



User Guide

GPS4 Satellite Synchronized Time & Frequency Standard

Model GPS4

P/N 001-0045

Revision 2.2

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Revision History

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2.2	11-02-04	Revision of entire GPS4 user guide.



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1 Introduction

The GPS4 disciplined time and frequency standard is a device that offers many desirable features. Utilizing signals from the Global Positioning System, the unit provides highly accurate time, synchronization, and frequency functions. The unit may operate in either GPS or UTC time mode. Local time offsets may be programmed into the unit in resolutions of minutes. A brief outline of the unit's features is described below.

- **PPS Output:** This 1 PPS output provides a TTL output level into 50 ohms. This output is available on the front panel BNC connector labeled "PPS".
- **10 MHz Output:** This 1 Vrms sinusoidal output is available on the front panel BNC connector labeled "10MHz".
- **Synthesizer Output:** This is a frequency output option that is factory configurable to produce one of three different frequencies (19.6608 MHz, 1.544 MHz, and 2.048 MHz). This output is available on the front panel BNC connector labeled "SYNTH". Other frequencies may also be synthesized so please contact Brandywine Communications for more information on a particular frequency.
- **IRIG B Time Code Output:** This is a time code output used to distribute time of day information to other devices. This output is available by an internal link selection (DC level shift code output or modulated time code output). It is available on the front panel BNC connector labeled "CODE". Other time code formats are possible so please contact Brandywine Communications for more information on a particular time code.
- **Serial I/O:** The GPS4 features one bi-directional control port and one dedicated output port used to provide time of day (TOD) information. The TOD output is an ASCII data string that is outputted each second shortly after the 1 PPS. These serial ports may be factory configured for either RS232 (bi-polar) or RS422 (differential) signal levels.

2 Product Specifications

2.1 Power Requirements

CONNECTOR	DESCRIPTION
Connector Type	MR series locking type AMP 1-640508-0
Connector Pin	Pin 1 Positive
	Pin 2 Chassis ground
	Pin 3 Negative

2.1.1 Standard

STANDARD	DESCRIPTION
Input Voltage/Current	15 VDC @ 1.4 A maximum and 0.5 A steady state
Isolation	None

2.1.2 Power Option 1

OPTION 1	DESCRIPTION
Input Voltage/Current	18 - 36 VDC @ 1 - 0.5 A maximum and 0.5 - 0.3 A steady state
Isolation	500 VDC

2.1.3 Power Option 2

OPTION 2	DESCRIPTION
Input Voltage/Current	36 - 60 VDC @ 1 - 0.34 A maximum and 0.5 - 0.2 A steady state
Isolation	Isolated, 500 VDC

2.2 Outputs

2.2.1 PPS

PPS	DESCRIPTION
Rate	1 pulse per second
Drive Output	TTL into 50 ohm load
Reference	Rising edge referenced to UTC (USNO)
Width	1 ms
Connector	BNC female
Accuracy	±150 ns to UTC after the stabilization period of 24 hours – static and time locked
	Standard deviation of 34 ns
Holdover	Less than 8 us/8 hr after the learning period
	Can be influenced by the antenna delay compensation

2.2.2 10 MHz

10 MHz	DESCRIPTION	
Frequency	10 MHz	
Period	100 ns	
Waveform	Sinusoid (standard) or square (link selectable)	
Drive Level	1 Vrms (minimum) into 50 ohm load	
Harmonics	< 30 dB	
Phase Noise	100 Hz	-140 dBc/Hz
	1000 Hz	-150 dBc/Hz
	10 KHz	-155 dBc/Hz
Stability (Short Term)	1 sec	1×10^{-11}
	10 sec	1×10^{-11}
	100 sec	8×10^{-12}
	1000 sec	1×10^{-11}
Accuracy	Long term	5×10^{-12} while locked over 24 hours
	Holdover	1×10^{-10} average during 24 hours

2.2.3 Synthesizer

SYNTH OPTION 1	DESCRIPTION	
Frequency	19.6608 MHz	
Connector	BNC female	
Drive Level	Single ended, HCMOS	
Duty Cycle	50/50 \pm 10%	
Accuracy	Long term	5×10^{-12} while locked over 24 hours
	Holdover	1×10^{-10} average during 24 hours

SYNTH OPTION 2	DESCRIPTION	
Frequency	2.048 MHz	
Connector	BNC female	
Drive Level	Single ended, HCMOS	
Duty Cycle	50/50 \pm 10%	
Accuracy	Long term	5×10^{-12} while locked over 24 hours
	Holdover	1×10^{-10} average during 24 hours

SYNTH OPTION 3	DESCRIPTION	
Frequency	1.544 MHz	
Connector	BNC female	
Drive Level	Single ended, HCMOS	
Duty Cycle	50/50 \pm 10%	
Accuracy	Long term	5×10^{-12} while locked over 24 hours
	Holdover	1×10^{-10} average during 24 hours

2.2.4 Status Indicators

INDICATOR	COLOR	DESCRIPTION
POWER	GREEN	Indicates the system power is available
LOCKED	GREEN	Indicates the system time locked status
HOLDOVER	YELLOW	Indicates the system is in holdover operation
ALARM	RED	Indicates the system fault

2.3 Inputs

2.3.1 System Reset

SYSTEM RESET	DESCRIPTION
Function	Resets the system microprocessor
Level	+5 V, active high (pin 4)
Pulse Width	2 ms minimum
Sink Current	30 mA maximum

2.3.2 Antenna

ANTENNA	DESCRIPTION
Connector	BNC female
Impedance	50 ohms
Bias Voltage	5 VDC
Bias Current	80 mA maximum

2.4 Environmental

ENVIRONMENTAL	DESCRIPTION
Operating	-10°C to +60°C
Maximum Rate Change	15°C per hour

2.5 GPS Receiver

GPS RECEIVER	DESCRIPTION
Number of Channels	8 parallel
Band	L1 (1575.42 MHz)

2.6 Serial Control

SERIAL CONTROL	DESCRIPTION
Connector	DE-9 female



2.6.1 Control Port

CONTROL PORT	DESCRIPTION
Baud Rate	75 – 19200 baud selectable by the DIP switch 4800, N, 8, and 1 is factory setting

2.6.2 TOD Port

TOD PORT	DESCRIPTION
Protocol	Time of day (ASCII)
Baud Rate	19.2 K

2.6.3 Serial Option 1

SERIAL OPTION 1	DESCRIPTION
I/O Level	RS232

2.6.4 Serial Option 2

SERIAL OPTION 2	DESCRIPTION
I/O Level	RS422

2.7 Hardware Status

HARDWARE	DESCRIPTION
Connector	DB-9
Level	Open collector – pulled to ground through 100 ohm resistor
Maximum Pull-Up Voltage	5 VDC
Maximum Current	30 mA
Status	Time lock (pin 8)
Status	Fault (pin 9)

2.8 Physical

PHYSICAL	DESCRIPTION
Length	5.84 inches (148.3 mm)
Width	5.58 inches (141.7 mm)
Height	1.61 inches (40.9 mm)
Weight	1.5 lbs (0.7 kg)

2.9 Connectors and Indicators

The GPS4 provides access to the power, I/O, and signal connectors on the front panel of the chassis. These various connectors and indicators are described below.

LABEL	FUNCTION	DETAIL		
PWR	Power input connector	Pins are numbered from left to right so Pin 1 = VDC, Pin 2 = chassis, and Pin 3 = ground		
I/O	I/O connector provides I/O for serial communications and hardware status indicators. Hardware statuses are open collector transistors that pull low when the described status is true.	PIN	RS232 (STANDARD)	RS422 (OPTIONAL)
		1	No connection	Control TX-Y
		2	Control TX	Control TX-Z
		3	Control RX	Control RX-A
		4	Hardware reset	Control RX-B
		5	Ground	Ground
		6	TOD TX	TOD TX-Y
		7	No connection	TOD TX-Z
		8	Time locked	Time locked
		9	Fault	Fault

LABEL	FUNCTION	DETAIL
POWER	Power good indicator LED	Green LED indicates that +5 V of power is present.
LOCKED	Time locked indicator LED	Green LED indicates time and position data is synchronized since power up. Turns off after 8 hours of no satellite reception.
HOLDOVER	Holdover indicator LED	Yellow LED indicates the unit is in holdover.
ALARM	Alarm indicator LED	Red LED indicates: <ul style="list-style-type: none"> - Phase lock loop control voltage is within 10% of its limit. - Synthesizer lost lock. - Processor malfunctions. - 8 hours of no satellite reception.
PPS	1 PPS output, BNC female	Output of 1 PPS at TTL levels into a 50 ohm load. 1 ms wide and rising edge on time.
10MHz	10 MHz sine wave output, BNC female	Output of 10 MHz at 1 Vrms (2.8 Vp-p) minimum into a 50 ohm load.
SYNTH	Synthesizer output, BNC female	Output of synthesizer frequency, HCMOS levels. Frequency is programmed at the factory.
CODE	Time code output, BNC female	IRIG B/AFNOR time code: <ul style="list-style-type: none"> - Modulated 3 Vp-p and modulation ratio 3:1 nominal (LK1 2-3). - IRIG B DC level shift. - TTL level into 50 ohm load (LK1 1-2).
ANT	GPS antenna input, BNC female	The input connects to a L1 band (1575.42 MHz) GPS antenna. The "input" provides a +5 VDC bias voltage to the GPS antenna at up to 80 mA of current to operate a low noise amplifier or line amplifier.

3 Installation

To maximize the performance of the GPS4, please consider the following guidelines.

3.1 Thermal Considerations

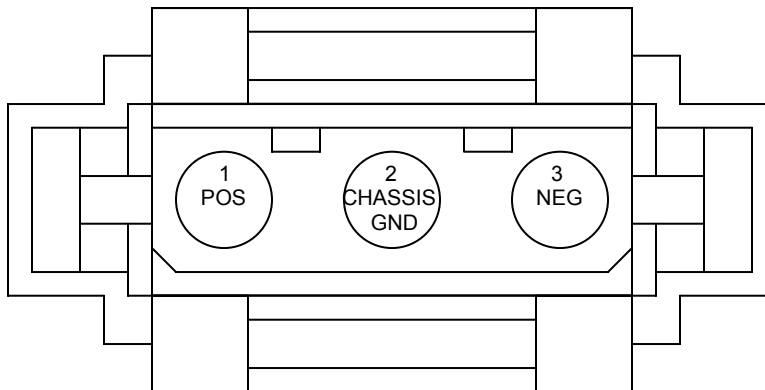
This unit is designed to operate over a temperature range of -10°C to $+60^{\circ}\text{C}$, but optimum performance will be achieved when the unit is allowed to operate at a relatively constant temperature. The internal temperature rise is about 15°C above the ambient temperature. For operation in environments above 50°C , forced air cooling should be provided across the unit.

Power consumption will also vary as a result of temperature. This unit utilizes an Ovenized Quartz Crystal Oscillator (OCXO) therefore a significant percent of the overall power is used by the OCXO to maintain the thermal stability of the quartz crystal oscillator. The OCXO achieves its frequency stability over temperature by housing the quartz crystal and other thermally sensitive components in an "oven". The temperature of this "oven" is regulated and maintained at a relatively high temperature usually 80°C to 90°C to a very close tolerance that is better than 0.1°C . This elevated temperature allows the oscillator to maintain good stability while the ambient temperature is exposed to changes. At low ambient temperatures the "oven" must generate and consume more power to maintain the "oven" temperature. Higher ambient temperatures reduce the amount of power needed to maintain the "oven" temperature.

3.2 Power Supply Connections

The GPS4 has different power supply options made available. Regardless of the power supply option installed, the power input to the unit is only DC and supplied to the unit through a three pin power connector. This connector is labeled 'PWR' and is located in the upper left corner of the front panel.

The power connector pin assignments are shown below. Note that the power connector pin assignments are the same for all power supply options. Pin 1 is always the positive supply voltage, Pin 2 is always tied to the unit's chassis ground, and Pin 3 is always the negative supply voltage, also known as the power return.



In all cases the maximum power required by the GPS4 is 20 watts. The maximum power consumption will be experienced when power is first applied to the unit and/or when the unit is operating at low temperatures (0°C to -10°C). After approximately 10 minutes of continuous operation the start up power will be reduced to approximately 6 to 8 watts when at room temperature (25°C).

