Link Overload Error Message	5..20	bit map (bit 0 -> ID #1, bit 127 -> ID #127)	N/A	N/A
126 Acknowledge Message	5	ID of first message acknowledged	N/A	N/A
	6	ID of second message acknowledged	N/A	N/A
	7	ID of third message acknowledged	N/A	N/A
	8	ID of fourth message acknowledged	N/A	N/A
	9	ID of fifth message acknowledged	N/A	N/A

SUPPORTED NMEA PROTOCOL

Note : you can order NMEA specification by calling the Executive Director at :
tel : 205-473-1793
fax : 205-473-1669

A. NMEA MESSAGE FORMAT

This section describes the serial protocol used to communicate with the Host CPU. The serial communication runs under the following set-up:

Speed: 300 to 38400 bauds.
Format: 8-bit data, 1 start bit, 1 stop bit, no parity (10 bits/character)

Data information passed on the serial line is divided in one or many NMEA approved or proprietary sentences having the following structure:

```
$PMCAG,xxx,xxx,xx,xx,...  *CK<CR><LF>

|| | |  |                 ||  |___|__End of sentence
|| | |  |                 |------ Checksum
|| | |  |                 |
|| | |  |                 ------ Checksum field delimiter1
|| | |  |
|| | |  -----------------  Data(1st field = msg identifier)
|| | |
|| | -------------------------   Interface ID
|| |                               (G = GPS)
|| |
|| ---------------------------   Originator ID
||                                 (MCA = JOHN)
||
|-----------------------------   Special ID
|                                   (P = Proprietary)
|
|
|
------------------------------   Record Sync Character
```

NOTE 1 : The checksum field delimiter and checksum are optional.
The checksum is a 8-bit exclusive OR of all characters in the sequence, including "," delimiters, between but not including the "$" and the "*" delimiters.

B. NMEA FIELD DEFINITIONS

Field Type	Symbol	Definition
Special Format Fields		
Status	A	Single character field: A = Yes, Data Valid, Warning Flag Clear V = No, Data Invalid, Warning Flag Set
Latitude	llll.ll	Fixed/Variable length field: degrees/minutes.decimal - 2 fixed digits of degrees, 2 fixed digits of minutes and a variable number of digits for decimal-fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
Longitude	yyyyy.yy	Fixed/Variable length field: degrees/minutes.decimal - 3 fixed digits of degrees, 2 fixed digits of minutes and a variable number of digits for decimal-fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal- fraction are optional if full resolution is not required.
Time	hhmmss.ss	Fixed/Variable length field: hours/minutes/seconds.decimal - 2 fixed digits of hours, 2 fixed digits of minutes, 2 fixed digits of seconds and a variable number of digits for decimal-fraction of seconds. Leading zeros always included for hours, minutes and seconds to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
Defined field		Some fields are specified to contain pre-defined constants, most often alpha characters. Such a field is indicated in this standard by the presence of one or more valid characters. Excluded from the list of allowable characters are the following which are used to indicate field types within this standard: "A", "a", "c", "hh", "hhmmss.ss", "llll.ll", "x", "yyyyy.yy".
Numeric Value Fields		
Variable numbers	x.x	Variable length integer or floating numeric field. Optional leading and trailing zeros. The decimal point and associated decimal-fraction are optional if full resolution is not required. (example: 73.10 = 73.1 = 073.1 = 73)
Fixed HEX field	hh_______	Fixed length HEX number only, MSB on the left.
Information Fields		
Variable text	c--c	Variable length valid character field.
Fixed alpha field	aa_____	Fixed length field of upper-case or lower-case alpha characters.
Fixed number field	xx_____	Fixed length field of numeric characters.
Fixed text field	cc_____	Fixed length field of valid characters.

NOTES:
1. Spaces can not be used in variable text field.
2. A negative sign "-" (HEX 2D) is the first character in a Field if the value is negative. The sign is optional if value is positive.

The following sections define the valid input and output sentences available on the Primary port.

NMEA PROTOCOL INPUT MESSAGES

Table 5-1 lists all valid input sentences.

The sentence type has the following meaning:

P-DR = Proprietary sentence issuing a data request
P-CM = Proprietary sentence issuing a command

Table 5-1
Primary Port Input Messages

Identifier	Name	Type	Sentence Length (Maximum) - Characters
000	Configure Primary Port Command.	P-CM	17
001	Initialization Data Command.	P-CM	77
003	Initiate BIT Selftest Command	P-CM	15
004	Request Output Message Command	P-DR	19
005	Set Output Configuration Command	P-CM	67
006	Switch to Reprogramming Mode Command	P-CM	20
007	Erase Non-Volatile Memory	P-CM	18
008	Set Receiver Parameters	P-CM	60
009	Define waypoint	P-CM	57
010	Select active waypoint	P-CM	18
MSK	Command message to the radiobeacon	P-CM/DR	27

A. CONFIGURE PRIMARY PORT COMMAND

This message is used to change the Primary port mode. Once this command is issued to ALLSTAR OEM the controller supporting the Monitor mode protocol is activated, then NMEA communications with the ALLSTAR OEM can be restored only by using binary message #110 of the appendix 5. On power-up, with NVM the primary port stay in the same mode. Without NVM the default mode is Monitor Mode (BINARY).

```
HEADER        |   CONTENTS OF DATA FIELDS
              |
$PMCAG,000    |
              |
              |   ,x*hh<CR><LF>
              |    |
              |    Baud Rate Selection1
```

1 Baud Rate selection :

Character	Baud Rate
0	19200
1	300
2	600
3	1200
4	2400
5	4800
6	9600
7	19200
8	38400

Example:

Configure the Primary port to Monitor Mode at 19200.

$PMCAG,000,0*58<CR><LF>

B. INITIALIZATION DATA COMMAND

This message initializes ALLSTAR OEM with reference UTC date and time and user position.

```
HEADER        | $PMCAG,001

CONTENTS OF DATA FIELDS
,xx,xx,xxxx,xx,xx,xx,±xx,xx,±llll.ll,a,yyyyy.yy,a,±x.x,c*hh<CR><LF>
 |  |  |    |      |   |  |  |        | |        |  |   |
 |  |  |    |      |   |  |  |        | |        |  |   Reserved8
 |  |  |    |      |   |  |  |        | |        |  altitude7
 |  |  |    |      |   |  |  |        | ----------- longitude-E/W6
 |  |  |    |      |   |  |   ---------- latitude-N/S5
 |  |  |    |      |   |  reserved4
 |  |  |    |      |  reserved3
 |  |  |    ---------time2
 -------- date1
```

1 UTC Date (Day 1..31, Month 1..12, Year 1980..2079)
2 UTC Time (Hour 0..23, Minutes 0..59, Seconds 0..59)
3 Reserved, must be 00.
4 Reserved, must be 00.
5 Latitude - N/S with respect to WGS-84.
6 Longitude - E/W with respect to WGS-84.
7 Altitude in meters above (below) mean sea level. Resolution : 0.01 meter.
8 Reserved, no character.

Example:

Set Reference Position sentence.

$PMCAG,001,08,07,1993,16,37,21,00,00,5301.97,N,00133.48,E,35.3*40<CR><LF>

Date	-	08/07/1993
Time	-	16:37:21
Reserved	-	Must be 00
Local zone minutes	-	Must be 00
Latitude	-	53° 01.97' North
Longitude	-	1° 33.48' East
Altitude	-	35.35 m above mean sea level
Reserved	-	No character

C. INITIATED BIT SELF-TEST COMMAND

This message will request a complete self-test of ALLSTAR OEM. Results of the engine self-test will be automatically output (output message 902) on the primary output port at completion of the BIT selftest sequence.

HEADER	CONTENTS OF DATA FIELDS
$PMCAG,003	*hh<CR><LF>

Example:

$PMCAG,003*47<CR><LF>

D. REQUEST OUTPUT MESSAGE COMMAND

This message will request only one transmission of one NMEA output message

```
             |
HEADER       |   CONTENTS OF DATA FIELDS
             |
$PMCAG,004   |
             |
             |   ,ccc*hh<CR><LF>
             |     |
             |    Sentence Identifier1
```

1 Valid sentence identifiers are those listed in Table D-2 (except message ID 901).

Example:

Request approved sentence GPGGA.

$PMCAG,004,GGA*2D<CR><LF>

E. SET OUTPUT CONFIGURATION COMMAND

This message is used to configure the output of the primary port. It contains the input/output primary port baud rate and the list of message identifiers with their minimum time interval between consecutive transmissions.

900	Navigation Status
906	Bearing and Distance to Waypoint
907	User Position in MGRS Format
GGA	Global Positioning System Fix Data
GLL	Geographic Position - Latitude/Longitude
GSA	GPS DOP and Active Satellites
GSV	GPS Satellites in View
RMC	Recommended Minimum Specific GPS Data
VTG	Track Made Good and Ground Speed
ZDA	UTC Time & Date

```
HEADER       |  CONTENTS OF DATA FIELDS
             |
$PMCAG,005   |
             |  ,x.x,ccc,xxx,...,ccc,xxxx*hh<CR><LF>
             |   |   |   |       |   |
             |   |   |   |       ------ nth message block2
             |   |   ------ first message block2
             |   baud rate1
```

1 baud rate : Valid baud rate :0.3, 0.6, 1.2, 2.4, 4.8, 9.6, 19.2, 38.4 (in KBaud unit).

0 : Keep same baud rate (no effect) and update message list with new update rate values.
1 : Save the included list in NVM and over-write the previous one.

2 message block: Each message block include :

ccc : message identifier
xxx : time interval between consecutive transmissions (001..999 seconds)
000 will stop the transmission

Example:

$PMCAG,005,4.8,GGA,010,RMC,001,VTG,001,ZDA,010*48<CR><LF>

output messages: GGA and ZDA transmitted every 10 seconds
RMC and VTG transmitted every second.
@4800 BAUD

$PMCAG,005,1,GLL,001*2A<CR><LF>

output messages: GGA and ZDA transmitted every 10 seconds
GLL, RMC and VTG transmitted every second.
@4800 BAUD
and store in NVM : GLL,001 @ 4800 (all previous messages in NVM will be overwritten

F. SWITCH TO REPROGRAMMING MODE COMMAND

See Appendix G for more information

```
HEADER      |  CONTENTS OF DATA FIELDS
            |
$PMCAG,006  |
            |
            |  ,xx.x*hh<CR><LF>
            |    |
            |   baud rate1
            |
```

1 baud rate : Valid baud rate :0.3, 0.6, 1.2, 2.4, 4.8, 9.6, 19.2 or 38.4 (in KBaud unit).
(Baud rate used for synchronisation with the programming utility)

Example:

$PMCAG,006,19.2*7A<CR><LF>

G. ERASE NON-VOLATILE MEMORY COMMAND

```
HEADER        |  CONTENTS OF DATA FIELDS
              |
$PMCAG,007    |
              |  ,xx*hh<CR><LF>
              |    |
              |   element1
              |
```

1 element : NVM element to erase

Characters	Element
00	ALL (note 1)
01-04	RESERVED
05	ALMANAC
06-08	RESERVED
09	TCXO PARAMETERS
10	IONO & UTC PARAMETERS
11	POSITION
12	TIME
13	DGPS CONFIGURATION
14	DEFAULT NMEA MSG LIST
15	RS232 CONFIGURATION (note 1)
W00 – W99	Waypoint ID
WXX	All waypoints

Example:

$PMCAG,007,15*6B<CR><LF>

Erase : configuration of the primary port and Binary message list transmitted by default after each power-up.

Note 1: These commands will force the ALLSTAR OEM to go in Binary mode @ 9600 at the next power-up.

H. SET RECEIVER PARAMETER COMMAND

```
HEADER       |  CONTENTS OF DATA FIELDS
             |
$PMCAG,008 |
             |
             |  ,15,a,a,a,x.x,x,a,x,x.x,,x,x,,,,*hh<CR><LF>
             |   |  | | |  |  | | |  | | | |
             |   |  | | |  |  | | |  | | | UTC Time Resolution (note 6,9)
             |   |  | | |  |  | | |  | | Lat/Long Resolution(note 6,8)
             |   |  | | |  |  | | |  | Reserved (note 1)
             |   |  | | |  |  | | |  Auxiliary Port Baud Rate (note 5,6)
             |   |  | | |  |  | | Diff Coast Time (note 4,6)
             |   |  | | |  |  | DGPS Mode (E/D) (note 6)
             |   |  | | |  |  Datum Number (note 10)
             |   |  | | |  Mask Angle(note 3,6)
             |   |  | | Tropo Model Use (E/D)
             |   |  | MSL Model Use (E/D)
             |   |  GPS Time Alignment Mode (E/D) (note 2,6)
             |   Number of elements (note 7)
```

Note 1 : All Reserved Fields shall be NULL.
Note 2 : At the next power up, the ALLSTAR will align its TIMEMARK pulse and GPS measurements on GPS time.
Note 3 : Value between 0.0 to 90.0 degree.
Note 4 : 0 - 255 seconds
Note 5 : Valid baud rate :0.3, 0.6, 1.2, 2.4, 4.8, 9.6, 19.2 (in KBaud unit).
Note 6 : Will be stored in NVM
Note 7 : This number indicates how many parameters are listed in the messages. Shall be 15.
Note 8 : This parameter control the number of digits that will be transmitted for the fraction part of the latitude and longitude data in all NMEA messages. The default value is 4 and the range is 0 to 5.
Note 9 : This parameter control the number of digits that will be transmitted for the fraction part of the UTC Time data in all NMEA messages. The default value is 2 and the range is 0 to 9.
Note 10: This parameter is used to specify the datum that shall be used to express the position. Refer to the supported datum list in Appendix E, Supported Datum List.

Each of the parameters (except the number of elements) may be NULL, the associated receiver parameter will be left unchanged.