Noise and ripple presence on the DC supply should be minimized. Certain power supply options provide better noise and ripple rejection.

3.3 Unit Mounting

Four 4–40 threaded inserts are provided in the bottom of the unit for mounting purposes. When mounting the unit to the interior of a cabinet or chassis some consideration must be given to location from the cooling, vibration, and electromagnetic interaction standpoint. One source of electromagnetic interaction can be traced to the transformers used in the power supplies. Power supplies that utilize toroidal wound transformers generally provide better magnetic flux containment than the bobbin or laminated core type. In general, keep the GPS4 away from the system power supply, particularly if the power supply is AC-DC linear or switching type.

In most cases the GPS4 will be used in stationary installations where vibration caused by dynamic movement will not be of any concern. However, the GPS4 utilizes a precision quartz oscillator and mechanical shock or vibration imparted to the quartz crystal can generate unwanted electrical output in the form of phase/frequency noise perturbations. In general, the GPS4 should be kept away from sources of moderate or high vibration. In most cases, exposure to vibration will not be of major concern and the degradation if any will not be noticeable.

The orientation of the unit should allow normal convection cooling. This means that airspace must be made available around the perimeter of the air slots so that natural airflow occurs. The unit should not be mounted upside down because this will disrupt the convection airflow cooling, unless some form of forced air cooling is provided. For operation in ambient temperatures at or above 50°C, forced air cooling should be provided. Refer to section 3.1 (Thermal Considerations).

The mounting screw length must not exceed 0.25 inches when measured from the bottom surface of the unit.

3.4 Serial Interface Connections

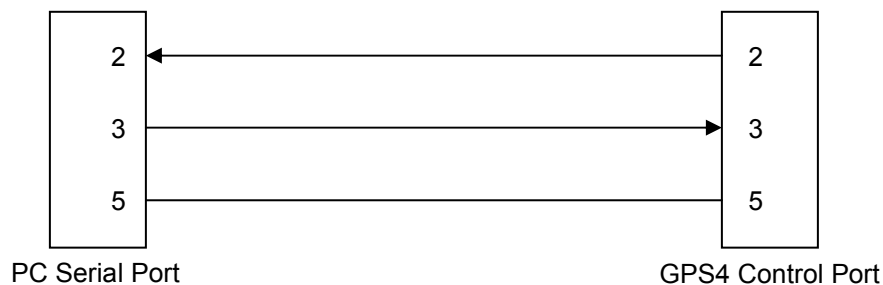
The GPS4 is shipped from the factory with either an RS232 or RS422 serial interface (determined by user). A bi-directional interface known as the 'TxD1/RxD1' port and uni-directional serial output known as 'TxD2/RxD2' used to output the time of day (TOD) are present on the DB-9 connector labeled 'I/O'. Both are simple interfaces that do not require or supply hand-shake signals. Other signals present on the DB-9 connector are the 'Time Locked', 'Fault', and 'HWRESET' signals. These three signals provide open collector outputs used as a hardware status indicator that reports the basic usability of the GPS4 and as a system reset. It is not necessary to use these signals so these signals may be left disconnected. The table below describes the pin assignments for both the 'PWR' (power) and 'I/O' connectors.

LABEL	FUNCTION	DETAIL		
PWR	Power input connector	<ul style="list-style-type: none"> - Pins are numbered from left to right so Pin 1 = VDC, Pin 2 = Chassis, and Pin 3 = Ground. - See the product label to determine the unit supply voltage. 		
I/O	I/O connector provides I/O for serial communications and hardware status indicators. Hardware statuses (Pin 8 & 9) are open collector transistors that pull low when the described status is true.	PIN	RS232 (STANDARD)	RS422 (OPTIONAL)
		1	No connection	TxD1-Y
		2	TxD1	TxD1-Z
		3	RxD1	RxD1-A
		4	Hardware reset	RxD1-B
		5	Ground	Ground
		6	TxD2	TxD2-Y
		7	No connection	TxD2-Z
		8	Time locked	Time locked
		9	Fault	Fault

3.5 Interfacing to the Serial Port

3.5.1 RS232

The connections necessary to interface the GPS4 control port to a standard PC serial port are shown below.





3.5.2 TxD2 ASCII Time of Day Output

The time of day (TOD) output is made available on pin 6. This is an ASCII message that is outputted every second and indicates the time of the last 1 PPS output. Three formats are made available for this message.

3.5.3 RS422

The GPS4 may also use RS422 I/O levels. The RS422 interface uses balanced (differential) wire pairs to transmit and receive data, thus four wires and a common ground are required for this bi-directional interface. Two wires and a common ground are required for a uni-directional interface such as the TOD output. Since RS422 has more varied connector types and interfaces, no specific connections are shown for this interface. Please refer to the pin connections and signals listed in the table above.

3.6 Antenna Installation

3.6.1 Location

Several factors need to be considered when installing the GPS antenna. In most cases the antenna is mounted externally (outdoor) and is exposed to the elements. A good quality coaxial cable of 50 ohm impedance is required to connect the GPS antenna to the GPS4. The cable provides two functions which are to conduct the GPS RF signals (1575.42 MHz) that are received from the GPS antenna to the GPS4 and to conduct the DC bias voltage (5 VDC) provided by the GPS4 to the LNA (low noise amplifier) contained inside of the GPS antenna. The antenna should be mounted securely, have a clear view of the sky, and the top of the antenna should point upwards. In some installations it may not be possible to mount the antenna such that it has a clear 360 degree view of the sky. In such cases pick the location that affords the best view of the sky.

3.6.2 Exposure to High RF Fields

Some installations may occur in locations where a variety of high power transmitters and antennas are present. The GPS antenna should not be directly exposed to or bombarded with high level RF energy. In such cases locate the antenna either above, below, or to the side of the high power RF transmission antennas.



3.6.3 Lightning Protection

The GPS4 does not provide any inherent protection against lightning strikes. In general, lightning protection (when desired or needed) is provided by an externally mounted protection device that is designed to shunt the high voltage transient to a well established earth ground. Lightning arresting devices designed for use in the GPS antenna systems are available at Brandywine Communications (P/N 001000914).

3.6.4 Antenna Cable Factors

Other factors affecting antenna mounting location deal with the cable length required to provide connection between the antenna and GPS4.

3.6.5 RF Loss

The RF signal attenuation experienced in the cable is important. The amount of attenuation is related to the type (quality) of coaxial cable and cable length. The antenna provides about 30 dB of gain to the received GPS signal. The purpose of this gain is to offset the loss that is experienced in the cable between the GPS antenna and GPS4. It is recommended that the overall antenna system gain (antenna gain – cable loss) be between 10 dB and 33 dB. Thus, using an antenna with 30 dB of gain allows for about 20 dB of cable loss. The GPS4 is shipped with 100' of antenna cable. Additional cable configurations are possible. For distances beyond 330' an in-line amplifier is required.

PART NUMBER	CABLE LENGTH	CABLE TYPE
002-0037	100 feet	RG58 (standard)
002-0039	330 feet	RG8
002-0040	150 feet	RG8
051000001	In-line amplifier 20 dB	TNC/TNC connectors

4 Operating Instructions

4.1 Scope of Section

Section 4 covers the operation, initialization, and configuration of the GPS4. It is assumed that power has been applied to the unit.

4.2 Operation

During normal operation the GPS4 automatically receives, analyzes, and processes data from up to eight GPS satellites simultaneously. This data is used to provide time, frequency, and position information, which are made available to the user via a range of output interfaces.

In applications where the unit is to be used for general test and measurement purposes it can be switched on and off as necessary. However, if the unit is to be used as a time and/or frequency standard it should continuously run to allow long term software processing to occur, which is essential if the unit is to achieve its optimum performance. This process takes a minimum of 24 hours. The unit carries out automatic position averaging and automatically transitions into this 'known position' to obtain the highest possible time and frequency precision. The position averaging process takes place during the first 24 hours after switch on.

Whenever the GPS4 is powered on it carries out a self-test routine before entering the operational program which sets the correct initial conditions for the receiver system. Satellite tracking is automatic, provided that at least one is visible and the GPS4 already has a valid position in its battery backed receiver. The time and frequency control can start within approximately 1 minute. If three or more satellites are visible, 3-D position information will also be processed. The GPS4 internal frequency standard will warm up within 5 minutes. At the end of the warm up period the frequency controller is reinitialized.

Synchronization of the local time to UTC (up to 15 minutes from satellite reception) is confirmed by the illumination of the 'LOCKED' indicator. The voltage control of the internal oscillator maintains synchronization of all outputs with GPS. If the control voltage of the internal oscillator is within 10% of its end of range, the red 'ALARM' indicator illuminates.



The final phase and frequency locking process may take several hours depending on the oscillator type fitted and satellite reception. The GPS4 uses a patented "Intelligent Phase Locked Loop" system incorporating a specially developed dynamic time constant, therefore the control parameters are continuously modified to achieve lock in the shortest possible time and thereafter optimize performance for the best time and frequency accuracy.

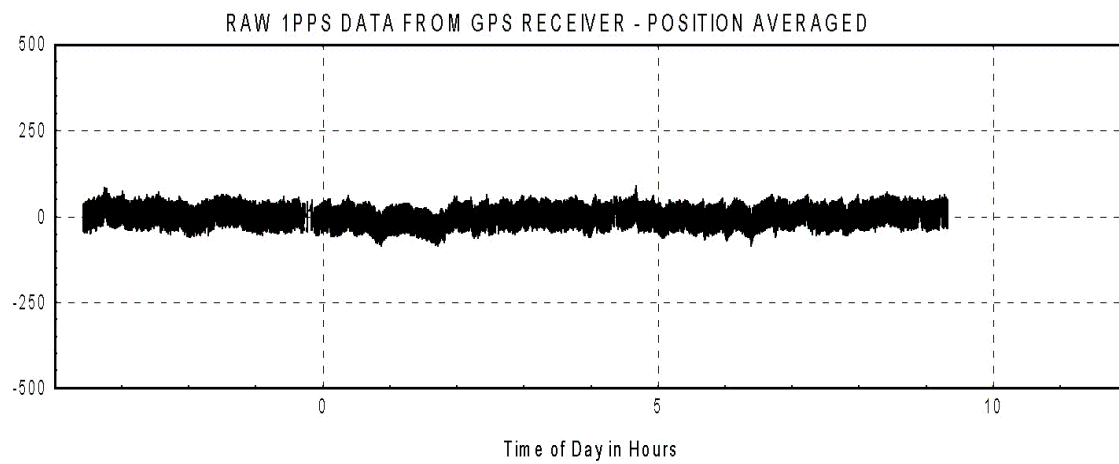
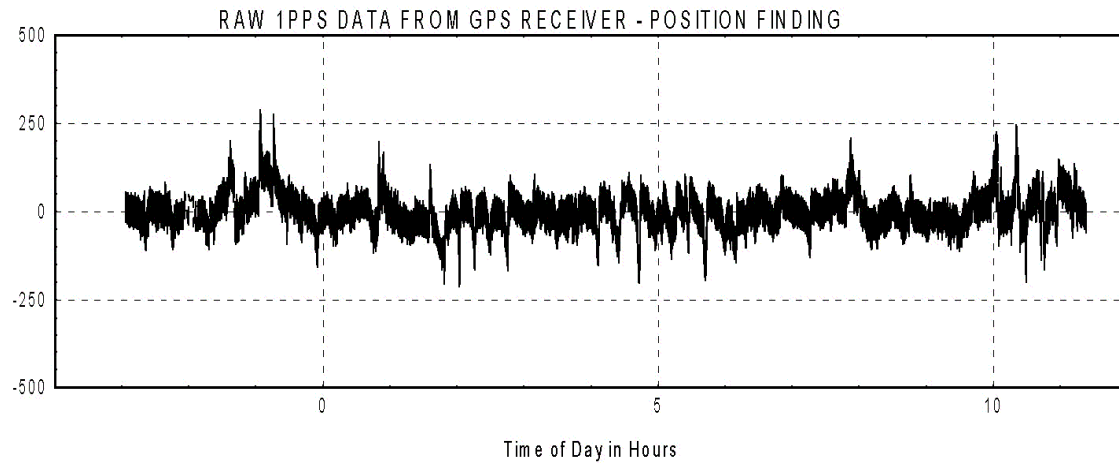
After a position has been successfully navigated the number of tracked satellites drops to 4 or less, the satellite receiver automatically selects 2-D positioning mode, and continues to recover time. If the number of tracked satellites then drops to 3, 2, or 1 satellite positioning is suspended, but time is recovered. If no satellites are tracked, the GPS4 runs in 'HOLD OVER' continuing to maintain all outputs. After 8 hours of lost reception the red 'ALARM' indicator is turned on.

If the unit has a current satellite ephemeris at switch on, the start up time (after system initialization has been completed) is approximately as follows:

- Initial acquisition : 1 - 15 seconds
- Satellite re-acquisition: 25 seconds
- Tracking: 20 seconds
- Navigating: 1 minute from start up
- Position averaging complete: 24 hours from start up

Synchronization of the receiver timing will normally be completed within 1½ minutes after switch on. If the receiver does not have an almanac already backed up in memory after switch on, it will take typically 8 or 9 minutes to acquire the necessary parameters to enable precise time acquisition indicated by the illumination of the 'LOCKED' indicator on the GPS4 front panel.

For fixed position operation precise averaging of the position is carried out by the GPS4 over 24 hours. The reason for this averaging is illustrated below. The illustration shows that the raw time data before processing is carried out by the GPS4 is improved by a factor of 3 when the GPS4 has averaged its position. The vertical scale on the graphs is the 1 PPS deviation in nanoseconds.



4.3 Serial Data Communication

The GPS4 has two asynchronous serial ports that communicate with the user. These serial ports may be connected to other units such as printers, computers, and terminals. These serial ports can be factory configured to be RS232 or RS422. This section describes the options in more detail.

4.4 Control TxD1/RxD1

TxD1 is designed for communication with the user giving the user access to the unit status and GPS reception. RxD1 receives command and data requests from the user.

SW1 controls TxD1/RxD1 baud rate and character format. Prior to the switch alteration the user must disconnect the power connection to the GPS4 and observe all normal safety precautions when removing the cover to access the 8 way DIL switch (SW1).

SWITCH	1	2	3	4	5	6	7	8
ON	- Baud Rate Selection - See Table Below				Parity	Odd Parity	8 Data Bits	2 Stop Bits
OFF					No Parity	Even Parity	7 Data Bits	1 Stop Bit

Table 3a TxD1/RxD1 Character Format

SW1-1	SW1-2	SW1-3	SW1-4	BAUD
OFF	OFF	OFF	OFF	75
ON	OFF	OFF	OFF	110
OFF	ON	OFF	OFF	134.5
ON	ON	OFF	OFF	150
OFF	OFF	ON	OFF	300
ON	OFF	ON	OFF	600
OFF	ON	ON	OFF	200
ON	ON	ON	OFF	1800
OFF	OFF	OFF	ON	2400
ON	OFF	OFF	ON	4800
OFF	ON	OFF	ON	4800
ON	ON	OFF	ON	9600
OFF	OFF	ON	ON	9600
ON	OFF	ON	ON	19200
OFF	ON	ON	ON	19200
ON	ON	ON	ON	19200

Table 3b TxD1/RxD1 Baud Rate



The factory default setting for SW1 is 4800 baud, 8 data, no parity, and 1 stop.

SW1

OFF	✓		✓		✓	✓		✓
ON		✓		✓			✓	
	1	2	3	4	5	6	7	8

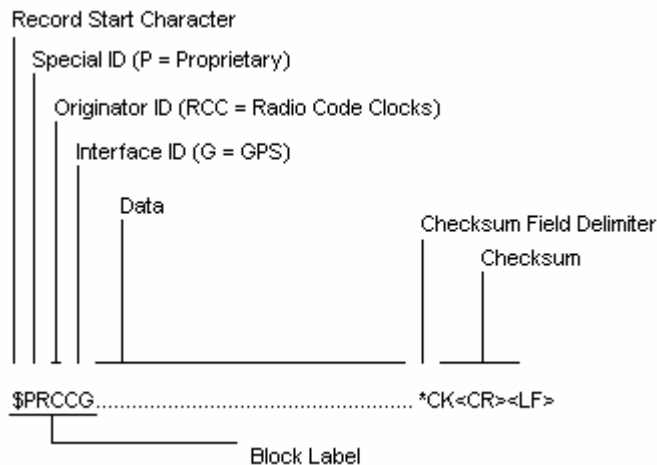
4.4.1 TxD1 / RxD1 User Commands and GPS4 Responses

The GPS4 asynchronous serial port RxD1/TxD1 provides time, position, and status data on request from the user. Furthermore, it accepts user commands. For example, to set the output time to UTC or local, you must set the local time offset from UTC.

The user can obtain information from the GPS4 by sending single ASCII character requests terminated by <CR><LF>. The GPS4 response message structure is based on the NMEA-0183 standard for interfacing Marine Electronics Navigation Devices. The same structure is used for commands from the user to set the GPS4 operating parameters. User characters are sampled at 1 millisecond intervals and will be missed if more than 1 character is received per millisecond. **If there is no time delay between the characters sent to the GPS4, the maximum baud rate for the user commands is 4800.**

The requested record will be directed to the GPS4 serial port TxD1 output. All characters transmitted by the GPS4 are consistent with the ASCII character or control code. When hexadecimal numbers are transmitted to communicate status bit values they are transmitted as ASCII characters 0 through 9 and A through F (A through F is always upper case).

Reserved characters are used to indicate the beginning and end of records in the data stream and to delimit data fields within a record. As an exception the time request may be a single character (optionally without termination) to minimize the overhead of obtaining a time stamp response from the GPS4.



The reserved characters are described in the following table:

CHARACTER	HEXADECIMAL VALUE	USAGE
\$	24	Start of record identifier
<CR><LF>	0D 0A	End of record identifier
,	2C	Record field delimiter
*	2A	Checksum field delimiter

Table 4

The notation 'CK' indicates the optional checksum value of the message computed by the exclusive-OR of all bytes between the '\$' and '*' characters. The '\$', '*', and checksum are not included in the checksum computation. For commands sent to the GPS4 the checksum may be omitted, in which case the associated '*' must also be omitted. The GPS4 will recognize the <CR> as the end of message and will not attempt to verify the missing checksum. If the checksum is attached by the user, it will be checked by the GPS4 and the message will be rejected if an error is detected. Errors in the format of the message will also cause a rejection. The list of available single character requests is described below.

REQUEST	RESPONSE
a<CR><LF>	Version number, time, position averager, and output status information
c<CR><LF>	Pulse output (local/UTC) time or pulse period, polarity, and pulse length
e<CR><LF>	Modulated time code, pulsed output, TxD1 format, and TxD2 format
f<CR><LF>	Frequency and phase controller data
h<CR><LF>	Health status of satellites
j<CR><LF>	Leap second date and UTC-GPS seconds offset value
l<CR><LF>	Location and signal strength of satellites (up to three records)
n<CR><LF>	Version number of firmware and GPS engine
o<CR><LF>	Run UTC/local time and local time hours offset
p<CR><LF>	Position of GPS receiver antenna
s<CR><LF>	Additional information (including magnetic deviation)
t	Precision time request*

Table 5

The precision time request is handled as a priority. The 't' request need not be followed by <CR><LF>, but if <CR><LF> is appended it will be ignored. The GPS4 continually polls the GPS receiver for satellite status and associated information. If the user request requires information from the GPS engine, the GPS4 immediately forwards the information it has already acquired in its internal buffer. The associated response is returned immediately. If several requests have been sent prior to the completion of the responses, the order of responses may be different from the order of requests. The precision time request is given priority. The time at which the request character was received is logged at the next whole millisecond and the GPS4 transmits as soon as the serial port is free. This special message is not in the NMEA format but in the industry standard Type 2 Serial Data Format.

4.5 Message Formats

4.5.1 Time and Date with Status, Position Averager Status, and Output Status

Requested by a<CR><LF>

Field 1 2 3 4 5 6 7 8
\$PRCCG, A, 007, 19:53:19, 07/06/00, 9, 3, 1, 0000, 00*09

FIELD	CONTENTS OF FIELD
1	Fixed text "A"
2	Version number of the GPS4 firmware 000 to 999
3	Hours, minutes, and seconds Day of the month, month, and year
4	The status is the ASCII representation of a hexadecimal character between 0 and F. Each bit of the hexadecimal character represents the following status condition when set to 1 (or 0): <div style="display: flex; justify-content: space-between;"> <div>Bit 3 (MSB) VALID TIME</div> <div>Bit 2 NOT GPS LOCKED</div> <div>Bit 1 LOCAL TIME</div> <div>Bit 0 (LSB) LEAP YEAR</div> </div>
5	The number of position average samples accumulated (target is 100).
6	Position Average Mode: "0" = not averaging "1" = averaging "2" = known averaged position in use
7	The output status (16 bits in 4 digits) as detected by the output detectors. Each hexadecimal character represents 4 bits and each bit set to '1' corresponds to the status described in the following table. When no failures are detected four 0's are transmitted.
8	The control status (8 bits in 2 digits) as reported by the frequency controller. Each bit set to '1' corresponds to the status described in the following table.

BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
					Always 1	Always 1	Always 1

Table of Field 7

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0 (LSB)
Synthesizer PLL Unlocked	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
	Always 1	Always 1	Always 1	Always 1	Always 1	Always 1	Always 1

Table of Field 7

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0 (LSB)
One or more OP failures detected	No satellites for 8 hours	Reserved	Oscillator frequency control near its limit	Frequency error oscillator cannot be controlled	Reserved	Rubidium oscillator status shows Rubidium cold	Reserved

Table of Field 8

Output Example

\$PRCCG, A, 007, 13:56:48, 09/06/00, 9, 100, 2, 0000, 00*0B

Software version 007, requested at 13 hours 56 minutes 48 seconds on the 9th of June 2000 with time status showing valid time, synchronized, and UTC in leap year. 100 position samples have been accumulated therefore position averaging is completed and the GPS receiver is reporting that it is in a known position and there are no output or control failures.

4.5.2 Pulse Output Data and Command

Requested by c<CR><LF>

Sending the single letter 'c' followed by <CR><LF> requests a message from the GPS4 describing its pulse output from J10. The same message format transmitted to the GPS4 sets the pulse output parameters stored in non-volatile RAM. The pulse output (logic levels 0 V and 5 V from 50R) can be commanded to be normally low going high for the pulse duration or normally high going low for the pulse duration. There are two ways to specify the pulse occurrence and duration. Note that the output at J10 can be commanded to be a time code (see the 'e' command).

1. The pulse output can be specified to occur at UTC or local time. In this case pulse outputs always start at the second's edge (UTC to within ± 150 ns) and terminate at a specified number of milliseconds later. The 'don't care' characters in the definition of the pulse time allow hour, minute, or second values to be ignored. The default pulse output setting is UTC midnight, positive pulse, and 100 ms long. The minimum pulse duration is 1 ms and the maximum pulse duration is 9999 ms.
2. Alternatively, multiple pulses per second can be specified. In this case the period of the pulse stream is specified together with the pulse active duration. The minimum period is 2 ms and the maximum period is 9999 ms. Immediately after receipt of the command the current pulse (if active) is terminated and the first new pulse commences at the start of the next second's edge. If the pulse period (specified in milliseconds) is a sub-multiple or a multiple of seconds, the pulses remain synchronized with 1 PPS. If the contrary is true, the pulses may require multiple seconds before the start of a pulse coincides with 1 PPS. However, they are always strictly related to real-time milliseconds as long as the unit is locked to the GPS.

Remember that if the checksum is omitted in the user command to the GPS4, then the '*' must also be omitted from the end of message so that the GPS4 recognizes that no checksum is available.