Example:

$PMCAG,008,15,E,E,,10.5,0,E,45,9.6,,,,,,*37<CR><LF>

Enable : GPS Time Alignment, DGPS and MSL modes
Don't affect current TROPO model status
Mask Angle : 10.5 Degrees
Datum 0 - WGS 1984
DGPS Coast time : 45 seconds
DGPS Baud Rate : 9600 (auxiliary port)
Don't affect present resolution on Lat\Long and UTC time data

I. DEFINE WAYPOINT IN MGRS FORMAT

Define the position of a waypoint in MGRS format.

```
              |
HEADER        |  CONTENTS OF DATA FIELDS
              |
$PMCAG,009    |
              |
              |  ,xx,a,a,a,xxxxx,xxxxx,±xxxxx.x,c--c,xx*hh<CR><LF>
              |   |  | | |   |     |      |      |    |
              |   |  | | |   |     |      |      |    Waypoint number (00 - 99)
              |   |  | | |   |     |      |     Waypoint name (max 8 char)
              |   |  | | |   |     |     Altitude above MSL (m)
              |   |  | | |   |    Grid northing
              |   |  | | |  Grid easting
              |   |  | | Square row
              |   |  | Square column
              |   |  Zone letter
              |   Zone number
```

Example:

$PMCAG,009,18,T,X,R,02090,38779,100.5,MARCONI,03*79<CR><LF>

Zone number	-	18
Zone letter	-	T
Square column	-	X
Square row	-	R
Grid easting	-	02090
Grid northing	-	38779
Altitude	-	100.5
Waypoint name	-	MARCONI
Waypoint ID	-	03

J. SELECT ACTIVE WAYPOINT

Selects the active waypoint to be used in subsequent requests to $PMCAG,906.

```
                |
HEADER          |  CONTENTS OF DATA FIELDS
                |
----------------------------------------------------------------
$PMCAG,010      |
                |
                |  ,xx*hh<CR><LF>
                |    |
                |    Waypoint ID
                |
```

Example:

$PMCAG,010,03*47<CR><LF>

K. COMMAND MESSAGE TO THE RADIOBEACON

This message is used to configure the set the frequency and bit rate parameters of the radiobeacon and also to set the rate of the output message MSS and $PMCAG,903.

```
HEADER     |   CONTENTS OF DATA FIELDS
           |
MSK        |
           |  ,x.x,a,x.x,a,x.x*hh<CR><LF>
           |   |   | |   | |
           |   |   | |   | ---Interval for sending $PMCAG,903 and MSS msg  1
           |   |   | |        in seconds
           |   |   | |   ---- Auto/Manual bit rate
           |   |   | ------ Beacon bit rate (25,50,100,200) bits per second 2
           |   |   ------ Auto/Manual frequency, A/M
           |  radiobeacon frequency, 285.5-325.0 kHz
```

1 Status Request : When status data is not to be transmitted this field is "null".
If not null, the MSS and $PMCAG,903 sentences will be sent at the specified rate

Example:

$GPMSK,308.0,M,25,A,010*71<CR><LF>

output messages: MSS and 903 transmitted every 10 seconds.
Set the frequency in manual mode and bit rate in automatic mode.

$GPMSK,308.0,M,25,M,010*7D<CR><LF>

output messages: MSS and903 transmitted every 10 seconds.
Set the frequency at 308kHz and bit rate at 25 bps.

NMEA PROTOCOL OUTPUT MESSAGES

Table 5-2 lists all valid output sentences.

Table 5-2
Primary Port Output Sentences

Message Identifier	Name	Sentence Length (Maximum) - Characters	Rate
900	Navigation Status.	21	Adjustable
901	Data Request List Overflow.	15	N/A
902	Self-Test Results	39	On Request
903	Radiobeacon Proprietary Info	40	Adjustable via MSK
906	Bearing, Distance & Delta-Elevation to waypoint	77	Adjustable
907	User Position - MGRS Format	57	Adjustable
908	Receiver Parameter Status (see note 1)	60	On Request
GGA	Global Positioning System Fix Data. (see note 2 and 3)	82	Adjustable
GLL	Geographic Position - Latitude/Longitude	51	Adjustable
GSA	GPS DOP and Active Satellites.(See note 2 and 3)	66	Adjustable
GSV	GPS Satellites in View.	3*70	Adjustable
MSS	MSS-MSK Radiobeacon Receiver Signal Status	29	Adjustable via MSK
RMC	Recommended Minimum Specific GPS Data.	69	Adjustable
VTG	Track Made Good and Ground Speed.. (see note 2 and 3)	37	Adjustable
ZDA	UTC Time & Date and local time zone 39	39	Adjustable

Note 1: The message can be longer in the future software release (see message description)
Note 2: This message will be sent at twice the requested update rate if the 2Hz PVT mode is active
Note 3: This message will be sent at five times the requested update rate if the 5Hz PVT mode is active

A. NAVIGATION STATUS

This message provides the current navigation mode and GPS fix quality indicator.

```
             |
HEADER       |  CONTENTS OF DATA FIELDS
             |
$PMCAG,900 |
             |
             | ,ccc,c*hh<CR><LF>
             |  |    |
             |  |    GPS Fix Quality Indicator2
             |  |
             |  Navigation mode1
```

1 Navigation mode:

3DD	-	3-D fix with differential aiding
3-D	-	3-D fix
2DD	-	2-D fix (constant altitude) with differential aiding
2-D	-	2-D fix (constant altitude)
D-R	-	Dead-Reckoning
INI	-	Initialized (Last good fix or external initialization)
NCD	-	No Computed Data. Fix data is not valid and should be ignored. The ALLSTAR doesn't have a valid time and/or a valid position (from Last good fix or external initialization).

2GPS Fix Quality Indicator :

L : Low. Navigation solution is obtained from less than 5 satellite measurements.
H : High. Navigation solution is obtained from at least 5 satellite measurements.

Example:

$PMCAG,900,3-D,H*5F<CR><LF>

Navigation Mode -3-D fix
GPS Fix quality -obtained from at least 5 SVs.

B. DATA REQUEST LIST OVERFLOW

Returned when more than 8 data requests are pending.

HEADER	CONTENTS OF DATA FIELDS
$PMCAG,901	*hh<CR><LF>

Example:

$PMCAG,901*4C<CR><LF>

C. SELF-TEST RESULTS MESSAGE

Result of ALLSTAR OEM self-test. This message is automatically outputed in response to an initiated BIT self-test request (see input message identifier 003). This message can also be requested through input message identifier 004 to retrieve the current status of the engine without initiating a self-test sequence.

```
            |
HEADER      |  CONTENTS OF DATA FIELDS
            |
$PMCAG,902  |
            |
            | ,xxxxxx,xxx,a,aaaa,xx,xx*hh<CR><LF>
            |  |      |   | |    |  |
            |  |      |   | |    |  Faults Identifier
            |  |      |   | |    nb of active faults
            |  |      |   | Engine Selftest Result1
            |  |      |   SW revision letter
            |  |      SW Variation Number
            |  SW Part Number (root number)
```

1 Engine Selftest Result from the last initiated BIT. (PASS, FAIL)

Faults Identifier Description (has to be converted in HEX format) :

General Results (0=fail, 1=Pass)

bit 0: RAM
bit 1: Flash
bit 2: EEprom
bit 3: Uart
bit 4: Real Time Clock
bit 5: Correlator & RF
bit 6-7: Reserved

Example:

$PMCAG,902,613913,042,A,PASS,00,63*23<CR><LF>
$PMCAG,902,613913,042,A,FAIL,03,49*3B<CR><LF>

Faults in Flash, EEprom and UART sections (49 = 0x31)

D. RADIOBEACON PROPRIETARY INFORMATION

This message is automatically outputed in response to an MSK request (see input message identifier MSK).

HEADER	CONTENTS OF DATA FIELDS
$PMCAG,903	,x.x,aa,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>

```
,x.x,aa,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>
 |   |  |   |   |   |   |
 |   |  |   |   |   |   --   reserved (shall be Null)
 |   |  |   |   |   --   reserved (shall be Null)
 |   |  |   |   --  reserved (shall be Null)
 |   |  |   --  reserved (shall be Null)
 |   |  -- SW Part Number (root number)
 |   -- Radiobeacon self test result[1]
 -- Impulse noise count
```

1 0 means all tests passed
- bit 0 : Antenna Fault detected
- bit 1 : Battery Backed RAM Invalid
- bits 2-5 : reserved

E. BEARING, DISTANCE AND DELTA-ELEVATION TO WAYPOINT

Bearing, distance and delta-elevation to, and location of, a specified waypoint from present position. The distance is calculated along the great circle path.

```
HEADER      | $PMCAG,906
            |

CONTENTS OF DATA FIELDS
,xx,a,a,a,xxxxx,xxxxx,±xxxxx.x,c—c,xx,xxx.x,xxxxxxxx.xxx,xxxxx.x,a*hh<CR><LF>
 |  | | |   |     |      |      |  |   |         |         |     |
 |  | | |   |     |      |      |  |   |         |         |     Status1
 |  | | |   |     |      |      |  |   |         |       Delta-Altitude (m)
 |  | | |   |     |      |      |  |   |       Distance (m)
 |  | | |   |     |      |      |  |  True bearing (degrees)
 |  | | |   |     |      |      | Waypoint number (00 - 99)
 |  | | |   |     |      |   Waypoint name (max 8 char)
 |  | | |   |     |   Altitude above MSL (m)
 |  | | |   |  Grid northing
 |  | | | Grid easting
 |  | | Square row
 |  | Square column
 | Zone letter
 Zone number
```

[1] Status: A = Data Valid
V = Data Invalid

Example:

$PMCAG,906,18,T,X,R,02069,38914,100.5,03,355.8,143.772,70.6,A*6E<CR><LF>

Zone number	-	18
Zone letter	-	T
Square column	-	X
Square row	-	R
Grid easting	-	02090
Grid northing	-	38779
Altitude	-	100.5
Waypoint ID	-	03
Bearing	-	355.8 degrees
Distance	-	143.772 meters
Delta-altitude	-	70.6 m
Status	-	Data Valid

F. USER POSITION IN MGRS FORMAT

Current position in MGRS format and UTC time of position.

```
HEADER       |  CONTENTS OF DATA FIELDS
-------------------------------------------------------------------------------
$PMCAG,907   |
             |
             |  ,xx,a,a,a,xxxxx,xxxxx,±xxxxx.x,hhmmss.ss,A*hh<CR><LF>
             |   |  | | |   |     |      |       |       |
             |   |  | | |   |     |      |       |      Status¹
             |   |  | | |   |     |      |      UTC time of position
             |   |  | | |   |     |     Altitude above MSL (m)
             |   |  | | |   |    Grid northing
             |   |  | | |  Grid easting
             |   |  | | Square row
             |   |  | Square column
             |   |  Zone letter
             |  Zone number
```

[1] Status: A = Data Valid
V = Data Invalid

Example:

$PMCAG,907,18,T,X,R,02090,38779,100.5,141105,A*79<CR><LF>

Zone number	-	18
Zone letter	-	T
Square column	-	X
Square row	-	R
Grid easting	-	02090
Grid northing	-	38779
Altitude	-	100.5
UTC time	-	14:11:05
Status	-	Valid Data

G. RECEIVER PARAMETER STATUS

```
HEADER        |  CONTENTS OF DATA FIELDS
--------------------------------------------------------------------------
$PMCAG,908    |
              |
              |  ,15,a,a,a,x.x,,a,x,x.x,,x,x,,,,*hh<CR><LF>
              |   |  | | |  | | | |  |   | |
              |   |  | | |  | | | |  |   | UTC Time Resolution
              |   |  | | |  | | | |  |   Lat/Long Resolution
              |   |  | | |  | | | |  Auxiliary Port Baud Rate (note 3)
              |   |  | | |  | | | Diff Coast Time (note 2)
              |   |  | | |  | | DGPS Mode (E/D)
              |   |  | | |  |Datum Number (note 4)
              |   |  | | |  Mask Angle
              |   |  | | Tropo Model Use (E/D)
              |   |  | MSL Model Use (E/D)
              |   |  GPS Time Alignment Mode (E/D)
              |   Nb of Elements(note 1)
```

Note 1 : Indicates the number of elements that follow. It is set to 15 but new receiver parameters can be added in the future software release.

Note 2 : 0 - 255 seconds

Note 3 : Valid baud rate :0.3, 0.6, 1.2, 2.4, 4.8, 9.6, 19.2 (in KBaud unit).

Note 4: This parameter reports the number of the datum that is currently used to report the position. Refer to the supported datum list in **Error! Reference source not found.**.

Example:

$PMCAG,908,15,D,E,E,8,35,E,45,9.6,,5,6,,,,*5B<CR><LF>

Enable : DGPS, TROPO and MSL modes
Disable : GPS Time Alignment
Mask Angle : 8.0 Degrees
Used datum: 35 - North American 1927 (Canada)
DGPS Coast time : 45 seconds
DGPS Baud Rate : 9600 (auxiliary port)
Lat/Long resolution : .00001 of minutes
UTC Time resolution : 1us

H. GLOBAL POSITIONING SYSTEM FIX DATA

Time, position and fix related data.

```
HEADER        |  CONTENTS OF DATA FIELDS
              |
$GPGGA        |
              |
              |  ,hhmmss.ss,llll.ll11,a,yyyyy.yyyy,a,x,xx,xx.x,
              |   |         |         | |          | | |  |
              |   |         |         | |          | | |  HDOP
              |   |         |         | |          | | SVs in use4
              |   |         |         | |          | Quality indicator3
              |   |         |         | |          E/W - East or West
              |   |         |         | Longitude2
              |   |         |         N/S - North or South
              |   |         Latitude1
              |   UTC of position
              |
              |   ±xxxxx.x,M,xxxx,M,xxxx,xxxx*hh<CR><LF>
              |   |        | |    | |    |
              |   |        | |    | |   Differential reference station
              |   |        | |    | |   ID(0000-1023)
              |   |        | |    | Age of Differential GPS Data7
              |   |        | |    Units of geoidal separation, meters
              |   |        | Geoidal Separation6
              |   |        Units of antenna altitude, meters
              |   Altitude5
```

1 Latitude with respect to WGS-84.
 - 2 digits of degrees, 2 digits of minutes, 4 digits of decimal fraction of minutes.
2 Longitude with respect to WGS-84.
 - 3 digits of degrees, 2 digits of minutes, 4 digits of decimal fraction of minutes
3 GPS Quality indicator,
 0 = fix not available or invalid
 1 = GPS fix
 2 = Differential GPS fix
4 May be different from number in view.
5 Altitude with respect to mean sea level.
6 Geoidal separation: the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid).
 "-" mean-sea-level below ellipsoid.
7 Time in seconds since last SC104 Type 1 or 9 update, empty field when DGPS is not used.

This message will be sent at twice the requested update rate if the 2Hz PVT mode is active

Example:

$GPGGA,012338.61,5619.2837,N,17235.8964,E,1,05,02.3,-00034.2,M,,M,,*66<CR><LF>

UTC	-	01:23:38.61
Latitude	-	56° 19.2837' North
Longitude	-	172° 35.8964' East
Quality	-	GPS fix
SVs used	-	5
HDOP	-	2.3
Altitude	-	-34.2 m below mean sea level

I. GEOGRAPHIC POSITION LATITUDE/LONGITUDE

Latitude and Longitude of present position,time of position and status.

```
HEADER      |  CONTENTS OF DATA FIELDS
            |
$GPGLL      |
            |
            |  ,llll.ll11,a,yyyyy.yyyy,a,hhmmss.ss,A*hh<CR><LF>
            |   |         | |          | |         |
            |   |         | |          | |         |
            |   |         | |          | |         Status3
            |   |         | |          | UTC of position
            |   |         | |          E/W - East or West
            |   |         | Longitude2
            |   |         N/S - North or South
            |   Latitude1
            |   UTC of position
```

1 Latitude with respect to WGS-84.
- 2 digits of degrees, 2 digits of minutes, 4 digits of decimal fraction of minutes.

2 Longitude with respect to WGS-84.
- 3 digits of degrees, 2 digits of minutes, 4 digits of decimal fraction of minutes

3 Status:
A = Data Valid
V = Data Invalid

Example:

$GPGLL,5619.2837,N,17235.8964,E,012338.61,A*0C<CR><LF>

Latitude	-	56° 19.2837' North
Longitude	-	172° 35.8964' East
UTC	-	01:23:38.61
Status	-	Valid Data

J. GPS DOP AND ACTIVE SATELLITES

Operating mode, satellites used for navigation and DOP values.

```
HEADER      |  CONTENTS OF DATA FIELDS
            |
$GPGSA      |
            |
            | ,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx.x,xx.x,
            |  | | |  |  |  |  |  |  |  |  |  |  |  |  |    |
            |  | | |  |  |  |  |  |  |  |  |  |  |  |  |    HDOP
            |  | | |  |  |  |  |  |  |  |  |  |  |  |  PDOP
            |  | |                                  PRNs of SVs Used1
            |  | Mode2
            |  |
            |  Mode3
            |
            |  xx.x*hh<CR><LF>
            |  |
            |  VDOP
            |
```

1 PRN numbers of satellites used in solution (null for unused fields).
2 Mode:
    1 = Fix not available
    2 = 2D
    3 = 3D
3 Mode:
    M = Manual, forced to operate in 2D or 3D mode.
    A = Automatic, allowed to automatically switch 2D/3D.