Form 1 (pulse output at specified time, local or UTC):

Field	1	2	3	
				\$PRCCG, C, UHHMMSS, +9999*CK<CR><LF>

Form 2 (pulse output with specified period):

Field	1	2	3	
				\$PRCCG, C, P9999, +9998*50<CR><LF>

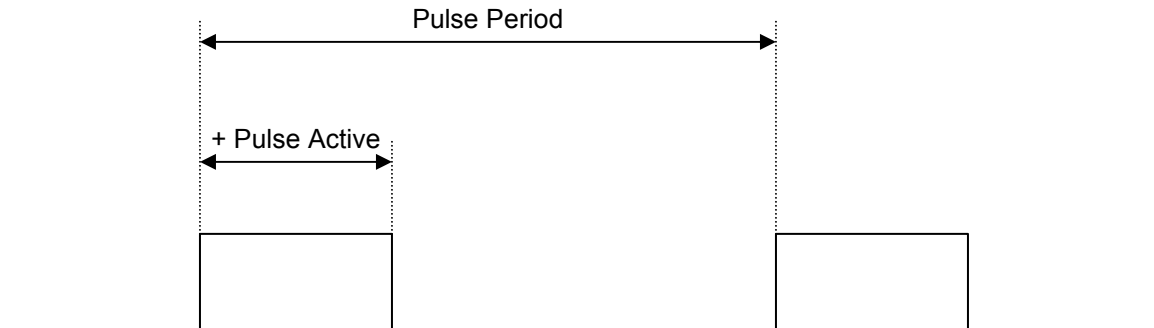
FIELD	CONTENTS OF FIELD
1	Fixed text letter 'C'
2	EITHER 'U' = UTC of the pulse output time and 'L' = local time of the pulse output time. Followed by HHMMSS = hours minutes seconds of the pulse output time. Leading zeros MUST be present in the time field (e.g. 5 hours becomes 05 hours). If HH or MM or SS are to be ignored, then XX is transmitted (where X = ASCII code 58 hexadecimal). OR 'P' = specifies the period (in ms) in the following number 2 to 9999.
3	'+' = pulse output when active is +5V from 50R and when inactive is 0V from 50R. '-' = pulse output when active is 0V from 50R and when inactive is +5V from 50R.
9999	From 1 to 4 digits (leading zeros NOT required) it defines the pulse length in milliseconds.

Note that the GPS4 responds to the pulse setting command by echoing the message recomputed from the values originally transmitted by the user after they have been decoded for use by the GPS4 and its own checksum is added to its message output. Illegal commands are ignored except when the pulse length is commanded to be greater than the pulse period, in which case the pulse length is reset to 1 ms.

Five examples of the pulse commands and responses are given below when the UTC or Local time is specified.

1. \$PRCCG, C, L202500, +100*79<CR><LF>
The pulse output commences at 20 hours 25 minutes 00 seconds local time and is active at +5V for 100 milliseconds.
2. \$PRCCG, C, UXXXXXX, +1*65<CR><LF>
The pulse output commences once per second and is active at +5V for 1 millisecond.
3. \$PRCCG, C, UXXXX10, -500*66<CR><LF>
The pulse output commences once per minute at 10 seconds past the minute and is active at 0V for 500 milliseconds.
4. \$PRCCG, C, UXX0000, +500*61<CR><LF>
The pulse output commences once per hour at 00 seconds past the minute and is active at +5V for 500 milliseconds.
5. \$PRCCG, C, UXX00XX, +500*61<CR><LF>
The pulse output commences once per second at 00 minutes past the hour for one minute (until minute changes to 01) and is active at +5V for 500 milliseconds.

Four examples of the pulse commands and responses are given below when the period of the pulse is specified instead of the UTC or Local time.



The pulse period may be a minimum of 2 ms to a maximum of 9999 ms. The pulse width is a minimum of 1 ms to a maximum of 9998 ms. If the pulse length command requests a length greater than the period, it is automatically reset to 1 ms.

1. \$PRCCG, C, P1000, +500*65<CR><LF>
The pulse output has a period of 1000 ms and is active high for 500 milliseconds. This is a square wave at 1 Hz with the positive edge commencing at the second's edge. It will remain synchronized.
2. \$PRCCG, C, P2, +1*52<CR><LF>
The pulse output has a period of 2 ms and is active high for 1 millisecond. This is a square wave at 500 Hz with the positive edges remaining synchronized with the seconds' edges because the period of 2 ms is a sub-multiple of 1 second.
3. \$PRCCG, C, P2, -1*54<CR><LF>
The pulse output has a period of 2 ms and is active high for 1 millisecond. This is a square wave at 500 Hz with the negative edges remaining synchronized with the seconds' edges because the period of 2 ms is a sub-multiple of 1 second and a negative pulse is specified.
4. \$PRCCG, C, P9999, +9998*50<CR><LF>
The pulse period is 9999 ms and the pulse output is high for 9998 ms. The output is high except for the 1 ms at the end of the pulse. The period is not a multiple of 1 Hz. The output goes high for the first time at the 1 Hz edge following the receipt of the command. The next pulse starts 1 ms before 10 seconds has elapsed. 9999 seconds must pass before the pulse commences again at a second's edge.

4.5.3 Dilution of Precision Values and Satellites Used

Requested by d<CR><LF>

Field

1 2 3 4 5 6 7 8 9 10 11...15 16 17
\$GPGSA, A, 1, NN, NN, NN, NN, NN, NN, NN, NN,...,PP.PP, HH.HH, VV.VV*CK<CR><LF>

FIELD	CONTENTS OF FIELD	
1	"A" or "M"	Operational Modes: "M" = 2-D mode only "A" = 2-D/3-D auto-switching mode
2	"1" to "3"	Positioning Status: "1" = positioning interrupted "2" = 2-D positioning "3" = 3-D positioning
3 – 14	NN	Satellite numbers 01 to 32 used for positioning. Note a null field is outputted unless a satellite is available.
15	PP.PP	PDOP (combined DOP). Note "00.00" is outputted unless 3-D positioning is performed.
16	HH.HH	HDOP (horizontal DOP). Note "00.00" is outputted while positioning is interrupted.
17	VV.VV	VDOP (vertical DOP). Note "00.00" is outputted unless 3-D positioning is performed.

Example Message

\$GPGSA, A, 3, 03, 15, 17, 19, 21, 22, 23, 27,...,01.96, 01.05, 01.66*37<CR><LF>

4.5.4 Time Code and Serial Data Output Formats

Requested by e<CR><LF>

Sending the single letter 'e' followed by <CR><LF> requests a message from the GPS4 that describes its time code outputs and serial data formats. The same message format transmitted to the GPS4 can be used to set the time code and serial data formats. The pulsed output is reported only. You must use the 'c' command to define the pulsed output requirement in terms of UTC/Local time pulses or period defined pulses. In each case the pulse length is also required.

Please note that field 4 is reserved to allow for future definition of different formats from TxD1. TxD1 is fixed as a serial type 2 requested time message.

Field 1 2 3 4 5
\$PRCCG, E, X, X, X, X*CK<CR><LF>

FIELD	CONTENTS OF FIELD	
1	E	Fixed letter 'E' identifies the command
2	0 to 4 or X	Time code 1 type
	0	None – 1 kHz sine wave carrier at maximum level only
	1	IRIG B – 1 kHz modulated carrier
	2	XR3/2137 – 1 kHz modulated carrier
	3	VELA – 1 kHz modulated carrier
	4	NASA36 – 1 kHz modulated carrier
	X	DO NOT CHANGE THE CURRENT OUTPUT SELECTION
3	0 to 3 or X	Pulsed output type
	0	None
	1	Digital time code (0 to 5V from 50R) as time code 1 above
	2	UTC/Local time defined pulse output – set by 'c' command only
	3	Period defined multi-pulse output – set by 'c' command only
4	X	DO NOT CHANGE THE CURRENT OUTPUT SELECTION
	1 to 3 or X	Reserved for TxD1 serial data format selection (not in use)
5	1 to 3 or X	TxD2 automatic or requested serial data output format selection (J12)
	1	Type 1 format 20:34:45 31/05/01 151 4
	2	Type 2 format 20:34:45.678 31/05/01 151 4
	3	GPS4 format 2001, 151:20:34:45, 3, 1
		At power on, TxD2 automatically transmits the selected time message once per second. On receipt of a lower case 't' TxD1 outputs the time at which 't' was received in the currently selected format above and then becomes a request port only transmitting the time message on receipt of 't' from the user. The user must send 'r' to turn on the automatic output of the time message at a one per second rate.

Message Examples

\$PRCCG, E, 1, 1, 1, 1*2C<CR><LF>	TC1 modulated time code output is IRIG B (1 kHz carrier). TC2 pulse output is IRIG B (0 and 5V from 50R). TxD1 is type 2 serial data requested only (this output is not currently changed by the command). TxD2 is type 1 format data that automatically outputs once per second until 't' request when it becomes requested, only until 'r' is received. 't' and 'r' do not require <CR><LF> termination.
\$PRCCG, E, 2, 1, 1, 1*2F<CR><LF>	TC1 modulated time code output is XR3/2137 (1 kHz carrier). TC2 pulse output is XR3/2137 (0 and 5V from 50R). TxD1 is type 2 serial data requested only (this output is not currently changed by the command). TxD2 is type 1 format data that automatically outputs once per second until 't' request when it becomes requested, only until 'r' is received. 't' and 'r' do not require <CR><LF> termination.
\$PRCCG, E, 1, 1, 1, 1*2C<CR><LF>	TC1 modulated time code output is IRIG B (1 kHz carrier). TC2 pulse output is IRIG B (0 and 5V from 50R). TxD1 is type 2 serial data requested only (this output is not currently changed by the command). TxD2 is type 1 format data that automatically outputs once per second until 't' request when it becomes requested, only until 'r' is received. 't' and 'r' do not require <CR><LF> termination.
\$PRCCG, E, 4, 1, 1, 1*29<CR><LF>	TC1 modulated time code output is NASA36 (1 kHz carrier). TC2 pulse output is NASA36 (0 and 5V from 50R). TxD1 is type 2 serial data requested only (this output is not currently changed by the command). TxD2 is type 1 format data that automatically outputs once per second until 't' request when it becomes requested only until 'r' is received. 't' and 'r' do not require <CR><LF> termination.
\$PRCCG, E, 1, 1, 1, 2*29<CR><LF>	TC1 modulated time code output is IRIG B (1 kHz carrier). TC2 pulse output is IRIG B (0 and 5V from 50R). TxD1 is type 2 serial data requested only (this output is not currently changed by the command). TxD2 is type 2 format data that automatically outputs once per second until 't' request when it becomes requested, only until 'r' is received. 't' and 'r' do not require <CR><LF> termination.



To change TC2 to a timed pulse output, the 'c' command must be used because the specification of pulse time or period and pulse duration is required. For example, make the TC2 output a 1 ms positive pulse with a 2 ms period (500Hz, +ve edge on time).

\$PRCCG, C, P2, +1*52<CR><LF>

Send e<CR><LF> to query the output setup as shown below.

\$PRCCG, E, 1, 3, 1, 2*2D	TC1 modulated time code output is IRIG B (1 kHz carrier). TC2 pulse output is a pulse with period specification. TxD1 is type 2 serial data requested only (this output is not currently changed by the command). TxD2 is type 2 format data that automatically outputs once per second until 't' request when it becomes requested, only until 'r' is received. 't' and 'r' do not require <CR><LF> termination.
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4.5.5 Frequency and Phase Controller Data

Requested by f<CR><LF>

Field 1 2 3 4 5 6 7 8 9 10 11 12
\$PRCCG, F, +XXX, +XXX, +XXX, +XXXXX, +X.XE-XX, +X.XXEXX, DDDHHMMSS, +XX.X, XX, XX, XX*CK<CR><LF>

The field lengths shown below are typical, but not fixed (leading zeros or spaces are not necessarily transmitted).