This message will be sent at twice the requested update rate if the 2Hz PVT mode is active

Example:

GPS DOP and Active Satellites Data sentence.

$GPGSA,A,3,14,22,03,09,08,29,17,,,,,,2.7,2.2,1.6*3A<CR><LF>

Mode	-	Automatic / 3D
SVs Used	-	PRNs 14, 22, 03, 09, 08, 29 and 17
PDOP	-	2.7
HDOP	-	2.2
VDOP	-	1.6

K. GPS SATELLITES IN VIEW

Number of SVs in view, PRN numbers, elevation, azimuth and SNR values. Four satellites maximum per transmission, additional satellite data sent in second or third sentence.

```
           |
HEADER     |  CONTENTS OF DATA FIELDS
           |
-------------------------------------------------------------------------------
$GPGSV     |
           |
           | ,x,x,xx,xx,xx,xxx,xx..........,xx,xx,xxx,xx.x*hh<CR><LF>
           |  | | |  |  |  |   | |        | |            |
           |  | | |  |  |  |   | |        | --------------4th SV
           |  | | |  |  |  |   | ----------2nd - 3rd SV
           |  | | |  |  |  |   SNR1
           |  | | |  |  |  Azimuth, degrees2
           |  | | |  |  Elevation, degrees3
           |  | | |  Satellite PRN number
           |  | | Total number of satellites in view
           |  | Message number, 1 to 3
           |  Total number of messages, 1 to 3
           |
```

1 SNR (C/No) 00-99 dB, null when not tracking.
2 Azimuth, range 000 to 359 degrees.
3 Elevation, range 00 to 90 degrees.

Example:

GPS Satellites in View Data sentence.

$GPGSV,2,1,06,03,12,238,06,07,82,008,15,11,04,053,,27,43,178,12*7F<CR><LF>

Messages	-	2
Msg. No.	-	1
SV Visible	-	6
PRN	-	03
Elevation	-	12°
Azimuth	-	238°
SNR	-	6 dB
PRN	-	07
Elevation	-	82°
Azimuth	-	8°
SNR	-	15 dB
PRN	-	11
Elevation	-	4°
Azimuth	-	53°
SNR	-	Not tracked
PRN	-	27
Elevation	-	43°
Azimuth	-	178°
SNR	-	12 dB

$GPGSV,2,2,06,15,23,187,8.2,17,35,323,11,,,,,,,,*4E<CR><LF>

Messages	-	2
Msg. No.	-	2
SV Visible	-	6
PRN	-	15
Elevation	-	23°
Azimuth	-	187°
SNR	-	8 dB
PRN	-	17
Elevation	-	35°
Azimuth	-	323°
SNR	-	11 dB

L. MSS - MSK RECEIVER SIGNAL STATUS

This message sent the information about the Signal-To-Noise ratio and signal strength, frequency and bit rate form a MSK (Beacon) receiver. This message will be transmitted at the rate set in the input message $GPCAG,MSK.

```
HEADER        |  CONTENTS OF DATA FIELDS
              |
MSS           |
              |  ,x.x,x.x,x.x,x.x*hh<CR><LF>
              |   |   |   |   |
              |   |   |   |   |
              |   |   |   |   ---- Beacon bit rate (25,50,100,200) bits
              |   |   |   |             per second
              |   |   |   ------ radiobeacon frequency, 285.5-325.0 kHz
              |   |   ------ Signal-to-Noise ratio (SNR),dB
              |   -------- Signal Strength (SS), dB re: 1uV/m
```

M. RECOMMENDED MINIMUM SPECIFIC GPS DATA

Time, date, position, course and speed data.

```
HEADER        |  CONTENTS OF DATA FIELDS
--------------------------------------------------------------------------
$GPRMC        |
              |
              | ,hhmmss.ss,A,llll.llll,a,yyyyy.yyyy,a,xxx.x,xxx.x,
              |  |         | |         | |          | |     |
              |  |         | |         | |          | |     Track1
              |  |         | |         | |          | Speed, knots
              |  |         | |         | |          E/W - East or West
              |  |         | |         | Longitude2
              |  |         | |         N/S - North or South
              |  |         | Latitude3
              |  |         Status4
              |  UTC of position fix
              |
              |  xxxxxx,,*hh<CR><LF>
              |  |
              |  Date5
              |
```

1The track made good, measured in clockwise from North direction, at the current position. Range 0-360 degrees.
2 Longitude - 3 digits of degrees, 2 digits of minutes, 4 digits of decimal fraction of minutes.
3 Latitude - 2 digits of degrees, 2 digits of minutes, 4 digits of decimal fraction of minutes.
4 Status,

A	-	Data Valid
V	-	Nav receiver warning.

5 Date - 2 digits day, 2 digits month and 2 digits year (ddmmyy).

Example:

Recommended Minimum Specific GPS Data sentence.

$GPRMC,224512.45,G,2518.3847,S,08339.8367,E,003.8,311.5,080793,,*2E<CR><LF>

UTC	-	22:45:12.45
Status	-	Good
Latitude	-	25° 18.3847' South
Longitude	-	083° 39.8367' East
Speed	-	3.8 knots
Heading	-	311.5° from North
Date	-	08/07/93

N. TRACK MADE GOOD AND GROUND SPEED

Actual track made good and speed relative to the ground.

```
HEADER       |  CONTENTS OF DATA FIELDS
$GPVTG       |
             |
             | ,xxx.x,T,,,xxx.x,N,xxx.x,K*hh<CR><LF>
             |  |      |   |      | |      |
             |  |      |   |      | Speed, km/hr
             |  |      |    Speed, knots
             |  Track, degrees True
```

This message will be sent at twice the requested update rate if the 2Hz PVT mode is active

Example:

Track Made Good and Ground Speed Data sentence.

$GPVTG,234.6,T,,,075.3,N,139.5,K*21<CR><LF>

Track	-	234.6° from North
Speed	-	75.3 knots
Speed	-	139.5 km/hr

O. TIME & DATE

UTC Time, date and local time zone.

```
HEADER       |  CONTENTS OF DATA FIELDS
             |
$GPZDA       |
             |
             | ,hhmmss.ss,xx,xx,xxxx,xx,xx*hh<CR><LF>
             |  |         |  |  |    |  |
             |  |         |  |  |    |  Local zone minutes description2
             |  |         |  |  |   Local zone description1
             |  |         |  |  Year
             |  |         |  month
             |  |         day
             |  UTC
             |
```

1 Zone description is the number of whole hours added to local time to obtain UTC. Zone description is negative for East longitudes. (00..+/-13 hrs)
2 Local zone minutes (00..59). Same sign as local hours.

Example:

Time & Date sentence.

$GPZDA,224512.45,12,01,2003,,*hh<CR><LF>

UTC	-	22:45:12.45
Date	-	12 January 2003
Local zone	-	GMT

SECTION VI - PRODUCT TEST AND QUALITY ASSURANCE PROVISIONS

CONTENTS

Subject **Page**

SECTION VI

PRODUCT TEST AND QUALITY ASSURANCE PROVISIONS

QA CONFORMANCE TESTING

The equipment is subjected to testing in accordance with this section to demonstrate compliance with this specification.

Production tests are those tests which are conducted on each production equipment prior to delivery.

STANDARD TEST CONDITIONS

Unless otherwise specified, the equipment is subjected to the acceptance tests under the following conditions:

1. Temperature - Room Ambient +25 deg. C ± 10 deg. C
2. Altitude - Normal Ground
3. Vibration - None
4. Humidity - Room Ambient

USER-DEFINED TESTS

The user is encouraged to design a customized test to ensure his system functions properly.

SECTION VII - SERVICE AND SUPPORT

CONTENTS

Subject **Page**

SECTION VII

SERVICE AND SUPPORT

POINTS OF CONTACT - CMC

Postal Address:
CMC Electronics Inc.
GPS OEM Group, Box 92
600 Dr.-Frederik-Philips Boulevard
St-Laurent, QC, CANADA
H4M 2S9

WEB Site:
http:// www.cmcelectronics.ca

Marketing / Sales:
Tel : 514 - 748 - 3070
Fax : 514 - 748 - 3017
Email : gpsmarket@bae.systems-canada.com

Contracts / PO / Shipment Status:
Tel : 514 - 748 - 3000 Ext 4943
Fax : 514 - 748 - 3017
Email : gpscontract@bae.systems-canada.com

Technical Support:
Tel : 514 - 748 - 3080
Fax : 514 - 748 - 3130
Email : gpshelp@bae.systems-canada.com

FTP Site:
ftp.bae.systems-canada.com

SERVICE AND REPAIRS

All receivers conform to the specifications stated herein. Should any damage occur to the receivers during shipping, handling, or misuse by the user, CMC can service them. Try to be as complete and accurate as possible when you describe a problem.

PRODUCT UPDATED

All product updates will be advertised on our Web site.

TROUBLESHOOTING AND FREQUENTLY ASKED QUESTIONS (FAQ)

A FAQ list is available on our Web site.

CONSULTATION

Technical consultation can be obtained from CMC if GPS expertise is needed for the integration of the receiver into your application. We can provide support either at the system design, implementation, or testing phase. For more details, please contact Technical Support (refer to Points of Contact section above).

APPENDIX A - RECEIVER DEVELOPMENT KIT

CONTENTS

Subject **Page**

APPENDIX A

RECEIVER DEVELOPMENT KIT

OVERVIEW

The Receiver Development Kit allows new users to easily evaluate the GPS receiver. The Development Kit implements the receiver control operation and I/O functions of the receiver using an IBM-compatible personal computer (PC), a serial port, an external geodetic GPS antenna, and an I/O cable with a 115 VAC to 12 VDC power adapter. The GPS receiver is contained in a plastic extrusion unit, with I/O connectors and status LEDs.

GPS Monitor is an MS-Windows application running on a PC that allows communication with the receiver. All commands and data requests can be sent through this application and all received data is decoded and displayed in specific windows. A data logging facility is also provided within this tool. Details on the use of GPS Monitor is provided in the GPS Monitor User's Manual (Ref [5]).

This Appendix explains how to configure the Development Kit and the receiver, and how to interconnect the equipment.

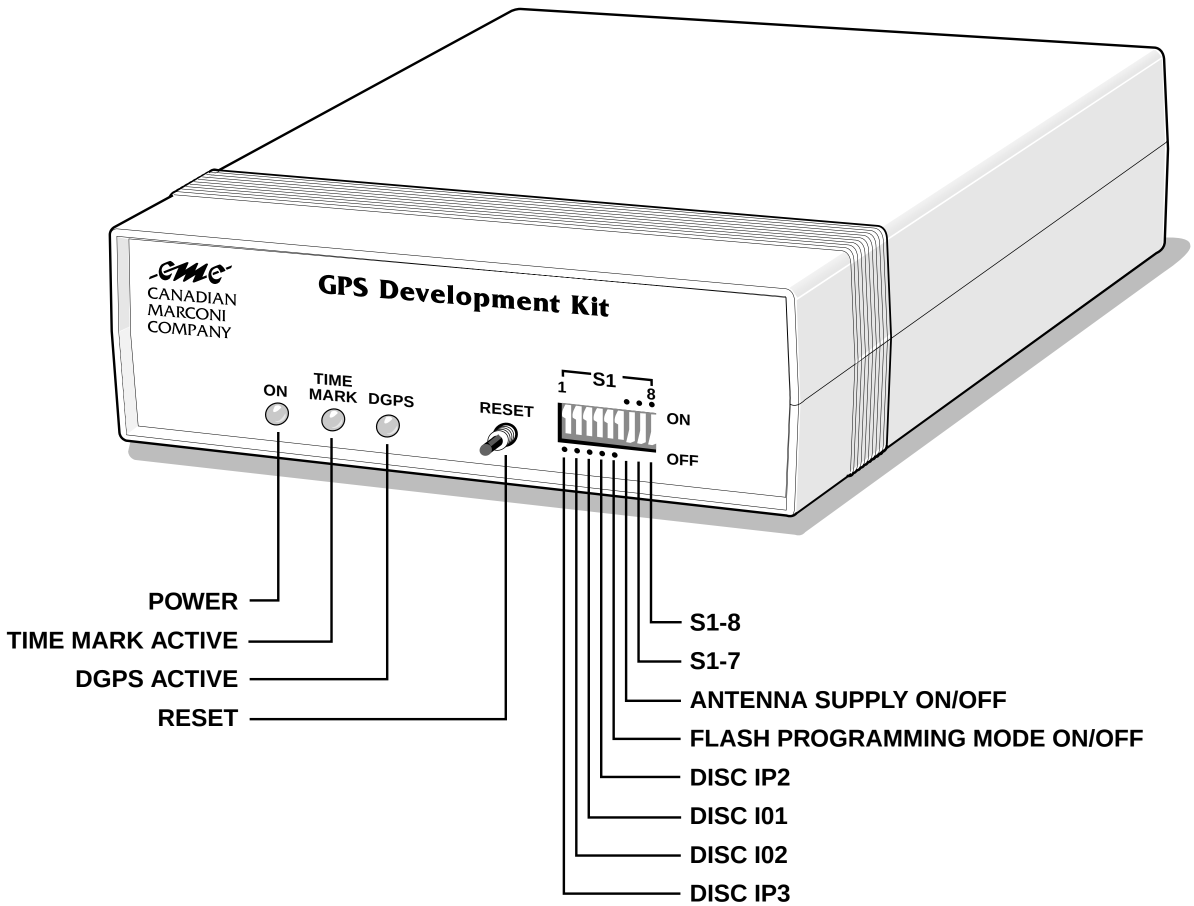
DESCRIPTION

The Development Kit (Order no.: 241-600246-XXX*) contains the following equipment:

QTY	DESCRIPTION	PART NUMBER
1	Development Kit Unit with built in ALLSTAR or SUPERSTAR receiver card.	100-600266-XXX*
1	+12dB Active GPS Antenna with 20 ft cable AT-575-70W-MCXM-240.0-50-12RM	201-990146-789
1	GPS Monitor Software diskette	189-613931-002
1	Cable Assy. DB-9 Female to DB-9 Male	217-990147-593
1	Power Supply Adapter 120VAC to 12VDC	504-990147-682
1	ALLSTAR or SUPERSTAR User's Manual	1826-1127
1	Schematic and Description of the Development Kit.	

* the last 3 digits of the part number corresponds to the GPS Receiver Part Number which depends on the connector type and software options. Please refer to the price list for a full description.

DEVELOPMENT KIT SETUP AND OPERATION



SETUP

Refer to the installation procedure to install the GPS Monitor software.

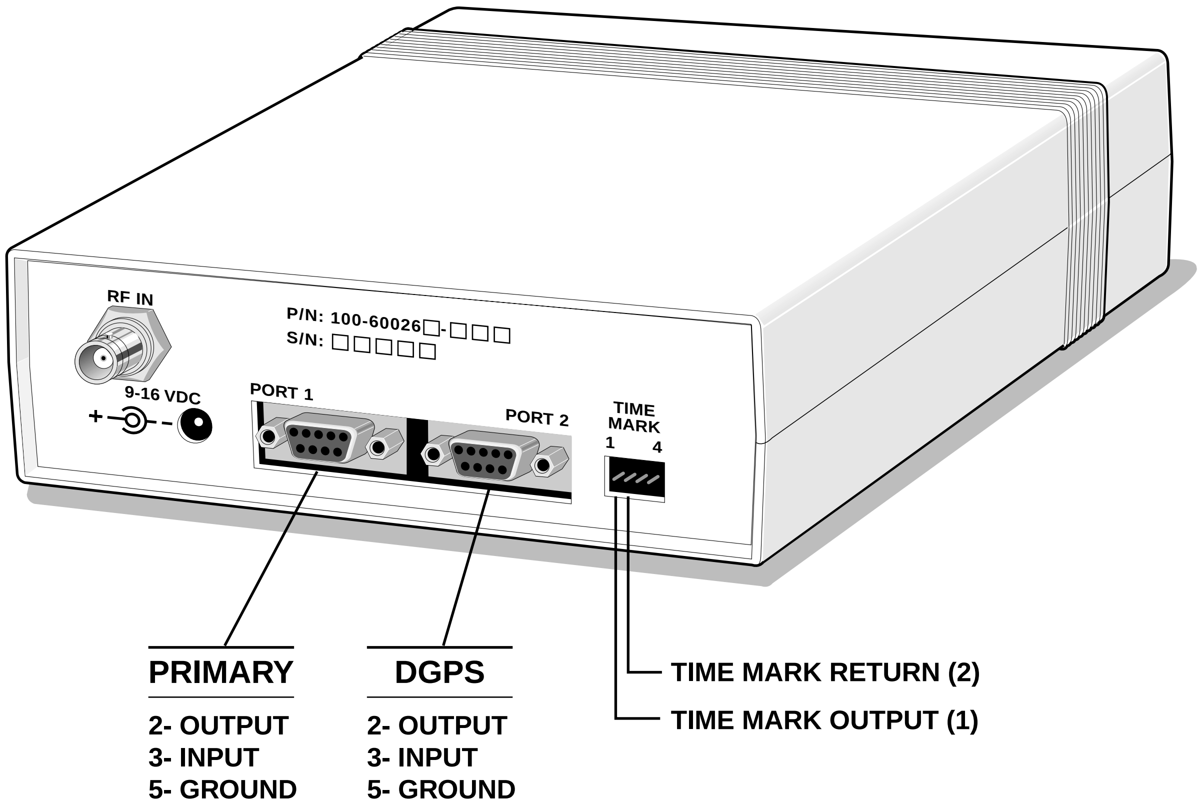
For normal operation of the Development Kit, DIP switches (S1) must be set as follows:

S1-1 to S1-5 set to OFF
S1-6 to S1-8 set to ON

and the reset push button must be not be pressed in.
Connect the Development Kit serial port '*PORT1'* to an IBM compatible computer (PC) serial port.

Connect the Development Kit serial port '*PORT2*' to an RTCM SC-104 DGPS correction receiver (if available).

Connect the GPS Antenna to the '*RF IN*' BNC connector.
Connect the power supply to the rear panel *9-16 VDC* input jack.



The ***POWER*** indicator should be ON.

Launch the GPS Monitor software application.

By default, the GPS Monitor software is configured to serial port COM1 at 9600 BPS. Your installation may require the selection of another communication port.

The ALLSTAR communication baud rate is 9600 BPS (except for the Carrier Phase Output option that requires 19200 BPS).

DIP SWITCHES

The I/O discretes of the GPS receiver can be driven HI or LO using switches S1-1 to S1-5. For normal operation, S1-1 to S1-5 must be set to OFF.

Switch	Function	Description
S1-1	IP_3	When ON, discrete IP_3 is set to LO
S1-2	IO_2	When ON, discrete IO_2 is set to HI
S1-3	IO_1	When ON, discrete IO_1 is set to HI
S1-4	IP_2	When ON, discrete IP_2 is set to LO
S1-5	IP_1	When ON, force programming mode
S1-6	PREAMP	When ON, power is applied to the antenna.
S1-7	ANT 5V/12V	If the antenna voltage regulator option is installed: When ON, the antenna supply is set to 5 VDC, when OFF, the antenna supply is set to 12 VDC. Without the voltage regulator option, the active antenna supply is set to 5 VDC.
S1-8	BATTERY	(If the battery option is installed) When ON, the battery backup is active.

TIME MARK CONNECTOR

The 1 pulse-per-second (1 PPS) time mark signal (CMOS level) is available on the rear panel connector. This 1 millisecond positive pulse can be aligned on the GPS time or free running (refer to User's Manual).

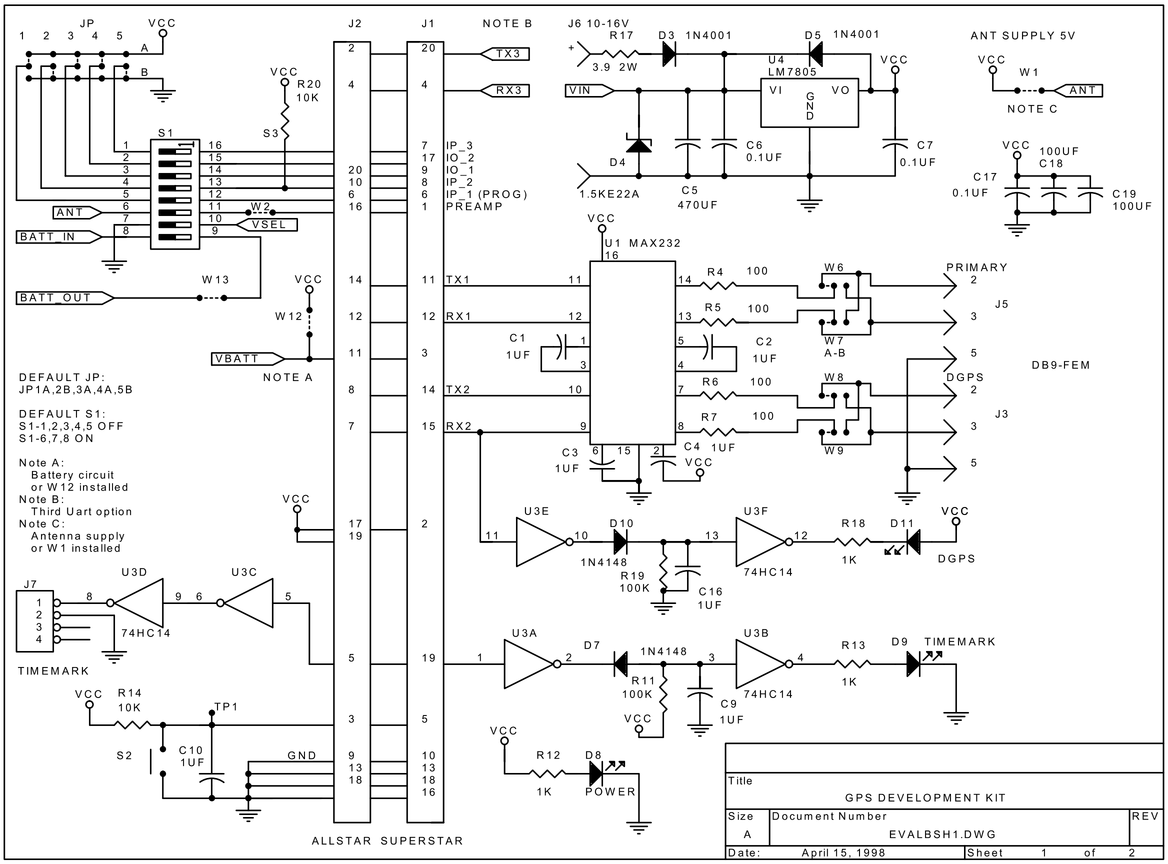
SOFTWARE UPGRADE

The Development Kit is forced in programming mode by setting S1-5 to ON.
Press the RESET button momentarily.

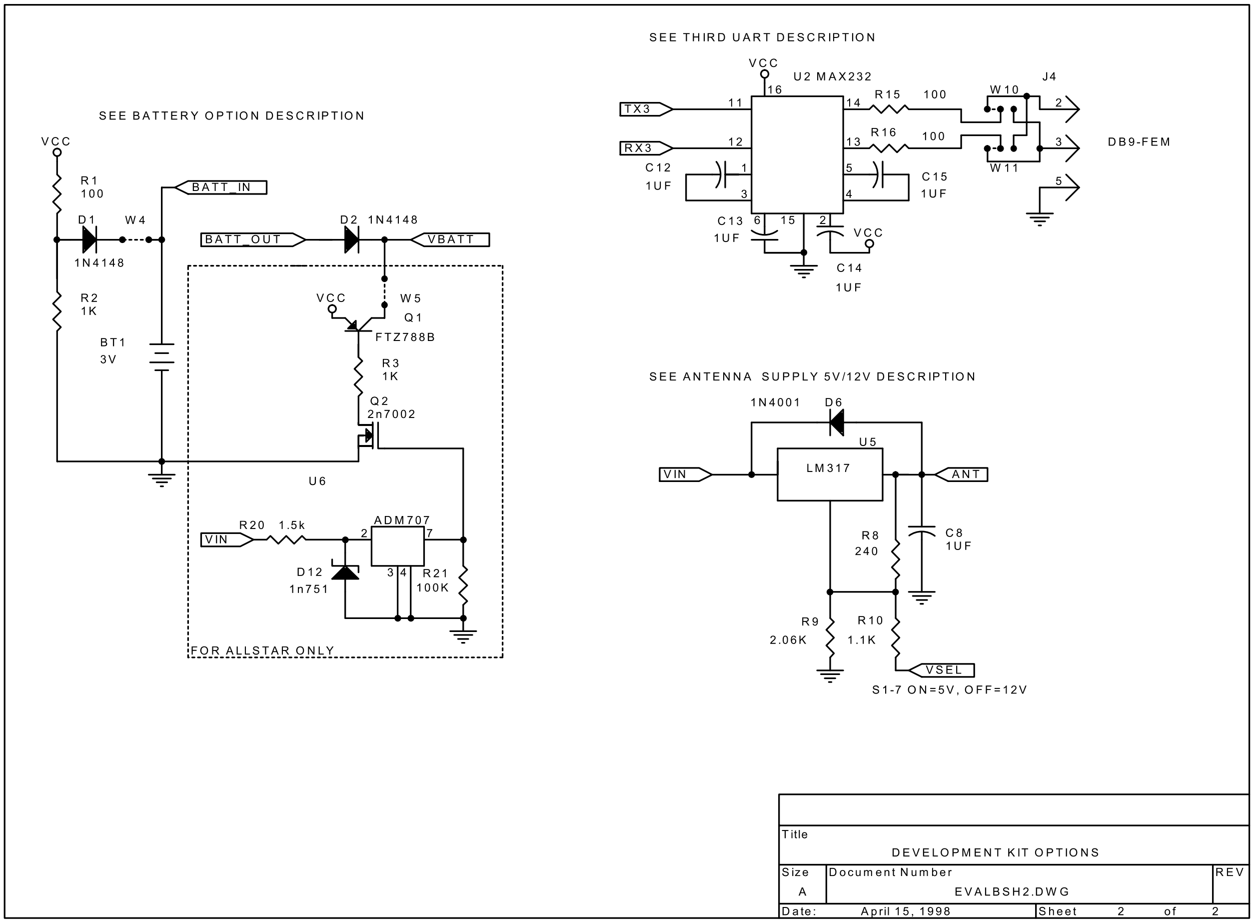
Prior to programming, the GPS Monitor software must be configured to 19200 BPS. The terminal window in the GPS Monitor should display ***w*** once per second.
From the menu select Options, Programming.

Select the directory and filename (the last 3 digits of the ALLSTAR software number represent the variation, e.g. 613913.058 stands for software variation 058).

After programming, select the communication port (ex: COM1), change the communication speed to 9600 BPS (if required) then set S1-5 to OFF.
Press the RESET button momentarily.



DEVELOPMENT KIT SCHEMATIC



DEVELOPMENT KIT OPTIONS

GPS MONITOR SOFTWARE INSTALLATION

1. If you are using Windows 3.1 or Windows NT 3.51

   Place the GPS Monitor diskette in your floppy drive.
   In the Windows Program Manager, select:

   File -> Run then type: a:\install and click OK.

   Note: the GPS Monitor software will be loaded into directory: c:\cmc\gpsmon

   You should now have a GPSMon Group containing two icons :

   GPSMon exec icon: just double-click on this icon to start the GPS Monitor

   Help icon : just double-click on this icon to get help information on the GPS Monitor and *ALLSTAR* or *SUPERSTAR*

2. If you are using Windows 95 or Windows NT 4.0

   Insert the GPS Monitor diskette in your floppy drive
   From the task bar, select :

   Start -> Run then type a:\install and click OK.

   Note: the GPS Monitor software will be loaded to directory: c:\cmc\gpsmon

   You should have a GPSMon Group with two icons in it.

   Start -> Programs -> GPSMON -> GPSMON to start the GPS Monitor

   Start -> Programs -> GPSMON -> HELP to start the help information on the GPS Monitor and the *ALLSTAR* or *SUPERSTAR*

NOTE: If you purchased the *GPS Receiver* with the Carrier Phase Output option, the default communication baud rate will be *19.2 Kbaud.* For all other versions the baud rate is 9.6 Kbaud.

APPENDIX B - STARBOX

CONTENTS

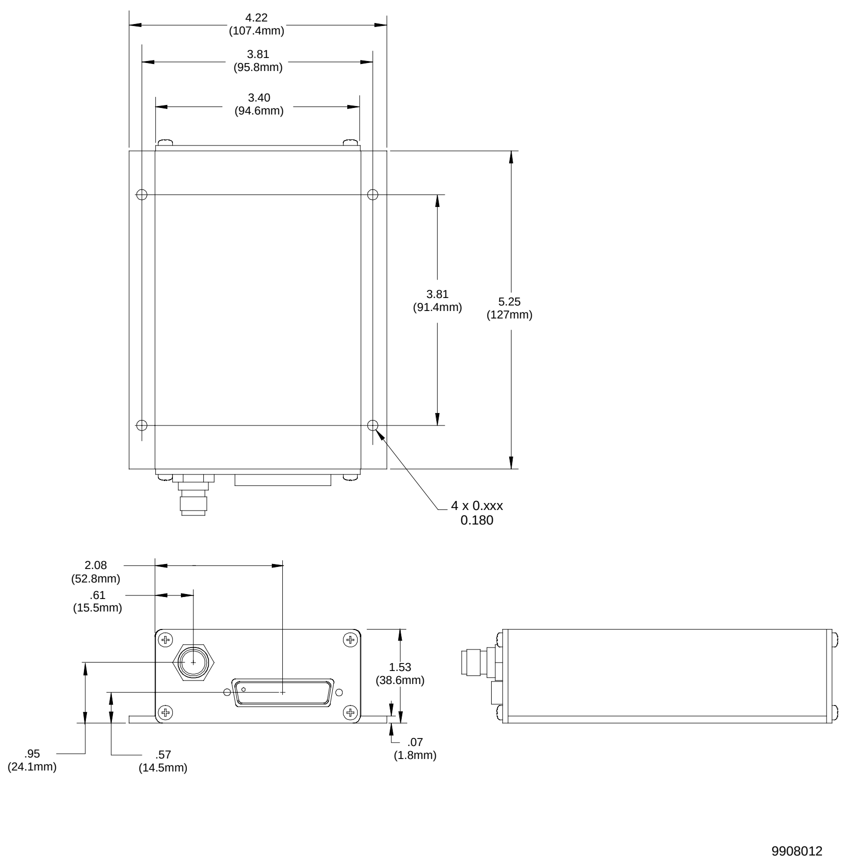
Subject **Page**

APPENDIX B

STARBOX

OVERVIEW

The STARBOX is a robust metal casing that houses the GPS receiver and a power supply. Communication with the receiver is performed via a DB-25 connector. Figure B-1 depicts the interconnection required for the STARBOX.