FIELD	CONTENTS OF FIELD	DESCRIPTION	RANGE
1	F	Fixed text "F" identifies the message type	ASCII 'F'
2	+XXX	Instantaneous phase (ns) (signed decimal integer)	-499999999 to +500000000 Typically +0 2 characters to 10 characters
3	+XXX	Phase controller value (ns) (signed decimal integer)	Will always be '+0' in GPS4 controller output 2 characters
4	+XXX	Average phase (ns) (signed decimal integer)	-32768 to +32767 Minimum 2 characters Limited to 5 characters Sign replaced by '%' if out of range
5	+XXXXX	Frequency controller value (signed decimal integer +0 = nominal center)	-32768 to +32767 2 characters to 6 characters
6	+X.XE-XX	Last frequency controller correction (decimal scientific notation)	1.0E-8 to 0.00E-14 7 characters to 9 characters
7	+X.XXE-XX	Frequency trend (decimal scientific notation)	±1.0E-8 to ±0.00E-14 7 characters to 9 characters
8	DDD:HH:MM:SS	UTC at last correction (day of year, hours, minutes, and seconds)	Fixed 12 characters
9	+XX.X	Reserved for temperature in degrees Celsius (not used in GPS4 controller, which outputs +69.4)	+0.0 is 4 characters +69.9 is 5 characters
10	XX	Status of phase and frequency controller (00 to FF)	Fixed 2 ASCII hexadecimal characters
11	XX	PLL constraint ("TCSW") and status	Fixed 2 ASCII hexadecimal characters
12	XX	Oscillator type (00 to FF)	Fixed 2 ASCII hexadecimal characters

Message Example

\$PRCCG, F, -450, -382, +0, -2186, +3.0E-13, +1.14E-10, 144:09:54:00, +69.4, 60, 03, 03*3B<CR><LF>

Instantaneous Phase

The instantaneous phase measurement between the 1 PPS recovered from the satellite receiver and the 1 PPS generated by the internal precision oscillator is reported in nanoseconds. The measurement resolution is 50 ns and the maximum value is limited to $\frac{1}{2}$ second (beyond this, the value is converted by the calculation of the [1 second phase] and the sign is reversed). A positive sign always means that the phase of the 1 PPS derived from the local oscillator and the output to the user is ahead of the satellite receiver 1 PPS. Similarly a negative sign means that the unit output 1 PPS is behind the satellite receiver 1 PPS. The instantaneous phase value is outputted even when the satellite receiver 1 PPS signal is known to be invalid.

Average Phase

The average phase is the mean value of the instantaneous phase readings that have been accepted. The resolution of this output is 1 nanosecond. Occasionally the instantaneous phase readings can be rejected by the GPS4 (these readings are not included in the average) for several reasons. The reasons are listed below.

- Corrupt satellite data
- Out of limit phase measurement

Phase Controller Value

The current value of the phase controller is used to adjust the local 1 PPS to UTC. In the GPS4 this phase control value is always set to zero because following initialization the 1 PPS is maintained in phase with the satellite 1 PPS by the frequency control. If a large 1 PPS phase offset is detected for any reason (e.g. after a long period in holdover), values from 6 μ s to 20 ms are removed by phase stepping the output 1 PPS in 400 ns steps. An error larger than 20 ms is corrected by resynchronization.

Frequency Controller Value

The frequency controller value is the decimal value for the 16 bit DAC used for controlling the frequency of the internal oscillator. The oscillator is initially factory calibrated with a center control value stored in EEPROM. This value is transmitted to the DAC after switch on. As the oscillator gradually ages this value increases or decreases to maintain the correct output frequency. The maximum range of the DAC is ± 32767 counts where a positive increase indicates an increase in oscillator frequency.

At switch on the GPS4 frequency control system starts with a fast time constant to achieve frequency correction of the oscillator in the shortest possible time. This process causes some rapid frequency changes while the oscillator is coarsely adjusted via the DAC. When sufficient measurements and a control history have been accumulated in memory and processed, a medium time constant is implemented resulting in smaller and less frequent corrections to the local oscillator. Finally, after more extensive measurements and control data have been stored and processed, the slow time constant is implemented resulting in optimum frequency control strategy and hence accuracy of the internal oscillator.

The time taken to change from FAST to MEDIUM to SLOW depends on several parameters such as oscillator stability, satellite reception, and temperature changes. Typical values are $\frac{1}{2}$ hour to MEDIUM and 1.9 hours to SLOW for a high stability crystal ovened oscillator. Typical values are 2.2 hours to MEDIUM and 9 hours to SLOW for a standard rubidium oscillator.

OSCILLATOR TYPE	WARM UP TIME	TIME IN FAST	TIME IN MEDIUM
OCXO	5 minutes	10 minutes	52 minutes
High Stability	5 minutes	30 minutes	1.9 hours
Rb_2	10 minutes	2.2 hours	9 hours

Last Frequency Controller Correction

The value of the last frequency correction is applied by the 16 bit DAC. When the unit has found its average position and the oscillator has overcome the high value of aging experienced in the first few days after switch on, this value will usually be either zero or the lowest possible frequency increment (e.g. $3E-13$ for XTAL_1). The GPS4 controller algorithm works to keep each correction step magnitude below the short term noise level of the oscillator type fitted such that the correction action does not degrade the short term stability of the oscillator which is better than can be recovered from the GPS.

Frequency Trend

The frequency trend is the movement in the average phase over a specified measurement period. The measurement period is dependent on the oscillator option fitted and the time elapsed since start up. For example, for a general purpose ovened oscillator the period starts at 1 second and after ten samples of 1 second it increases to 10 seconds and after ten samples it increases to 100 seconds at which point the measurement resolution is 1×10^{-11} . The sample intervals and measurement periods for four oscillator options are shown below.

OSCILLATOR TYPE	SAMPLE INTERVAL	MEASUREMENT PERIOD	FREQUENCY MEASUREMENT RESOLUTION
TCXO	1 second	1 second 10 seconds 100 seconds	1E-9 1E-10 1E-11
XTAL_2 (General Purpose)	1 second	1 second 10 seconds 100 seconds	1E-9 1E-10 1E-11
XTAL_1 (Medium Performance)	10 seconds	10 seconds 100 seconds 1000 seconds	1E-10 1E-11 1E-12
Rb_1 (High Performance)	100 seconds	100 seconds 1000 seconds 10000 seconds	1E-11 1E-12 1E-13

Phase readings are stored at every sample interval and the value transmitted is updated at this point even when the measurement period is 1000 seconds. This output gives the user a continuous and uninterrupted general indication of the frequency accuracy of the internal disciplined oscillator.

UTC at Last Correction

The time at which the last frequency controller correction was applied is outputted in the format shown above.

Status of the Phase and Frequency Controller

Two ASCII hexadecimal characters indicate the status of the controller, where '1' represents the described status in the table below.

msb		lsb	msb		lsb		
PLL Limit	Reject PLL Data	/TMV Not Time Mark Valid	Reject Phase (HW Limit)	Reject Phase (Noise)	Rb Status Cold	Medium	Slow

PLL Constraint

The PLL constraint consists of two ASCII hexadecimal characters. Each character represents 4 bits of status, where '1' represents the described status below.

msb			lsb	msb			lsb
PLL Control 'TCSW' Bit 3	PLL Control 'TCSW' Bit 2	PLL Control 'TCSW' Bit 1	PLL Control 'TCSW' Bit 0	Valid Time	RJ Code	Output or Synthesizer Fault	Frequency Control Fault

The PLL control represents the user's test command on a constraint called 'TCSW', which has been applied to the frequency disciplining section. The values are shown in the table below.

PLL CONTROL 'TCSW'	PLL CONSTRAINT
'0'	No constraint because standard 3 time constant loop is running.
'1'	PLL is commanded to only 'fast' control.
'2'	PLL loop is open with the EFC set for center frequency.
'3'	PLL loop is open with the EFC frozen at its last setting.
'4'	PLL loop is open with the EFC set to the maximum.
'5'	PLL loop is open with the EFC set to the minimum.

STATUS	DESCRIPTION
Valid Time	The valid time is set to 1 when the GPS4 has synchronized to the satellite receiver. It is reset to 0 if 8 hours elapsed without satellite reception or the user re-enters time from the keypad, until the GPS4 has resynchronized to the GPS time. It is reset to 0 if 15 consecutive 1 PPS recovered time pulses are outside the allocated phase limit. It is reset to 0 if a frequency error is detected.
Reject Code	The reject code is set to 1 at power on and when the satellite receiver time recovery data is marked not valid, is late, or inconsistent. During this condition the GPS4 is outputting back up time not verified by comparison with the GPS data.
Output or Synthesizer Fault	The output or synthesizer fault is set to 1 if any or up to 10 output failures have been detected or the E1/T1 synthesizer is not locked. Each of the 10 outputs is monitored for amplitude and a failure results in this bit being set. The associated indicator LED for the output will be turned OFF. If the E1/T1 synthesizer is faulty, a red LED indicator is turned on.
Frequency Control Fault	The frequency control fault is set to 1 if the frequency controller is unable to set the oscillator frequency to track the reference frequency from the GPS receiver.



The oscillator type consists of two ASCII hexadecimal characters. Each character represents 4 bits of status, where '1' represents the described status below.

msb		lsb	msb	lsb			
Reserved	Reserved	Reserved	Reserved	Oscillator Type Bit 3	Oscillator Type Bit 2	Oscillator Type Bit 1	Oscillator Type Bit 0

The oscillator type is determined by a parameter stored in the EEPROM. Refer to the table below.

EEPROM CODE				
00	High grade rubidium/cesium	positive	LPFRS opt A	48 hours
01 TO 07	RESERVED			
08	Standard grade plain XTAL	positive		
09	Brandywine High Stability OCXO (SC)	positive		9 hours



4.5.6 Health Status of Satellites

Requested by h<CR><LF>

Field 1 2 3
\$PFEC, GPanc, YYMMDDhhmmss, XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX*CK<CR><LF>

FIELD	CONTENTS OF FIELD	
1	GPanc	Fixed text identifier
2	YYMMDDhhmmss	Almanac with date and time, where YY = year, MM = month, DD = day of the month, hh = hours, mm = minutes, and ss = seconds
3	X	32 columns containing the status of satellites PRN 1 – 32, where the status is as follows:
		“0” = almanac not collected or satellite not launched yet
		“1” = unhealthy (not used for positioning and timing)
		“2” = healthy (used for positioning and timing)

Example Response

\$PFEC, GPanc, 990524095412, 2222222222002222222022222202220*4D<CR><LF>

4.5.7 Leap Second Information

Requested by j<CR><LF>

```
Field      1 2                3 4
$PRCCG, J, YYMMDDhhmmss, +1, dd*CK<CR><LF>
```

FIELD		CONTENTS OF FIELD
1	J	Fixed text identifier "J".
2	YYMMDDhhmmss	Leap second date, where YY = year, MM = month, DD = day of the month, hh = hours, mm = minutes, and ss = seconds.
	000000000000	The leap second date information has not been acquired.
		Usually a GPS satellite announces the date, time, and value for the leap second adjustment repeatedly for two to six months before the adjustment is actually executed. After the adjustment has been made the announcement is continued for some period of time. In this period of post-execution announcement, if the pre-execution announcement was not received, the leap second field 3 below is filled with 00 because it is no longer available from the satellites.
3	+1	Leap second to be inserted at the leap second date.
	-1	Leap second to be deleted at leap second date.
	00	Leap second date has passed or the parameter is not yet available.
4	SS	The GPS-UTC seconds offset.
	00	The GPS-UTC value has not yet been acquired.
		This field accumulates leap seconds since the GPS system started operation on January 6 th 1980. As of April 2001 this value is 13.

Example Response

Field	1	2	3	4
	\$PRCCG, J,	9901010000,	+1,	13*CK<CR><LF>

4.5.8 Location and Signal-Noise Ratio of Satellites

Requested by I<CR><LF>

Please note that the response to the I request contains a maximum of three records.

Field 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
\$GPGSV, N, n, NN, SS, XX, XXX, XX, SS, XX, XXX, XX, SS, XX, XXX, XX, SS, XX, XXX, XX*CK<CR><LF>

FIELD	CONTENTS OF FIELD	
1	N	The number of messages (1 to 3)
2	n	The number of this message
3	NN	The number of satellites in line-of-site (with elevation > 5 degrees only and 00 to 12)
4	SS	1 st satellite PRN
5	XX	1 st satellite elevation (degree between 05 to 90)
6	XXX	1 st satellite azimuth (degree between 000 to 359)
7	XX	1 st satellite signal to noise ratio (dB Hz 00 to 99)
08 – 11		2 nd satellite details
12 – 15		3 rd satellite details
16 – 19		4 th satellite details

Example Messages

\$GPGSV, 2, 1, 07, 03, 41, 270, 51, 06, 18, 083, 33, 17, 64, 083, 49, 19, 09, 329, 45*74

\$GPGSV, 2, 2, 07, 22, 74, 208, 48, 23, 21, 126, 45, 25, 06, 195, 39*4B

CHARACTERISTICS	DESCRIPTION
PRN	Shows the unique identification number of the satellites from 1 to 32.
ELV	Shows the elevation of each satellite in degrees.
AZ	Shows the azimuth of each satellite in degrees.
S/N	Shows the signal to noise ratio of each satellite in dB, where a ratio below 40 is poor, 40 - 46 is average, and above 46 is good. The signal to noise ratio is a relative value for a single receiver and may not be the same for two receivers operating in identical conditions.