Outline Drawing
Figure B-1

DESCRIPTION

The pinout of the DB-25 connector is as follows:

DB-25 PIN #	STAR-BOX	DESCRIPTION
1	DISC_IP_1	OPEN-GND CMOS discrete input with 10K pull-up resistor (Note 3)
2	GND	Ground Connection
3	DISC_IP_2	OPEN-GND CMOS discrete input with 10K pull-up resistor (Note 3)
4	RESERVED	
5	TIMEMARK_1	1 Pulse Per Second Output TTL level with a 100 series resistor
6	Serial Intf TX 1	Main Serial Interface Port Transmitter (Note 1)
7	Serial Intf RX 1	Main Serial Interface Port Receiver (Note 2)
8	GND	
9	RESERVED	
10	RESERVED	
11	TEST	CMOS discrete input with 10KΩ pull-up resistor Force the Reprogramming Mode at power up if connected to Ground. Shall be left OPEN for normal operation
12	RESERVED	
13	GND	
14	RESERVED	
15	RESERVED	
16	DISC_OP_1	CMOS discrete output with 100 Ω series resistor
17	RESERVED	
18	TIMEMARK_2	OPEN-DRAIN output with a 10KΩ pull-up resistor 500ma maximum
19	GND	
20	Serial Intf TX 2	Auxiliary Serial Interface Port Transmitter (Note 1)
21	Serial Intf RX 2	Auxiliary Serial Interface Port Receiver (Note 2)
22	RESERVED	
23	RESERVED	
24	RESERVED	
25	12V_DC	9V-36V Power Input With Reversed Voltage Protection

Note 1 : RS232 Driver
± 5V in 3KΩ
Short Circuit Protection 60mA max

Note 2 : RS232 Receiver
Vil 0.7V
Vih 2.0V
±8V max for normal operation

Note 3 : Should be lefted OPEN in not used in the application

RF CONNECTOR

The GPS RF connector is a TNC female connector.

LEDs

The STARBOX has 2 LEDs:

LED's COLOR	DESCRIPTION
YELLOW	When flashing at a 1 Hz rate, indicates that the receiver had enough satellite information to perform a Navigation solution. Doesn't flash by default after a power-up.
GREEN	Valid Internal 5 Volt Indicator

CABLE

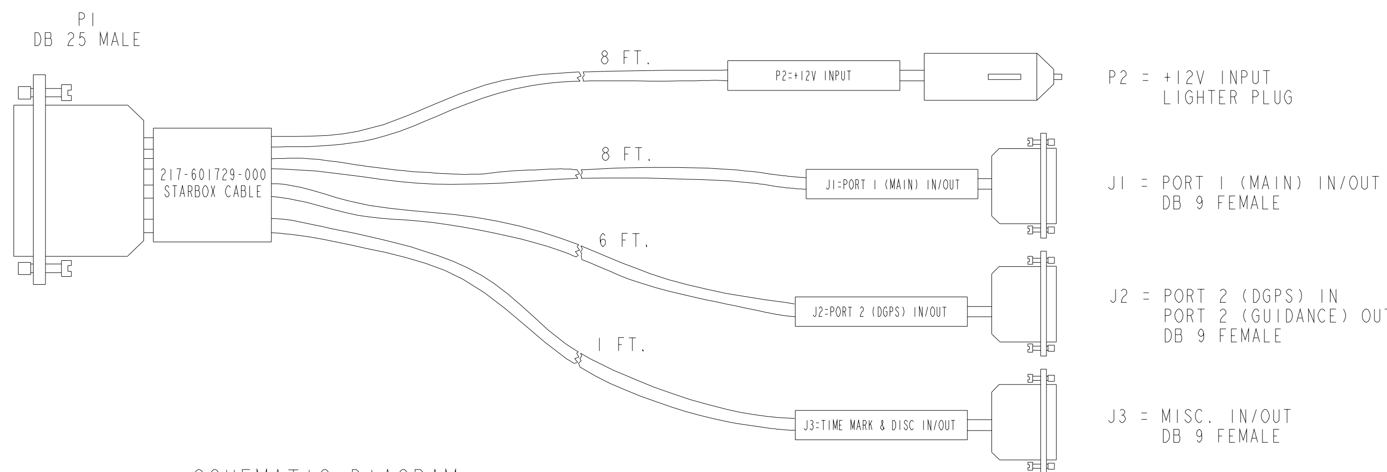
A schematic of the cable to be used with the STARBOX is depicted in Figure B-2. It's part number is-217-601729-VAR.

REVISION STATUS OF SHEETS										
SHEET	1	2	3	4	5	6	7	8	9	10
REV										

ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES:

1. ALL WIRES TO BE 22 AWG UNLESS OTHERWISED SPECIFIED.
2. BAND MARKER TO BE WHITE.



SCHEMATIC DIAGRAM

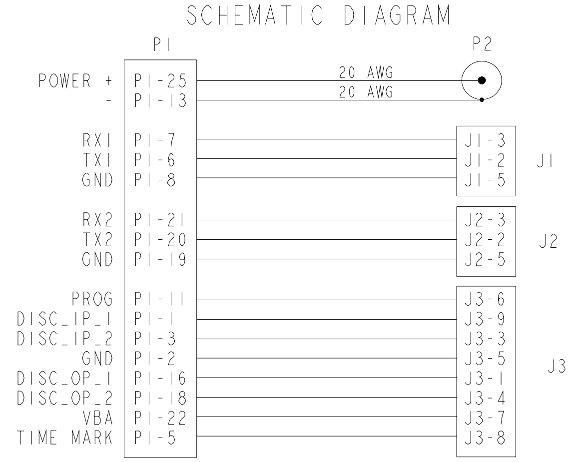


TABLE				
	INCLUDED CONNECTORS			
PART NO.	P2	J1	J2	J3
217-601729-000	X	X		
217-601729-001	X	X	X	
217-601729-002	X	X	X	X

217-601729-VAR

SEE SEPARATE PARTS LIST

THIRD ANGLE PROJECTION

XXX	XXX
NEXT ASSY	USED ON
APPLICATIONS	

CMC REF ONLY

ANGULAR TOLERANCE ±

UNLESS OTHERWISE SPECIFIED: DIMENSIONS APPLY AFTER FINISHING AND ARE IN
INCHES TOLERANCES .XX ± .XXX ±
MILLIMETERS TOLERANCE ±

MATERIAL

FINISH

CONTRACT NO
CONTRACTOR
DRAWN BY D.C. DATE (YR-MO-DY) 98-02-09
CHECKER ENGINEER
DRAWING APPROVAL
DESIGN APPROVAL

CMC CANADIAN MARCONI COMPANY
MONTREAL, QUEBEC, CANADA

CABLE, STARBOX

SIZE C CAGE CODE 90073 DWG NO 217-601729-VAR
DRAWING SCALE SHEET

GENERATED ON PRO/ENG.

APPENDIX C - EXTERNAL INTERFACE CHARACTERISTICS

CONTENTS

Subject **Page**

APPENDIX C

EXTERNAL INTERFACE CHARACTERISTICS

CONNECTOR PIN ASSIGNMENT

Figure C-1 shows the Interface and Power connector (J1 or J3 depending of OEM variation) pin assignment.

J1 PIN #	J3 PIN #	SIGNAL NAME	I/O	COMMENTS
1		Reserved		
2		Disc_IP_3	I	Note 4
3		Reserved		
4	1	Reserved		
5	3	Power Control Input	I	Note 4
6	4	Rx_No_3 (Optional Port)	I	
7	5	Time Mark (1 PPS) Output	O	
8		Ground		
9	6	Disc_IP_1	I	Note 2,3,5
10	2	Tx No 3 (Optional port)	O	
11	7	Rx No 2 (Auxiliary port)	I	Note 4
12	9	Ground		
13	8	Tx No 2 (Auxiliary port)	O	
14	10	Disc_IP_2	I	Note 4
15	11	VDD		
16		Ground		
17	12	Rx No. 1 (Primary port)	I	Note 5
18	13	Ground		
19	14	Tx No. 1 (Primary port)	O	
20	15	Reserved		
21	17	+5V Digital		
22		Ground		
23	16	Preamp (Active Antenna supply)		
24	18	Ground		
25	20	Disc_I/O_1	I/O	Note 5
26	19	+5V RF		

Figure C-1. J1 and J3 Interfaces and Power Connector Pin Assignment

Note 1: Not used.
Note 2: For normal operation the pin should be tied to GND (preferred option) or left open.
Note 3: The pin has been reserved for the reprogramming mode (see Appendix G).
Note 4: On-board pull-up resistor
Note 5: On-board pull-down resistor
Note 6: Reserved pins shall be left unconnected

I/O ELECTRICAL CHARACTERISTICS

Figure C-2 shows the voltage level limits for all different I/O signals:

SIGNAL NAME	TYPE	Vil max	Vih min	Vol max	Voh min	Input Rise & Fall Time
		Volt	Volt	Volt	Volt	uSEC
Power Control Input (note1)	I	0.50	2.00			< 1
Disc_IP_1,Disc_IP_2, Disc_IP_3,DISC_IO_1, Rx No.1 ,Rx No 2,	I	0.7	2.3			< 1
Rx No 3	I	0.8	2			
Tx No 1, TX No 2, Timemark Output 1PPS, DISC_IO_1	O			0.4	(0.8 *VDD)-0.1 Io<=200uA	
Tx No 3	O			0.4	2.4	

Note 1: A LO pulse of 150ns minimum will invoke a master reset to the receiver.
Note 2: Conditions : 5V +/- 5%(for all limits)

Figure C-2. I/O Signals Voltage Limits

APPENDIX D - ANTENNA SPECIFICATIONS

CONTENTS

Subject **Page**

APPENDIX D

ANTENNA SPECIFICATIONS

The GPS antenna is an important part of the total system performance and should be selected depending of your application. All the GPS receivers designed and manufactured in the GPS-OEM, include a Low Noise Amplifier (LNA) before the the RF ASIC. This +20dB LNA permit raisonnable performances with a passive GPS antenna. But depending of the cable loss between the antenna element and the GPS receiver and also the position accuracy requirements, then a +12dB up to +36dB Active GPS Antenna could be needed.

This appendix is divided in characteristics for high end Active Geodetic Antenna including Choke Ring Antenna, then lower cost Active Antenna and then Passive Antenna.

We are also able to offer the coax cables required between the GPS Antenna and the our Receiver. You will also find in this section, different coax cables required in your GPS system. The end of this section includes very detailed Antenna drawings

CABLE SELECTION

The interconnection cable between the GPS Antenna and the Receiver is of prime importance for the proper performance of the system. Three parameters are to be considered: the Loss, Isolation, and Outer Diameter. The bigger the Outer Diameter, the lower the Loss. The Loss increases with the length of the cable and decreases with extra isolation. If the highest accuracy possible is not required GPS-OEM receivers can accept a total cable loss of 3 dB. Depending of the cable type, this could represent a cable run from 2 meters up to 10 meters if expensive cable is used.

Table D-1 details the specifications of the RG-58 Low Loss Cable (RG-58/U LLDS80) used in the GPS Antenna Cable 217-601730-XXX. The RG-58/U LLDS80 is a custom-made low loss noise coax cable made according to AeroAntenna specifications. It is a double-shielded cable similar to Belden Type 9310 but with the improvement of having 85% miniumum coverage of the second shield versus the Belden at 55% coverage. The electrical characteristics are included in Table D-1.

Center Conductor	#20 Bare Copper wire, Resistance - 33.1 ohms per Km
Insulation	Polyethylene
Inner Shield	Aluminium Foil - 100% coverage
Outer Shield	Tinned copper braid - 85% coverage, Resistance 45.9 ohms per Km
Jacket	Black PVC
Nominal Impedance	50 ohms
Nominal Vel. of propagation	66%
Nominal Capacity	101.7 pf per meter
Attenuation	@ 1000mhz: 44.3 dB per 100 meters (or 54 dB @ 1575MHz)

Table D-1. Coax Cable Specifications

Table D-2 shows the minimum and maximum cable length when using GPS Antenna cable drawing 217-601730-XXX used in conjunction with the smaller cable (Drawing 217-601727-XXX) which is usually required between the receiver and the chassis case of the user system. You will find the drawings for these two cables at the end of this section.

Cable PNs	**ANTENNA GAIN**	**CABLE TYPE**	**MAX. LENGTH ***	**MIN. LENGTH**
217-601730-XXX	0 dB (no LNA)	RG-58 Low Loss	3 meter (3 dB)	0 feet
217-601730-XXX	+12dB	RG-58 Low Loss	20 meter (12dB)	0 feet
217-601730-XXX	+26dB	RG-58 Low Loss	50 meter (28dB)	20 meter (12dB)
217-601730-XXX	+36dB	RG-58 Low Loss	65 meter (36dB)	50 meter (28dB)

Table D-2. Antenna Gain Depending on Cable Length Required

* A 1 dB loss for the coax cable is usually required between the RG-58 cable and the GPS Receiver MCX connector and it is included in attenuation number in parentheses. If the distance between the antenna and the GPS receiver needs to be longer than 65 meters, the user shall select an other type of coax cable with a lower lost per meter.

The +26dB and +36dB antenna can accept a supply voltage between 5V and 18VDC. It is recommended to compute the drop in the coax cable so the active antenna will always see the minimum operating voltage of 4.5Volt. The Table D-3 list the current taken by each of these antenna.

Antenna Gain	Current Consumption
+12dB	20 mA
+26dB	35 mA
+36dB	50 mA

Table D-3. Typical Current Consumption Versus Antenna Gain

GEODETIC ACTIVE ANTENNA

For RTK applications where centimeter-level accuracy is required, it is strongly recommended to use an active geodetic GPS antenna if possible. In the event where the cable length between the receiver and the antenna is very short (less than one meter), a passive antenna could then be considered. Table D-4 lists the specifications for recommended Passive Antennas. Complete drawings could be find at the end of this appendix.

Antenna Types	Part Numbers	SUPPLIER Part Numbers
Choke ring antenna with trypod mount and permanent mount. Ground plane included	201-990146-888 201-990147-607 201-990147-680	AT575-90W with +12 dB AT575-90W with +26 dB AT575-90W with +36 dB
Completely sealed round disk antenna with 1 inch tread and 5/8 inch adaptor, with build in ground plane	201-990146-887 201-990147-606 201-990147-679	AT575-75W with +12dB AT575-75W with +26 dB AT575-75W with +36dB
Smaller mobile mount, ground plane required	201-990147-684	AT575-32W with +12dB
Ground plane with 5/8 inch adaptor, for AT575-32 antenna above	267-990148-137	SK0044

Table D-4. Recommended Geodetic Active Antennas

The Antenna gain should be selected depending on the cable loss between the antenna and the receiver Prices and availability can be found in the latest GPS-OEM Price List. You can request this list by sending an e-mail to the GPSMARKET (the exact e-mail address is supplied in section 7 of this document).

ACTIVE ANTENNA

Lower cost antennae for higher volume applications or for more cost sensitive applications are available.

GPS receivers implement a 20dB LNA on board. For this reason, an Active +12dB is more than adequate; antenna with +26 dB and +36 dB may overdrive the RF input of the GPS Receiver, if used with a short cable between the Antenna and the Receiver. The Table D-5 lists the active antennae which could be used with any of the GPS receivers.

Table D-5
Recommended Active Antennae

Typical Applications	Part Numbers	Supplier Part Numbers
AVL (This antenna is currently supplied with ALLSTAR and the SUPERSTAR development kit)	201-990146-716 (MCX connector & 6 meter cable) 201-990146-789 (BNC connector & 6 meter cable) 201-990148-152 (TNC connector & 6 meter cable)	AT575-70W +12 dB
The lowest cost available for AVL	201-990147-432 TNC Female Bulk head	AT575-104W +12dB
Marine application	201-990144-807 TNC Female Bulk head	AT575-68W +12dB

NOTE: Prices and availability can be found in the latest GPS-OEM Price List. You can request this list by sending an e-mail to the GPSMARKET (the exact e-mail address is supplied in section 7 of this document).

PASSIVE ANTENNA

For RTK applications where centimeter-level accuracy is required, it is strongly recommended to use an active geodetic GPS antenna if possible. In the event where the cable length between the receiver and the antenna is very short (less than one meter), a passive antenna could then be considered. The Table D-6 lists the specifications for recommended Passive Antennae patch itself.

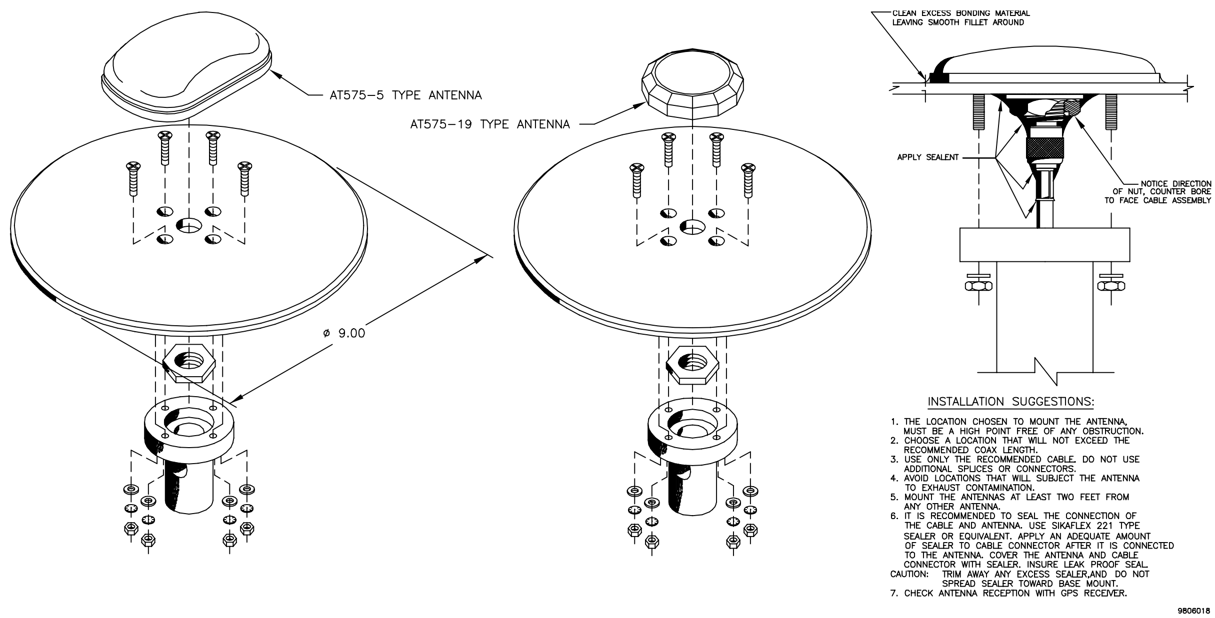
Table D-6
Passive Antenna Specifications (Patch Element)

Frequency	1575 MHz +/ - 2 MHz	
Polarization	Right Hand Circular	
Radiation Coverage	4.0 dBic -1.0 dBic -2.5 dBic -4.5 dBic -7.5 dBic	0 degrees 0 < elev. Angle < 75 75 < elev. Angle < 80 80 < elev. Angle < 85 85 < elev. Angle < 90
Connector	TNC Female (most common)	Other connectors also available
Temperature	-55 C to +85C	
Environmental	DO-160C	

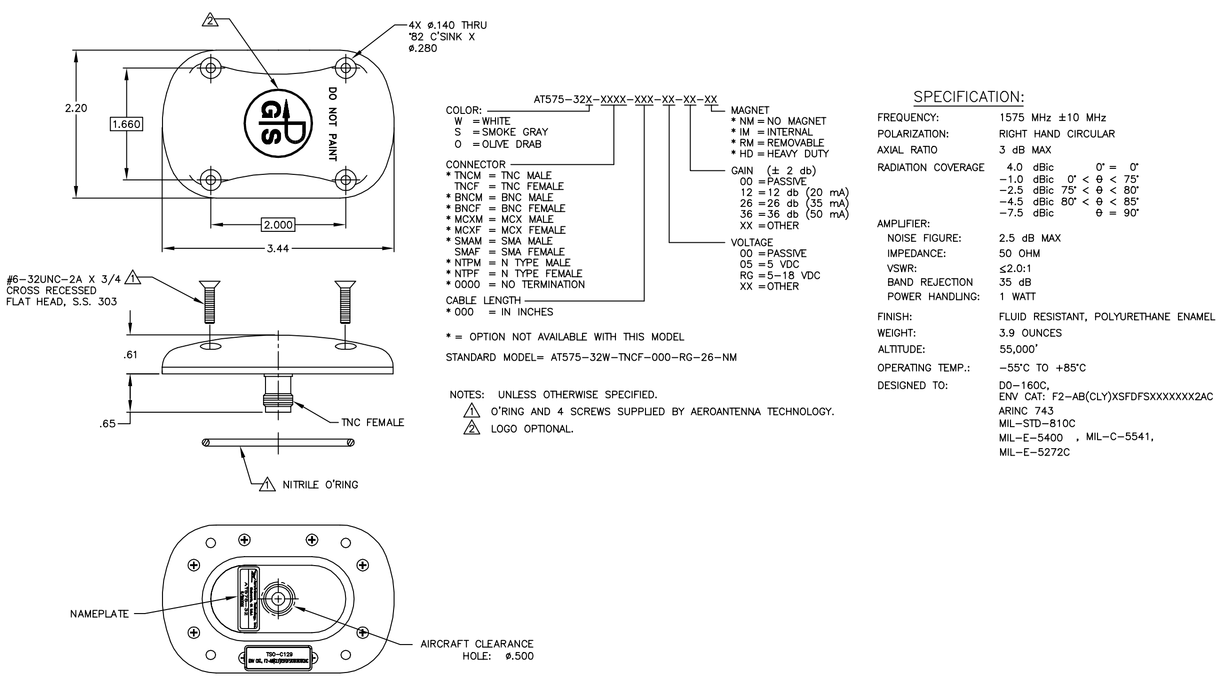
Lower cost antennae for higher volume applications or for more cost sensitive applications are available. GPS receivers implement a 20dB LNA on board. For this reason, in many cost sensitive applications it may be necessary to select one of the following passive antennas in conjunction with a low loss coax cable. The Table D-7 lists the passive antennae which could be used with any of the GPS receivers.

Typical Applications	Part Numbers	Supplier Part Numbers
The lowest cost available for AVL	201-990147-433 TNC Female Bulk head	AT575-97CA

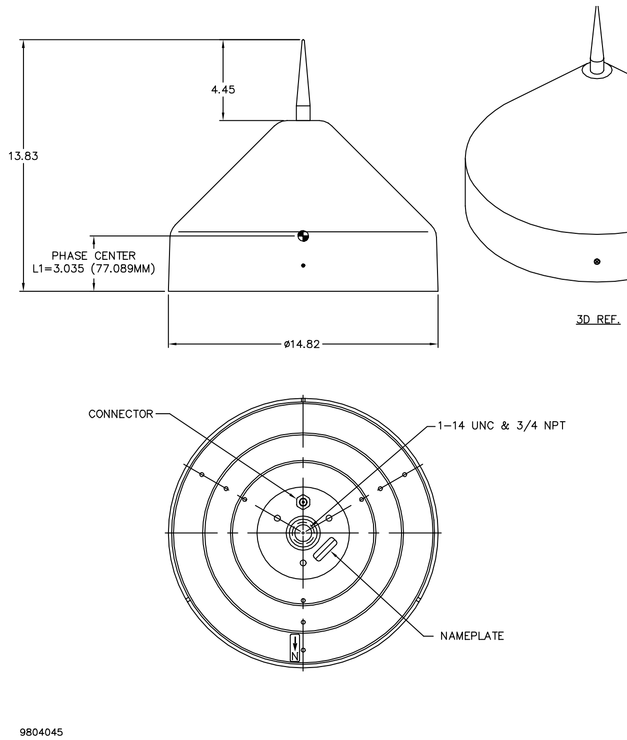
Figure D-7. Recommended Passive Antennae



GPS Pre-Amplifier Antenna, AT575-19 Rev E



Outline Drawing GPS Antenna, 1575 MHz, AT575-32 Rev E



SPECIFICATION:

FREQUENCY:	575 MHz ±5 MHz
POLARIZATION:	RIGHT HAND CIRCULAR
AXIAL RATIO	3 dB MAX.
RADIATION COVERAGE:	4.0 dBic 0° = 0°
	−1.0 dBic 0° < θ < 75°
	−2.5 dBic 75° ≤ θ < 80°
	−4.5 dBic 80° ≤ θ < 85°
	−7.5 dBic θ = 90°
AMPLIFIER:	
NOISE FIGURE:	2.5 dB MAX.
IMPEDANCE:	50 OHM
VSWR:	≤2.0:1
BAND REJECTION	35 dB
POWER HANDLING:	1 WATT
FINISH:	POLYURETHANE ENAMEL COLOR: WHITE
WEIGHT:	10 Lbs. MAX.
ALTITUDE:	20,000'
OPERATING TEMP.:	−55°C TO +85°C
DESIGNED TO:	DO-160C

AT575-90X-XXXX-XXX-XX-XX-XX

COLOR:
W = WHITE
* S = SMOKE GRAY
* O = OLIVE DRAB

CONNECTOR
* TNCM = TNC MALE
TNCF = TNC FEMALE
* BNCM = BNC MALE
BNCF = BNC FEMALE
* MCXM = MCX MALE
* MCXF = MCX FEMALE
* SMAM = SMA MALE
* SMAF = SMA FEMALE
* NTPM = NTP MALE
NTPF = NTP FEMALE
* 0000 = NO TERMINATION

CABLE LENGTH
000 = IN INCHES

MAGNET
NM = NO MAGNET
* IM = INTERNAL
* RM = REMOVABLE
* HD = HEAVY DUTY

GAIN (± 2 db)
00 = PASSIVE
12 = 12 DB (20 mA)
26 = 26 db (35 mA)
36 = 36 db (50 mA)
XX = OTHER

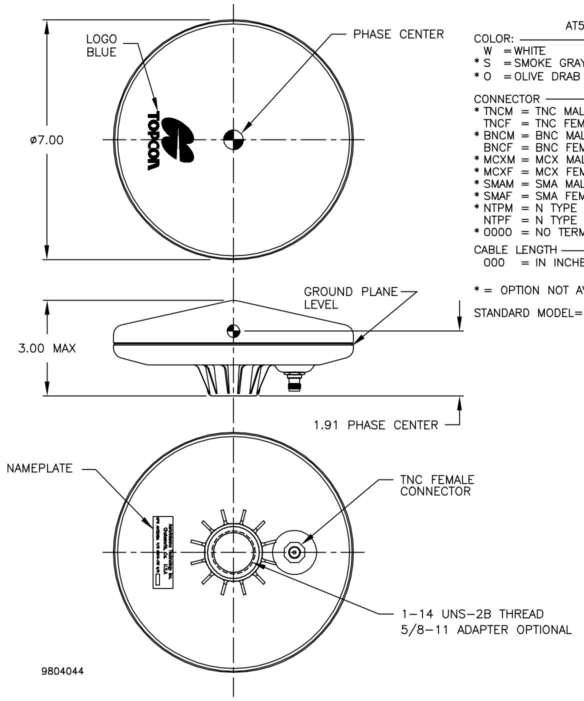
VOLTAGE
00 = PASSIVE
05 = +5 VDC
* RG = +5 TO +18 VDC
XX = OTHER

* = OPTION NOT AVALIABLE WITH THIS MODEL
STANDARD MODEL= AT575-90W-TNCF-000-05-26-NM

NOTES: UNLESS OTHERWISE SPECIFIED.
1. LOGO OPTIONAL.
2. SIZE, SHAPE, AND CONTENTS OF NAMEPLATE ARE SUBJECT TO CHANGE WITHOUT NOTICE.