4.5.9 Firmware Version Number

Requested by n<CR><LF>

Field 1 2 3 4
\$PRCCG, N, nnn, pppppppp-vvv, t*CK<CR><LF>

FIELD	CONTENTS OF FIELD
1	Fixed text letter "N".
2	3 digit decimal firmware serial number with leading zeros included.
3	7 digit engine program and 3 digit version number.
4	Test result.

For example, if the firmware version is EGPS13 and the engine is 4850102 with version number 009, the format would be as follows:

\$PRCCG, N, 013, 4850102-009, 1*CK<CR><LF>

The firmware resides in both flash memory and EPROM. If the flash memory has been reprogrammed, the current version may be a higher number than is written by the label on the EPROM. It is possible to revert to the EPROM firmware by fitting the jumper at LK1. If reprogramming of the flash memory is to be undertaken, LK1 must be open.

4.5.10 Offset of Local Time Data and Command

Requested by o<CR><LF>

The local time parameters as listed below are reported by the GPS4 in response to the single character o<CR><LF> request. The same format is used in a user command transmitted to the GPS4 to set the local time parameters, which are stored in non-volatile RAM. The message format must be exactly as shown below including the colon and dummy data for the minutes offset (which is not used). Remember that if the checksum is to be omitted, the '*' must be omitted from the end of message so that the GPS4 recognizes that no checksum is available.

Note that the pulse output time (see the 'c' response and associated command) has its own local time and UTC switch, which is independent of the 'o' command local time and UTC switch for time and time code outputs. However, the sign and number of the hours offset of local time is programmed by the 'o' command alone. The user can set the GPS4 time code output to UTC, but generate pulse outputs which follow local time.

Field 1 2 3
\$PRCCG, O, U, +HH:00*CK<CR><LF>

FIELD	CONTENTS OF FIELD
1	Fixed text letter "O"
2	'U' = time and time code outputs are UTC 'L' = time and time code outputs are local time
3	'+' = adds the following hours offset to UTC to obtain the local time '-' = subtract the following hours offset from UTC to obtain the local time HH = number of hours offset (must have a leading zero if < 10 hours or two zeros if the value is zero). The maximum offset is + or – 23 hours :00 = hours and minutes separator and data reserved for minutes offset



Example Commands

\$PRCCG, O, L, +01:00*7A<CR><LF>

The time code output and the time returned in response to the 't' time request is local time. Local time is UTC with an hour added. The count of offset time rolls over through days to years if required.

\$PRCCG, O, L, -23:00*7C<CR><LF>

The time code output and the time returned in response to the 't' time request is local time. Local time is UTC with 23 hours subtracted. The count of offset time borrows from days through to years if required.

When a command has been accepted by the GPS4 the message is echoed, but the contents of the response are recalculated from the data used by the GPS4 to implement the user request. A checksum is always returned.



4.5.11 Position of GPS Antenna

Requested by p<CR><LF>

Field 1 2 3 4 5 6 7 8 9 10 11 12 13 14
 \$GPGGA, hhmmss, DDMM.MMMM, N, DDDMM.DDDD, E, s, NN, 00.00, AAAAAA.A, M, GGGG.G, M,,,*CK<CR><LF>

FIELD	CONTENTS OF FIELD	
1	hhmmss	Time (UTC) of position update
2	DDMM.MMMM	Latitude(degrees, minutes, and decimal fraction of minutes)
3	N	"N" = north and "S" = south
4	DDDMM.MMMM	Longitude
5	W	"W" = west and "E" = east
6	Status	"0" = positioning not operational (or KNOWN position) "1" = positioning operational "2" = differential positioning
7	NN	Number of satellites used for positioning
8	DOP	DOP (2-D: HDOP and 3-D: PDOP)
9	Altitude	AAAAAA.A (-00999.9 to 017999.9)
10	M	Unit for altitude (M = meters)
11	GGGG.G	Geoid altitude (-999.9 to 9999.9)
12	M	Unit for geoid altitude (M = meters)
13	Null field	Reserved for DGPS data (time elapsed since last RTCM-SC104 data updating)
14	Null field	Reserved for DGPS station identification

Example Response

\$GPGGA, 095427, 5147.1358, N, 00049.8371, E, 1, 06, 01.71, 000026.0, M, 0046.3, M,,,*73



4.5.12 Software Reset Command

The unit can be reset using the NMEA style command \$PRCCG, Z, 0*2F<CR><LF>. It is unnecessary, but recommended that the checksum be included at the end of this message. The value is always '2F' because the content of the command is fixed. The message must contain the correct header, right number of characters, 'Z', '0', and the correct checksum. The '0' is the number of zeros (ASCII code 30 hexadecimal) and it describes the type of reset. If the message corresponds correctly to the reset command and the checksum is valid, the GPS4 returns the message as an acknowledgment, waits 160 ms, and restarts the initialization as though the unit had just been switched on. The initialization messages are outputted as each stage is completed. Note that there is a pause of about 5 seconds after the reset (a decimal point is outputted as each second passes) in which downloading new firmware to the GPS4 flash memory could be initiated.



4.5.13 Additional Information

Requested by s<CR><LF>

Field 1 2 3 4 5 6 7 8 9 10 11
 \$GPRMC, hhmmss, A, DDMM.MMMM, N, DDDMM.DDDD, E, 000.0, 000.0, DDMMYY, MMM.M, W*CK<CR><LF>

FIELD	CONTENTS OF FIELD	
1	hhmmss	Time (UTC) of the position update
2	A or V	A = positioning V = positioning interrupted or KNOWN position
3	DDMM.MMMM	Latitude(degrees, minutes, and decimal fraction of minutes)
4	N	"N" = north and "S" = south
5	DDDMM.MMMM	Longitude (degrees, minutes, and decimal fraction of minutes)
6	W	"W" = west and "E" = east
7	Speed	Speed in knots (000.0 to 999.9)
8	True Course	True course in degrees (000.0 to 359.9)
9	DDMMYY	UTC date as the day, month, and year (1994 to 2040)
10	MMM.M	Magnetic deviation in degrees (000.0 to 180.0)
11	W	"W" (MAG = TRUE - DEV) or "E" (MAG = TRUE + DEV)

Example Response

\$GPRMC, 095431, A, 5147.1362, N, 00049.8371, E, 000.3, 005.7, 240599, 003.1, W*6F

4.5.14 Request Precision Time

Requested by t<CR><LF>

The purpose of this request is to capture time for data logging, time tagging, and etcetera. This message takes priority over other messages that will be inhibited while 't' is active. Therefore, if a message is already being transmitted, use of the 't' request may cause a disjointed message when the high priority output is immediately transmitted. The time in the message reflects the instant the stop bit of 't' was received and is advanced by 1 ms to compensate for a typical character delay. If the serial port is busy when a request is received, it will be ignored. The maximum request rate will depend on the baud rate. For example, at 4800 baud the serial port can transmit about ten messages per second. The format of the message is "Type 2".

Type 2 Format

Field 1 2 3 4 5
 HH:MM:SS.SSS DD/MN/YY NNN W S<CR><LF>

FIELD	CONTENTS OF FIELD
1	Hours, minutes, seconds, and milliseconds (UTC)
2	Day of the month, month, and year
3	Day of the year (January 1 = 001)
4	Day of the week (Monday = 1 and Sunday = 7)
5	Status

The status character is an ASCII representation of a hexadecimal figure from 0 to F (see section 3.3), where the bits are allocated as follows.

BIT 3 (MSB)	BIT 2	BIT 1	BIT 0 (LSB)
Valid Time	Reject Code	Local Time	Leap Year

BIT ALLOCATION	DESCRIPTION
Valid Time	The valid time is set to 1 when the GPS4 has synchronized to the satellite receiver. It is reset to 0 if 8 hours elapsed without satellite reception or after the user re-enters time from the keypad, until the GPS 8000 has resynchronized to the GPS time. It is reset to 0 if 15 consecutive 1 PPS recovered time pulses are outside the allocated phase limit. It is reset to 0 if a frequency error is detected.
Reject Code	The reject code is set to 1 at power on and when the satellite receiver time recovery data is marked not valid, late, or inconsistent. During this condition the GPS4 is outputting backup time not verified by comparison with the GPS data. It is quite normal for the occasional 'Reject Code' indication to be seen.
Local Time	The local time is set to 1 for local time. It is reset to 0 for UTC time.
Leap Year	The leap year is a year divisible by 4, including the century if it is also divisible by 4 (e.g. 2000 but not 2100).



Example Message (Fixed Format 31 Characters Including Spaces)

The example message below is seen when a request is made thirty four minutes, three seconds, and 123 milliseconds past eight in the evening on Tuesday the 15th. Furthermore, the GPS Synchronized Master Clock is reporting valid time, the GPS is locked, and UTC is in a leap year.

20:34:03.123 17/03/88 077 2 9<CR><LF>

The status character '9' is indicating the following seen below.

BIT 3 (MSB)	BIT 2	BIT 1	BIT 0 (LSB)
1	0	0	1
Valid Time	Synchronized Last Second (no reject code)	UTC	Year is a leap year.

4.6 TxD2/RxD2 Messages

The GPS4 second serial output is configured to output serial data in the user's chosen format automatically after initialization. The format selection can be changed by entering a simple command into the TxD1/RxD1 command port. The three formats are shown below. Other customer specific outputs and protocols are available. **The baud rate and character format are fixed as described above (19200, 8, N, and 1).**

To request data from the port, the user sends the character 't' to request the time. The port sends a message reporting the time at which 't' was received and the automatic 1 per second output stops. No further output is transmitted until another request 't' is received. To restore the automatic 1 per second output, the user must send 'r' to the port.

Type 1 Format

Field 1 2 3 4
HH:MM:SS DD/MM/YY NNN W<CR><LF>

FIELD	CONTENTS OF FIELD
1	Hours, minutes, and seconds (UTC)
2	Day of the month, month, and year
3	Day of the year (January 1 = 001)
4	Day of the week (Monday = 1 and Sunday = 7)

An example message (fixed format 25 characters including spaces and termination) is given below.

20:34:03 08/11/91 312 5<CR><LF>

Type 2 Format

The second port responds with an identical format to that described for TxD1/RxD1. Both ports can be polled rapidly and asynchronously to report the time to independent users.

Type 3 Format (GPS4 Format)

Field 1 2 3 4
 YYYY, DDD:HH:MM:SS, T, S<CR><LF>

FIELD	CONTENTS OF FIELD
1	Year (UTC)
2	Day of the year (January 1 = 001), hours, minutes, and seconds
3	TFOM
4	Status of the time

An example message (fixed format 23 characters including commas and termination) is given below.

2001, 156:15:17:43, 3, 1<CR><LF>

Please note that TFOM refers to the Time Figure of Merit and S refers to the Status.

TFOM	DESCRIPTION
9	10 ms < PPS
8	1 ms < PPS ≤ 10 ms
7	100 μs < PPS ≤ 1 ms
6	10 μs < PPS ≤ 100 μs
5	1 μs < PPS ≤ 100 ns
4	100 ns < PPS ≤ 1 μs
3	PPS ≤ 100 ns

STATUS S	DESCRIPTION
0	Coasting
1	Time locked
2	Holdover
3	Recovery
4	Power up

4.7 IRIG B and AFNOR NF 2 87-500 Time Code Output

IRIG B/AFNOR NF 2 87-500 time code is generated as a standard by the GPS4. This time code consists of a 1 kHz carrier which is modulated in the pattern described below. The carrier and time code is synchronized precisely to the GPS time by the GPS4.

SPECIFICATION	DESCRIPTION
Time	Universal time (UTC)
Time Frame	1.0 second
Code Digit Weighting	BCD and SB as follows:
a	Binary Coded Decimal time of year code word is 30 binary digits. (1) Seconds, minutes, hours, and days (2) Recycles yearly
b	Straight Binary time of day code word is 17 binary digits. (1) Seconds only (2) Recycles every 24 hours
a	BCD: word begins at index count 1. Binary coded elements occur between position identifier elements (7 for seconds, 7 for minutes, 6 for hours, 8 and 2 for days) until the code word is complete. An index marker occurs between decimal digits in each group to provide separation for visual resolution.
b	SB: word begins at index count 80. Five decimal digits (17 binary coded elements) occur with a position identifier between the 9 th and 10 th binary coded elements.
Bit Order	Least significant digit occurs first.
Element Rate	100 per second
Element Identification	
a	"On time" reference point for all elements is the leading edge.
b	Index marker is 2 ms (binary zero or un-coded element).
c	Code digit is 5 ms (binary one).
d	Position identifier - 10 per second for 8 ms (refers to the leading edge of the succeeding element).
e	Reference marker - 1 per second for two consecutive position identifiers.
Resolution	10 ms (un-modulated) or 1 ms (modulated)
Carrier Frequency	1 kHz (modulated)

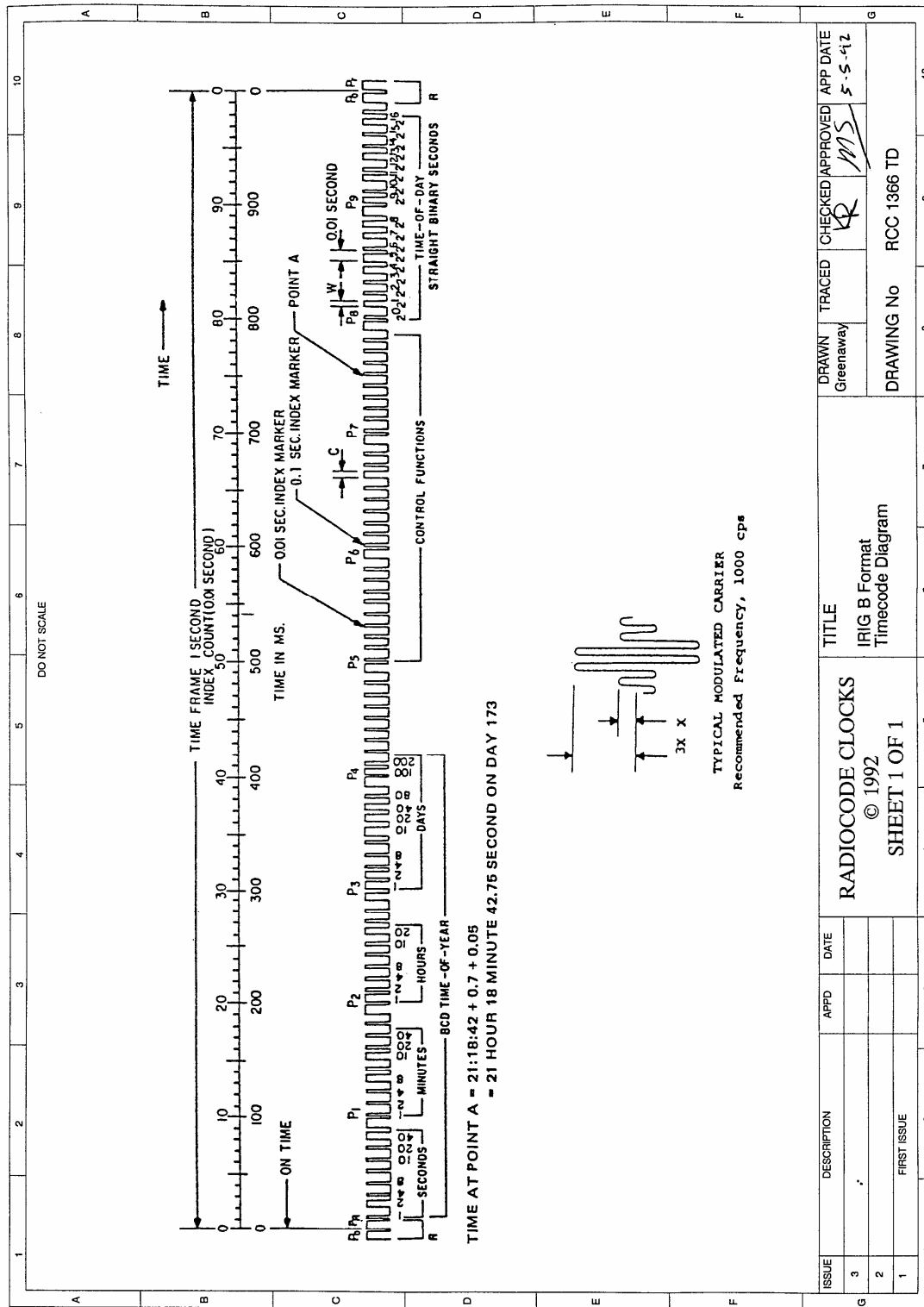
IRIG B Format Specification

The "on time" point to which the code word refers to is the leading edge of the second position identifier.

IRIG B and AFNOR NF 2 87-500 Time Code Bit Allocation

Each time code bit has 10 ms duration therefore it contains 10 cycles of the 1 kHz carrier. In the table below '0' is 2 ms higher level carrier duration, '1' is 5 ms higher level carrier duration, and 'Marker' is 8 ms higher level carrier duration. The standard output level for the higher level carrier (AFNOR specification) is 0 dB into 600R (2.17 Vp-p \pm 10%). The lower level is $\frac{1}{3}$ of the higher level or the higher level – 10 dB. There are 100 bits total in one second with bit 0 (8 ms marker) starting at the second's edge. The GPS4 is normally configured to send the full AFNOR specification time code contents when IRIG B is selected.

BIT	WEIGHT	CODE	BIT	WEIGHT	CODE
00	Marker Pr	IRIG B	50	Year 1	AFNOR
01	Seconds 1	IRIG B	51	Year 2	AFNOR
02	Seconds 2	IRIG B	52	Year 3	AFNOR
03	Seconds 4	IRIG B	53	Year 4	AFNOR
04	Seconds 8	IRIG B	54	Always 0	IRIG B
05	Always 0	IRIG B	55	Year 10	AFNOR
06	Seconds 10	IRIG B	56	Year 20	AFNOR
07	Seconds 20	IRIG B	57	Year 40	AFNOR
08	Seconds 40	IRIG B	58	Year 80	AFNOR
09	Marker P1	IRIG B	59	Marker P6	IRIG B
10	Minutes 1	IRIG B	60	Month 1	AFNOR
11	Minutes 2	IRIG B	61	Month 2	AFNOR
12	Minutes 4	IRIG B	62	Month 4	AFNOR
13	Minutes 8	IRIG B	63	Month 8	AFNOR
14	Always 0	IRIG B	64	Always 0	IRIG B
15	Minutes 10	IRIG B	65	Month 10	AFNOR
16	Minutes 20	IRIG B	66	Always 0	AFNOR
17	Minutes 40	IRIG B	67	Always 0	AFNOR
18	Always 0	IRIG B	68	Always 0	IRIG B
19	Marker P2	IRIG B	69	Marker P7	IRIG B
20	Hours 1	IRIG B	70	Day of month 1	AFNOR
21	Hours 2	IRIG B	71	Day of month 2	AFNOR
22	Hours 4	IRIG B	72	Day of month 4	AFNOR
23	Hours 8	IRIG B	73	Day of month 8	AFNOR
24	Always 0	IRIG B	74	Always 0	AFNOR
25	Hours 10	IRIG B	75	Day of month 10	AFNOR
26	Hours 20	IRIG B	76	Day of month 20	AFNOR
27	Always 0	IRIG B	77	Always 0	IRIG B
28	Always 0	IRIG B	78	Always 0	IRIG B
29	Marker P3	IRIG B	79	Marker P8	IRIG B
30	Day of year 1	IRIG B	80	Counter clock 2 ⁰	IRIG B
31	Day of year 2	IRIG B	81	Counter clock 2 ¹	IRIG B
32	Day of year 4	IRIG B	82	Counter clock 2 ²	IRIG B
33	Day of year 8	IRIG B	83	Counter clock 2 ³	IRIG B
34	Always 0	IRIG B	84	Counter clock 2 ⁴	IRIG B
35	Day of year 10	IRIG B	85	Counter clock 2 ⁵	IRIG B
36	Day of year 20	IRIG B	86	Counter clock 2 ⁶	IRIG B
37	Day of year 40	IRIG B	87	Counter clock 2 ⁷	IRIG B
38	Day of year 80	IRIG B	88	Counter clock 2 ⁸	IRIG B
39	Marker P4	IRIG B	89	Marker P9	IRIG B
40	Day of year 100	IRIG B	90	Counter clock 2 ⁹	IRIG B
41	Day of year 200	IRIG B	91	Counter clock 2 ¹⁰	IRIG B
42	Always 0	IRIG B	92	Counter clock 2 ¹¹	IRIG B
43	Always 0	IRIG B	93	Counter clock 2 ¹²	IRIG B
44	Day of week 2	AFNOR	94	Counter clock 2 ¹³	IRIG B
45	Day of week 4	AFNOR	95	Counter clock 2 ¹⁴	IRIG B
46	Day of week 8	AFNOR	96	Counter clock 2 ¹⁵	IRIG B
47	Always 0	IRIG B	97	Counter clock 2 ¹⁶	IRIG B
48	Always 0	IRIG B	98	Counter clock 2 ¹⁷	IRIG B
49	Marker P5	IRIG B	99	Marker P0	IRIG B



4.8 NASA36 Time Code Output Option

NASA36 time code must be specified at time of ordering. NASA36 time code operates in a similar manner to IRIG B with the bit allocations described below. 1 kHz is the standard carrier for the NASA36 time code.

SPECIFICATION	DESCRIPTION
Time	Universal time (UTC) or local time
Time Frame	1.0 second
Code Digit Weighting	BCD as follows:
a	Binary Coded Decimal time of year code word is 30 binary digits. (1) Seconds, minutes, hours, and days (2) Recycles yearly
	Word begins at index count 1. Binary coded elements occur between position identifier elements for 600 ms duration every 100 ms from the 100 ms to 900 ms inclusive.
Bit Order	Least significant digit occurs first.
Element Rate	100 per second
Element Identification	
a	"On time" reference point for all elements is the leading edge.
b	Index marker is 2 ms (binary zero or un-coded element).
c	Code digit is 6 ms (binary one).
d	Position identifier - 9 per second for 6 ms (refers to the leading edge of the succeeding element).
e	Reference marker - 1 per second for five consecutive position identifiers followed by a zero.
Resolution	10 ms (un-modulated) or 1 ms (modulated)
Carrier Frequency	1 kHz (modulated)

NASA36 Format Specification

BIT	WEIGHT	BIT	WEIGHT
00	Reference always 0	50	Position identifier
01	Seconds 1	51	Hours 10
02	Seconds 2	52	Hours 20
03	Seconds 4	53	Always 0
04	Seconds 8	54	Always 0
05	Always 0	55	Always 0
06	Always 0	56	Always 0
07	Always 0	57	Always 0
08	Always 0	58	Always 0
09	Always 0	59	Always 0
10	Marker	60	Position identifier
11	Seconds 10	61	Day of year 1
12	Seconds 20	62	Day of year 2
13	Seconds 40	63	Day of year 4
14	Always 0	64	Day of year 8
15	Always 0	65	Always 0
16	Always 0	66	Always 0
17	Always 0	67	Always 0
18	Always 0	68	Always 0
19	Always 0	69	Always 0
20	Position identifier	70	Position identifier
21	Minutes 1	71	Day of year 10
22	Minutes 2	72	Day of year 20
23	Minutes 4	73	Day of year 40
24	Minutes 8	74	Day of year 80
25	Always 0	75	Always 0
26	Always 0	76	Always 0
27	Always 0	77	Always 0
28	Always 0	78	Always 0
29	Always 0	79	Always 0
30	Position identifier	80	Position identifier
31	Minutes 10	81	Day of year 100
32	Minutes 20	82	Day of year 200
33	Minutes 40	83	Day of year 400
34	Always 0	84	Day of year 800
35	Always 0	85	Always 0
36	Always 0	86	Always 0
37	Always 0	87	Always 0
38	Always 0	88	Always 0
39	Always 0	89	Always 0
40	Position identifier	90	Position identifier
41	Hours 1	91	Control functions
42	Hours 2	92	Control functions
43	Hours 4	93	Control functions
44	Hours 8	94	Control functions
45	Always 0	95	Position identifier
46	Always 0	96	Position identifier
47	Always 0	97	Position identifier
48	Always 0	98	Position identifier
49	Always 0	99	Position identifier

NASA36 Bit Allocation

4.9 2137 Time Code Output Option

2137 time code must be specified at time of ordering. 1 kHz is the standard carrier frequency for 2137.