CMC PART NUMBER 201-990146-888 (12db)
CMC PART NUMBER 201-990147-607 (26db)
CMC PART NUMBER 201-990147-680 (36db)

Outline Drawing, AT575-90 Rev E



AT575-75TX-XXXX-XXX-XX-XX-XX

COLOR:
W = WHITE
* S = SMOKE GRAY
* O = OLIVE DRAB

CONNECTOR
* TNCM = TNC MALE
TNCF = TNC FEMALE
* BNCM = BNC MALE
BNCF = BNC FEMALE
* MCXM = MCX MALE
* MCXF = MCX FEMALE
* SMAM = SMA MALE
* SMAF = SMA FEMALE
* NTPM = N TYPE MALE
NTPF = N TYPE FEMALE
* 0000 = NO TERMINATION

CABLE LENGTH
000 = IN INCHES

MAGNET
NM = NO MAGNET
* IM = INTERNAL
* RM = REMOVABLE
* HD = HEAVY DUTY

GAIN (± 2 db)
00 = PASSIVE
12 = 12 db (20 mA)
26 = 26 db (35 mA)
36 = 36 db (50 mA)
XX = OTHER

VOLTAGE
00 = PASSIVE
05 = +5 VDC
RG = +5 TO +18 VDC
XX = OTHER

* = OPTION NOT AVAILABLE WITH THIS MODEL

STANDARD MODEL= AT575-75TW-TNCF-000-RG-26-NM

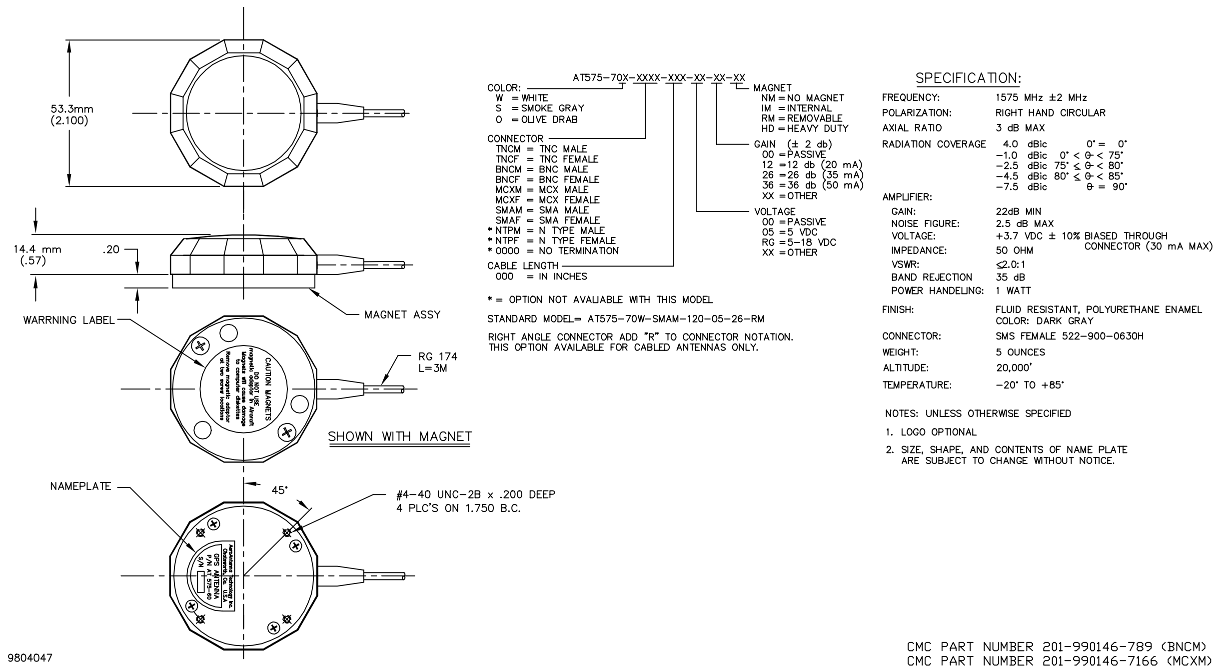
SPECIFICATION:

FREQUENCY:	1575 MHz ±2 MHz
POLARIZATION:	RIGHT HAND CIRCULAR 0°
AXIAL RATIO	3 dB MAX
RADIATION COVERAGE	4.0 dBic θ = 0°
	−2.0 dBic 0° < θ ≤ 70°
	−4.0 dBic 70° < θ ≤ 85°
	−5.0 dBic θ = 90°
AMPLIFIER:	
NOISE FIGURE:	2.5 dB MAX
IMPEDANCE:	50 OHM
VSWR:	≤2.0:1
BAND REJECTION	35 dB @ 1625 MHz
POWER HANDLING:	1 WATT
MATERIAL:	GELOY XP1001
FINISH:	WEATHERABLE POLYMER
CONNECTOR:	SEE TABLE
WEIGHT:	13 OUNCES MAX
ALTITUDE:	12,000'
OPERATING TEMP:	−40°C TO +70°C
DESIGNED TO:	DO-160C

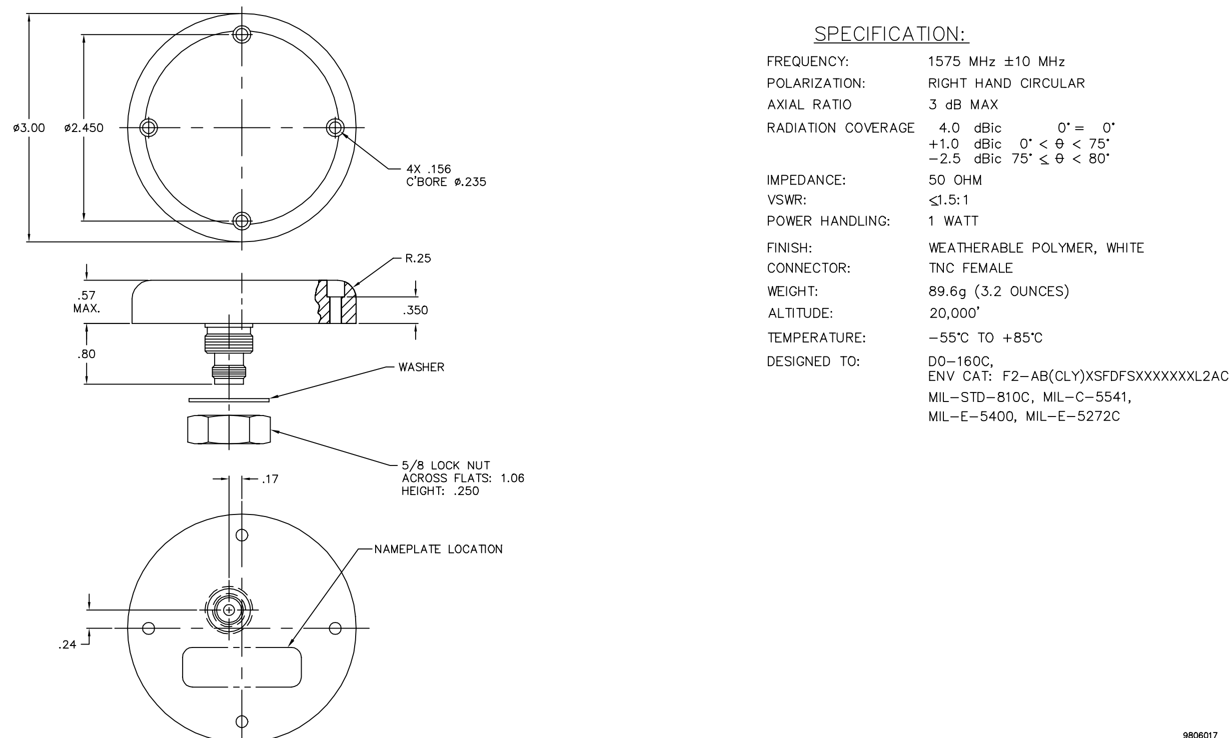
NOTES: UNLESS OTHERWISE SPECIFIED.
1. SIZE, SHAPE, AND CONTENTS OF NAMEPLATE ARE SUBJECT TO CHANGE WITHOUT NOTICE.
2. LOGO OPTIONAL

CMC PART NUMBER 201-990146-887 (12db)
CMC PART NUMBER 201-990147-606 (26db)
CMC PART NUMBER 201-990147-679 (36db)

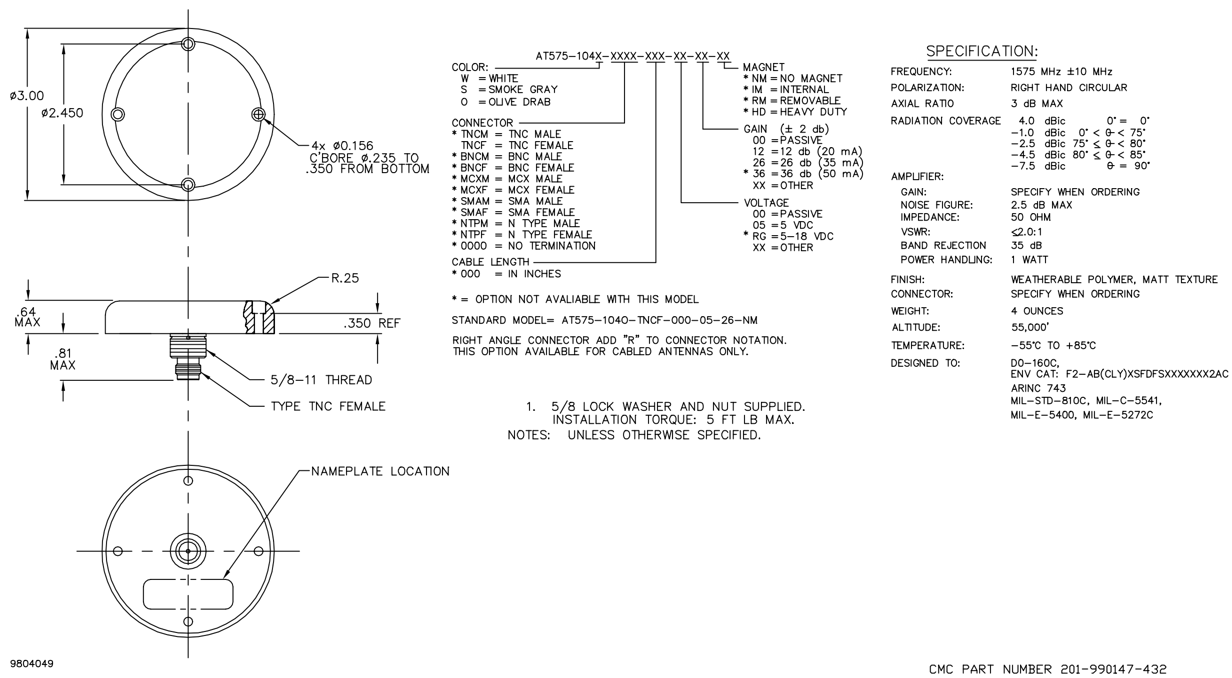
Outline GPS Antenna, AT575-75T Rev A



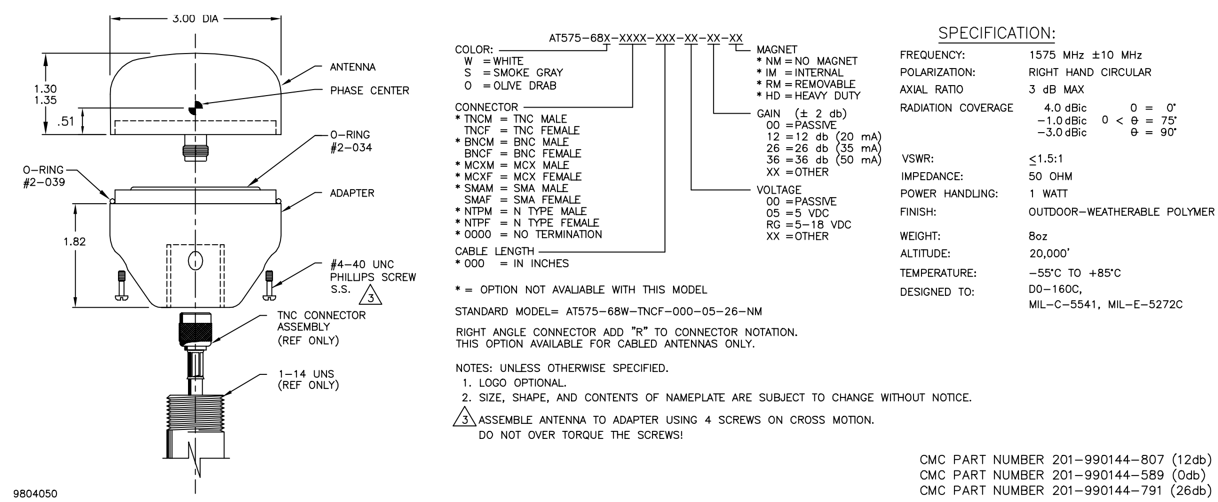
GPS Pre-Amplifier Antenna, AT575-70 Rev B



Outline Drawing GPS Antenna, 1575 MHz, AT575-97CA Rev -



Outline Drawing GPS Antenna, 1575 MHz, AT575-104 Rev -



GPS Pre-Amplifier Antenna, AT575-68 Rev F

REVISION STATUS OF SHEETS										
SHEET	1	2	3	4	5	6	7	8	9	10
REV	-									

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED
	-	PRODUCT BASELINE RA 98-0004	98-05-06	D.C.

NOTES:

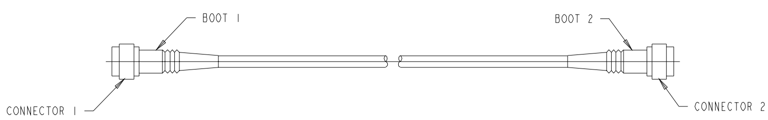
1. PART NO. 217-601730-X[XX],LAST 2 DIGITS=LENGHT OF CABLE IN METER

2. CABLE CONSTRUCTION:

CENTER CONDUCTOR	#20 BARE COPPER WIRE,RESISTANCE-33.1 OHMS PER Km.
INSULATION	POLYETHELENE
INNER SHIELD	ALUMINUM FOIL-100% COVERAGE
OUTER SHIELD	TINNED COPPER BRAID 85% COVERAGE,RESISTANCE 45.9 OHMS PER Km.
JACKET	BLACK PVC

NOMINAL IMPEDANCE	50 OHMS
NOMINAL VEL. OF PROPAGATION	66%
NOMINAL CAPACITY	101.7 Pf. PER METER
ATTENUATION	@ 1000MHZ 44.3Db PER 100 METERS

A LAS 2 D G S OF PAP NO. N ME EP



TABLE

PART NUMBER	CONNECTOR 1	CONNECTOR 2
217-601730-001 THRU -099	TNC MALE STRAIGHT	TNC MALE STRAIGHT
217-601730-100 THRU -199	TNC MALE STRAIGHT	TNC MALE RIGHT ANGLE
217-601730-200 THRU -299	TNC MALE RIGHT ANGLE	TNC MALE RIGHT ANGLE
217-601730-300 THRU -399	BNC MALE STRAIGHT	TNC MALE STRAIGHT
217-601730-400 THRU -499	BNC MALE STRAIGHT	TNC MALE RIGHT ANGLE
217-601730-500 THRU -599	BNC MALE STRAIGHT	BNC MALE STRAIGHT

~~SEE SEPARATE PARTS LIST~~

THIRD ANGLE PROJECTION

NEXT ASSY	USED ON
---	ALLSTAR

APPLICATIONS

CMC REF ONLY

UNLESS OTHERWISE SPECIFIED: DIMENSIONS APPLY AFTER FINISHING AND ARE IN [ ] INCHES [X] MILLIMETERS

ANGULAR TOLERANCE ±

INCHES TOLERANCES .XX ± .XXX ±

TOLERANCE ± 6

MATERIAL

FINISH

CONTRACT NO

CONTRACTOR

DRAWN BY D.C. DATE (YR-MO-DY) 98-02-13

CHECKER D.C. ENGINEER D.GERMAIN

DRAWING APPROVAL

DESIGN APPROVAL H.PELLERIN

CANADIAN MARCONI COMPANY
MONTREAL, QUEBEC, CANADA

CABLE ASSY-COAX

SIZE C CAGE CODE 90073 DWG NO 217-601730-VAR

SCALE 1/1 SHEET

GENERATED ON PRO/ENG.

REVISION STATUS OF SHEETS										
SHEET	1	2	3	4	5	6	7	8	9	10
REV										

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	-	PRODUCT BASELINE RA98-0004	98-01-20	D.C.

NOTE:

1. BAG IDENTIFICATION ONLY (NO MARKING ON CABLE REQUIRED).

2. VARIATION NO. DENOTES

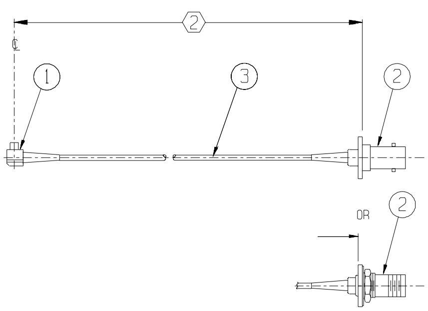
217-601727- X XX ← LENGTH OF CABLE CM
15 = 15 CM
21 = 21 CM

0 = RIGHT ANGLE JACK + TNC BULKHD FEMALE WITH RG316 CABLE

1 = RIGHT ANGLE JACK + TNC BULKHD FEMALE WITH RG174 CABLE

5 = RIGHT ANGLE JACK + BNC BULKHD FEMALE WITH RG316 CABLE

6 = RIGHT ANGLE JACK + BNC BULKHD FEMALE WITH RG174 CABLE



LIST OF PARTS

ITEM NO.	CMC PART NO. (REF)	NOMENCLATURE	MFR PART NO. (OR EQUIV)	QTY
1	230-990142-271	CONNECTOR,COAX,MICROAX RIGHT ANG.	SUHNER 16MCX-50-2-5C/111	A/R
2	230-990144-437	CONNECTOR,COAX,BNC BULKHD MTG JACK	OMNI-SPECTRA 3234-7388-10	A/R
2	230-990127-480	CONNECTOR,COAX,TNC BULKHD MTG JACK	OMNI-SPECTRA 3134-7388-10	A/R
3	207-990007-646	CABLE RF, COAX RG316/U	N/A	XX CM
3	207-990006-277	CABLE RF, COAX RG174/U	N/A	XX CM

THIRD ANGLE PROJECTION

NEXT ASSY	USED ON
	ALLSTAR

APPLICATIONS

CMC REF ONLY

UNLESS OTHERWISE SPECIFIED: DIMENSIONS APPLY AFTER FINISHING AND ARE IN [ ] INCHES [X] MILLIMETERS

ANGULAR TOLERANCE ±

INCHES TOLERANCES .XX ± .XXX ±

MILLIMETERS TOLERANCE ± 6

MATERIAL

FINISH

CONTRACT NO

CONTRACTOR

DRAWN BY P.L. DATE (YR-MO-DY) 97-12-19

CHECKER ENGINEER

DRAWING APPROVAL

DESIGN APPROVAL

CANADIAN MARCONI COMPANY
MONTREAL, QUEBEC, CANADA

CABLE, RF MICRO GPS

SIZE C CAGE CODE 90073 DWG NO 217-601727-VAR

SCALE 1/1 SHEET

GENERATED ON CADKEY

APPENDIX E - SUPPORTED DATUM LIST

CONTENTS

Subject **Page**

APPENDIX E

SUPPORTED DATUM LIST

DATUM DESCRIPTION TABLE

#	NAME	ELLIPSE	DX	DY	DZ	COUNTRIES
0	WGS 1984	WGS-84	0	0	0	Global definition
1	User Defined 1					
2	User Defined 2					
3	Adindan	Clarke_1880	-161	-14	205	Sudan
4	Arc 1950	Clarke_1880	-143	-90	-294	Botswana, Lesotho, Malawi, etc.
5	Arc 1950	Clarke_1880	-169	-19	-278	Zaire
6	Arc 1960	Clarke_1880	-160	-6	-302	Kenya, Tanzania
7	Australian Geodetic 1984	Australian_National	-134	-48	149	Australia, Tasmania
8	Bogota Observatory	International	307	304	-318	Colombia
9	Campo Inchauspe	International	-148	136	90	Argentina
10	Cape	Clarke_1880	-136	-108	-292	South Africa
11	Carthage	Clarke_1880	-263	6	431	Tunisia
12	Chatham Island Astro 1971	International	175	-38	113	New Zealand (Chatham Island)
13	Chua Astro	International	-134	229	-29	Paraguay
14	Corrego Alegre	International	-206	172	-6	Brazil
15	European 1950	International	-87	-98	-121	Austria, Belgium, Denmark, Finland, France, West Germany, Gibraltar, Greece, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland
16	European 1950	International	-104	-101	-140	Cyprus
17	European 1950	International	-130	-117	-151	Egypt
18	European 1950	International	-86	-96	-120	England, Channel Islands, Ireland, Scotland, Shetland Islands
19	European 1950	International	-117	-132	-164	Iran
20	European 1950	International	-97	-88	-135	Italy (Sicily)
21	European 1979	International	-86	-98	-119	Austria, Findland, Netherlands, Norway, Spain, Sweden, Switzerland
22	Geodetic Datum 1949	International	84	-22	209	New Zealand
23	Hjorsey 1955	International	-73	46	-86	Iceland

#	NAME	ELLIPSE	DX	DY	DZ	COUNTRIES
24	Hong Kong 1963	International	-156	-271	-189	Hong Kong
25	Hu-Tzu-Shan	International	-637	-549	-203	Taiwan
26	Indian 1954	Everest 1830	218	816	297	Thailand, Vietnam
27	Ireland 1965	Airy_modified	506	-122	611	Ireland
28	Kertau 1948	Everest 1948	-11	851	5	West Malaysia & Singapore
29	Liberia 1964	Clarke_1880	-90	40	88	Liberia
30	Luzon	Clarke_1866	-133	-77	-51	Philippines (Excluding Mindanao)
31	Massawa	Bessel_1841	639	405	60	Ethiopia (Eritrea)
32	Merchich	Clarke_1880	31	146	47	Morocco
33	Minna	Clarke_1880	-92	-93	122	Nigeria
34	Nahrwan	Clarke_1880	-247	-148	369	Oman (Masirah Island)
35	North American 1927	Clarke_1866	-5	135	172	Alaska
36	North American 1927	Clarke_1866	-3	142	183	Antigua, Barbados, Bermuda, Caicos Islands, Cuba, Dominican Republic, Grand Cayman, Jamaica, Turks Islands
37	North American 1927	Clarke_1866	-10	158	187	Canada
38	North American 1927	Clarke_1866	-7	162	188	Canada (Alberta, British Columbia)
39	North American 1927	Clarke_1866	-9	157	184	Canada (Manitoba, Ontario)
40	North American 1927	Clarke_1866	-22	160	190	Canada (New Brunswick, Newfoundland, Nova Scotia, Quebec)
41	North American 1927	Clarke_1866	4	159	188	Canada (Northwest Territories, Saskatchewan)
42	North American 1927	Clarke_1866	-7	139	181	Canada (Yukon)
43	North American 1927	Clarke_1866	0	125	201	Canal zone
44	North American 1927	Clarke_1866	0	125	194	Central America
45	North American 1927	Clarke_1866	-12	130	190	Mexico
46	North American 1983	GRS-80	0	0	0	Alaska, Canada, CONUS, Central America, Mexico
47	Old Egyptian 1907	Helmert_1906	-130	110	-13	Egypt
48	Old Hawaiian	Clarke_1866	61	-285	-181	Hawaii, Kauai, Maui, Oahu
49	Oman	Clarke_1880	-346	-1	224	Oman
50	Ord. Survey G. Britain 1936	Airy	375	-111	431	England, Isle of Man, Scotland, Shetland Islands, Wales
51	Pitcairn Astro 1967	International	185	165	42	Pitcairn Island
52	Qatar National	International	-128	-283	22	Qatar
53	Qornoq	International	164	138	-189	Greenland (South)

#	NAME	ELLIPSE	DX	DY	DZ	COUNTRIES
54	Schwarzeck	Bessel_1841_in_Namibia	616	97	-251	Namibia
55	South American 1969	South_America_1969	-57	1	-41	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Trinidad & Tobago, Venezuela
56	South American 1969	South_America_1969	-60	-2	-41	Brazil
57	South American 1969	South_America_1969	-44	6	-36	Colombia
58	South American 1969	South_America_1969	-45	8	-33	Venezuela
59	South Asia	Modified Fisher 1960	7	-10	-26	Singapore
60	Tananarive Observatory 1925	International	-189	-242	-91	Madagasgar
61	Tokyo	Bessel_1841	-148	507	685	Japan
62	Tokyo	Bessel_1841	-128	481	664	Mean Value
63	WGS 1972	WGS-72	0	0	0	Global definition

ELLIPSOID DESCRIPTION TABLE

Ellipsoid name	Semi-major axis (a)	Inverse flattenning (1/f)
Airy	6377563.3960	299.324964600
Airy_modified	6377340.1890	299.324964600
Australian_National	6378160.0000	298.250000000
Bessel 1841	6377397.1550	299.152812800
Bessel 1841 in Namibia	6377483.8650	299.152812800
Clarke 1866	6378206.4000	294.978698200
Clarke 1880	6378249.1450	293.465000000
Everest (Sabah & Sarawak)	6377298.5560	300.801700000
Everest 1830	6377276.3450	300.801700000
Everest 1948	6377304.0630	300.801700000
Everest 1956	6377301.2430	300.801700000
Everest_Modified	6377304.0630	300.801700000
GRS-80	6378137.0000	298.257222101
Helmert 1906	6378200.0000	298.300000000
Hough	6378270.0000	297.000000000
International	6378388.0000	297.000000000
Krassovsky	6378245.0000	298.300000000
Modified Fisher 1960	6378155.0000	298.300000000
SGS 85	6378136.0000	298.257000000
South America 1969	6378160.0000	298.250000000
WGS-72	6378135.0000	298.260000000
WGS-84	6378137.0000	298.257223563

APPENDIX F - SOFTWARE REPROGRAMMING MODE

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APPENDIX F

SOFTWARE REPROGRAMMING MODE

GENERAL

The receiver has an integrated reprogramming facility. The receiver has Flash Memory devices that allow software updates via the RS-232 communication port in less than 2 minutes. The OEM circuit card assembly is forced to enter reprogramming mode when the voltage at the input pin DISC_IP_1 is HI. More information on this mode is available on request.

PROGRAMMING MODE PROCEDURE

The receiver can be set to programming mode by hardware or by software.

1. PROGRAMMING MODE SETTING BY HARDWARE

   a. At the 26 pin ZIF connector (J1), tie pin 9 to the 5V supply.

   b. At the 20 pin header connector (J3), tie pin 6 to the 5V supply

   c. Apply either 5V supply voltage to the receiver or a master reset pulse to the power control input pin (J1-5 or J3-3)

   Notes:

   1. If a programming adapter (#220-600932-000) is used, set S2 to PROG then apply 5V supply voltage or press S1 if supply voltage is already applied.

   2. The baud rate for programming mode setting by hardware is 19200.

2. PROGRAMMING MODE SETTING BY SOFTWARE

   To set the programming mode by software, enter message $PMCAG,006 when in NMEA mode or message ID #112 when in Binary mode. In either case the receiver will be forced to enter the programming mode at a specific baud rate.

   The commands are sent at the operating baud rate. Once these commands are decoded, the receiver will enter programming mode at the specified baud rate, independently of the operating baud rate.

   Example **NMEA : $PMCAG,006,19.2*7A<CR><LF>**
   Binary : 0x01,0x70,0x8F,0x01,0x40,0x41,0x01

   The programming utility will send one of these commands to force the programming mode, thus avoiding the need to tie the DISC_IP_1 pin to 5 volts. It is useful when the system does not provide external access to the DISC_IP_1 pin.

HOW TO VERIFY IF IN PROGRAMMING MODE OR NOT

Once in programming mode, the receiver sends the following information to both communication ports :

Ready !!!
wwwwww

Character **"w"** means waiting for data exchange and will be repeated until the programming utility starts to send data.

The baud rate will be 19200 if the programming mode setting is done by hardware and any other baud rate if done through operational software command.

WHICH PORT TO USE

The MAIN port or the AUXILIARY port can be used to program the receiver. It is recommended to stop any communication on the unused port for proper operation in programming mode.

PROGRAMMING UTILITY

The programming utility "PROG.EXE" is used to :

a. Set the receiver to programming mode (if not already done)
b. Erase the Operational S/W
c. Transfer the new operational S/W data to the receiver
d. Verify if the operation has been done successfully

Type "PROG" at the DOS prompt to get help information on the utility :

Example:
C:\>PROG
PROGRAMMING UTILITY VERSION : 1.104
NOTE : this utility uses the serial port interrupt

Example:

PROG UGPSO.SUM 1 0 1 0 <ENTER>
parameter 1 : Operational S/W filename
parameter 2 : PC Serial Port (1or2)
parameter 3 : 0: Binary 1: NMEA protocol
parameter 4 : Synchronisation baud rate (300 to 19200)
parameter 5 : Data transfer baud rate (300 to 38400)

Baud Rate Code :
0:38400 1:19200 2:9600 3:4800 4:2400 5:1200 6:600 7:300

Parameters 3, 4 and 5 are optional and their default values are: 0 1 0

PROG.EXE PARAMETERS

The PROG.EXE utility requires the following parameters:

PROG FILENAME, COM# , MODE BAUD_RATE, TRANSFER_B_R

Parameters MODE, BAUD_RATE and TRANSFER_B_R are optional and have the following default values:

FILENAME : New receiver binary file (provided)

COM#: PC Serial Communication Port presently used

COM 1: 1
COM 2: 2

MODE : Actual receiver operating mode

Binary: 0
NMEA: 1

Default Value: 0 (Binary)

SYNC_B_R: Synchronisation Baud Rate

38400:	0
19200:	1
9600:	2
4800:	3
2400:	4
1200:	5
600:	6
300:	7

Default Value: 1 (19200)

Note: This baud rate will be used by the receiver to start data exchange with the Programming utility when in Programming mode.

TRANSFER_B_R : Data Transfer Baud Rate (see SYNC_B_R description for possible values)

Default Value: 0 (38400)

PROGRAMMING UTILITY ALGORITHM

1. Programming utility performs the following tasks:
   a Verify the parameter values
   b Verify the receiver binary file validity
   c Send the input message $PMCAG,006 (MODE = 1) or message #112 (MODE =0) at the specified baud rate (SYNC_B_R parameter)
   d Wait for "w" character (@ SYNC_B_R)
   e Start & Verify Erase process
   f Change communication baud rate to the TRANSFER_B_R value
   g. Start and Verify Programming process

2. Examples

   a. If the receiver is forced into programming mode via the DISC_IP_1 input pin, only the following command is necessary :

      PROG FILENAME 1 (if COM 1 in use)
      (see Default Value for other parameters)

   b. If the receiver is in NMEA mode @ 9600 :

      PROG FILENAME 1 1 2 0

      This forces the utility to send NMEA message $PMCAG,006 on COM 1 @ 9600 and to transfer the binary data @ 38400.

   c. If the receiver is in Binary mode @ 19200 and wish to set the transfer baud rate @ 19200 :

      PROG FILENAME 1 0 1 1

   d. If the receiver sends "w" characters @ 4800 :

      PROG FILENAME 1 0 3 0

In programming mode, the MODE parameter is no longer important and can be set to "0" or "1". But the SYNC_B_R parameter has to be set to the programming mode baud rate in use by the receiver (sending "w" characters).

930-600018-000

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