SPECIFICATION	DESCRIPTION
Time	Universal time (UTC)
Time Frame	1.0 second
Code Digit Weighting	BCD: Binary Coded Decimal time of day code word is 20 binary digits. (1) Hours, minutes, and seconds (2) Recycles every 24 hours
Code Word Structure	Word begins during the first 40 ms index count of the current time frame. Binary coded elements occur every 40 ms during the current time frame (6 for hours, 7 for minutes, and 7 for seconds) until the code word is complete. A reference marker occurs during the last 40 ms index count of the current time frame.
Bit Order	Most significant digit occurs first.
Element Rate	25 per second
Element Identification	
a	"On time" reference point for all elements is the leading edge.
b	Index marker is 12 ms (binary zero).
c	Code digit is 24 ms (binary one).
d	Reference marker - 1 per second for 36 ms. The "on time" point to which the code word refers to is the trailing edge of the reference marker.
Resolution	1 ms (1 kHz modulated) 4 ms (250 Hz modulated) 200 ms (un-modulated)
Carrier Frequency	1 kHz or 250 Hz (modulated)

2137 Format Specification

4.10 VELA Time Code Output Option

VELA time code must be specified at time of ordering. The VELA logic level time code output is a positive pulse commencing at the second's edge with a duration of 200, 500, or 800 ms according to the details below.

SECOND	FUNCTION	DURATION		SECOND	FUNCTION	DURATION
0	P0	800 ms		30	P3	800 ms
1	Year 8			31		200 ms
2	Year 4			32	Mins 40	
3	Year 2			33	Mins 20	
4	Year 1			34	Mins 10	
5		200 ms		35	Mins 8	
6		200 ms		36	Mins 4	
7	DOY 200			37	Mins 2	
8	DOY 100			38	Mins 1	
9		200 ms		39		200 ms
10	P1	800 ms		40	P4	800 ms
11	DOY 80			41	MSS 8000	
12	DOY 40			42	MSS 4000	
13	DOY 20			43	MSS 2000	
14	DOY 10			44	MSS 1000	
15	DOY 8			45	MSS 800	
16	DOY 4			46	MSS 400	
17	DOY 2			47	MSS 200	
18	DOY 1			48	MSS 100	
19		200 ms		49		200 ms
20	P2	800 ms		50	P5	800 ms
21		200 ms		51	MSS 80	
22		200 ms		52	MSS 40	
23	Hours 20			53	MSS 20	
24	Hours 10			54	MSS 10	
25	Hours 8			55	MSS 8	
26	Hours 4			56	MSS 4	
27	Hours 2			57	MSS 2	
28	Hours 1			58	MSS 1	
29		200 ms		59	R	800 ms

P0 to P5 and R are 800 ms markers. The durations not shown are 200 ms for a zero weighting or 500 ms for the weight shown. The count MSS is the count of minutes elapsed since the clock has been synchronized. It is set to 9999 at switch on, reset at synchronization and incremented once per minute if the clock is not synchronized. If the counter reaches its maximum, it ceases to count any further. The maximum count of 9999 minutes represents 6.9 days.

5 Maintenance and Calibration

5.1 Scope of Section

Section five describes the recommended maintenance checks for the GPS4 and outlines a general approach to fault finding and repair.

5.2 Routine Maintenance

During normal operation the GPS4 functions automatically and does not require continuous manual intervention. Preventative maintenance can therefore be restricted to a regular inspection of the status indicators.

5.3 Fault Finding



CAUTION:

In the case of equipment malfunction or failure, it is recommended that the GPS4 be returned to the factory for repair. If this is not practical, fault finding and repair must only be undertaken by a qualified test engineer.

Internal fault finding and repair of the GPS4 requires specialized knowledge. Identifying a malfunction to the module level is straightforward if using the self test routines and status indicators. The following table identifies the most likely module responsible for a fault condition.

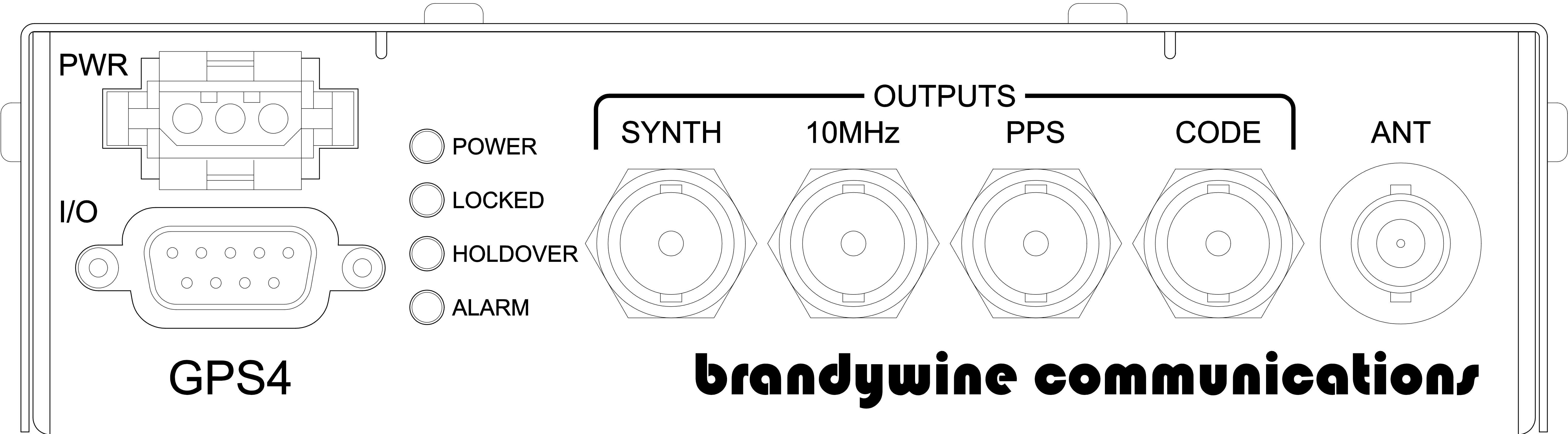
BUILT IN TEST	SUSPECT MODULE
ANT FLT	ANTENNA/RECEIVER
INIT FAIL	MICROCOMPUTER
RCVR FLT	RECEIVER
OSC I/P FLT	INTERNAL OSCILLATOR
FRQ ERR FLT	INTERNAL OSCILLATOR (may require adjustment)
RAM FAIL	MICROCOMPUTER
EFC LIM FLT	INTERNAL OSCILLATOR (may require adjustment)
ROM FAIL	MICROCOMPUTER

A malfunction of the output interfaces will be immediately apparent to the user. A major failure of the power supply will cause a complete loss of functionality. *It should be noted that the unit contains static sensitive devices.*

The precision oscillator installed in the GPS4 may be one of several different types. The oscillator is factory installed and does not require further adjustments. The type is specified by an entry in EEPROM memory.

6 Diagrams

FIGURE	DESCRIPTION
1	GPS4 Front Panel
2	GPS4 Mechanical Outline
3	GPS4 Link Settings Table



THIRD ANGLE PROJECTION

The diagram illustrates the Third Angle Projection of a truncated cone. On the left is the front view, represented by a circle with a smaller concentric circle in the center, indicating the top surface. On the right is the top view, represented by a truncated cone. Horizontal projection lines connect the two views, showing how the geometry is projected from one plane to the other.

				QTY REQ -2	ITEM NO. -1	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL	SPECIFICATION	CODE
				UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		PROG./PROJ	GPS4		brandywine communications 2230 South Fairview, Santa Ana, California 92704	
				DIMENSIONS APPLY AFTER FINISH		DRAWN	Jeff Lind	9/28/04		
				TOLERANCES		ENGINEERING	GHS	SEP 04		
				HOLE DIA±		.XX ±				
				ANGLE±		XXX ±				
				MATERIAL					TITLE OUTLINE DRAWING GPS4	
				FINISH						
				QTY	QTY	NEXT ASSEMBLY	USED ON	SIZE		CAGE CODE
N/A	U/O			D		03NF8	850000043	N/C		
APPLICATION				SURFACE ROUGHNESS		✓				
						SCALE 1/1		DO NOT SCALE DRAWING		
								SHEET 1 OF 1		

LINK	STANDARD BUILD	CONSEQUENCE
PL1	NO FIT	EMULATOR PORT
R90	NO FIT	TXD2- (TOD) RS422 CONNECTION OPEN
R91	NO FIT	TXD2+ (TOD) RS422 CONNECTION OPEN
R92	FIT	TXD2 (TOD) RS232 OUTPUT CONNECTED
R93	NO FIT	RXD1 RS422 INPUT BUFFER OUTPUT CONNECTION OPEN
R94	NO FIT	RXD1+ RS422 CONNECTION OPEN
R95	NO FIT	TXD1- RS422 CONNECTION OPEN
R96	NO FIT	TXD1+ RS422 CONNECTION OPEN
R97	NO FIT	RXD1- RS422 CONNECTION OPEN
R98	FIT	HARDWARE RESET FROM PIN 4 OF SK1 (9 WAY DTYPE) -> RESET
R99	FIT	RXD1 RS232 INPUT FROM PIN 3 SK1 -> RS232 RECEIVER
R100	FIT	TXD1 RS232 OUTPUT FROM PIN 2 SK1
R101	FIT	RXD1 RS232 INPUT BUFFER OUTPUT -> UART
LK1	2-3 FIT	OUTPUT 1 kHz MODULATED CARRIER TIME CODE TC1 (IRIG B)
LK1	1-2	OUTPUT DC LEVEL SHIFT TIME CODE TC2
LK3	OPEN	NO RS422 TERMINATION
LK5	OPEN	NO SiRF ENGINE PROGRAMMING
LK6	2-3 FIT	10 MHz SINEWAVE OUTPUT
LK6	1-2	10 MHz TTL OUTPUT
LK7	OPEN	TEST LINK INTO CPLD OR TEST SIGNALS FROM CPLD
LK8	OPEN	SCREWDRIVER RESET CONTACTS
LK9	1-2	/CS6 STROBES WATCHDOG
LK10	OPEN	RUNS FROM FLASH MEMORY (JUMPER FOR EPROM ONLY)
SK1	FIT	9 WAY D TYPE SOCKET FOR COMMUNICATIONS
SK2	NO FIT	MOTOROLA ENGINE CONNECTOR
J1	BNC	IRIG B OUTPUT
J2	BNC	1 PPS OUTPUT
CON3	NO FIT	SiRF ENGINE CONNECTOR
CON4	ENGINE	FURUNO GT77 ENGINE CONNECTOR
CON5	NOT USED	OPTIONAL Rb CONNECTOR
CON6	NOT USED	OPTIONAL Rb 10 MHz
J7	BNC	10 MHz OUTPUT
CON8	10 WAY HEADER	PROGRAMS F3GPSNT1
CON9		POWER INPUT
CON10	10 WAY HEADER	PROGRAMS F3SYN1
J11	BNC	19.6608 MHz OUTPUT

Link Settings Table



1153 Warner Avenue
Tustin, CA 92780
714 755 1050 Tel
714 755 0175 Fax

CUSTOMER FEEDBACK

Please take a moment to help us improve your experience with Brandywine Communications. When you're done, please either email this form to lisap@brandywinecomm.com or fax this form to 714 755 0175.

PRODUCT QUALITY

How would you rate our product?

- ☐ High quality
- ☐ Generally good
- ☐ Quality varies
- ☐ Poor quality

How would you rate our user guide?

- ☐ High quality
- ☐ Generally good
- ☐ Quality varies
- ☐ Poor quality

What product did you purchase?

Model# _____

Part# _____

Do you have any questions or concerns regarding our user guide? If so, please make note of them in the Additional Comments section.

- ☐ Yes
- ☐ No

ADDITIONAL COMMENTS

ABOUT YOU (OPTIONAL)

Name _____ E-mail _____

Address _____ Phone _____

City, State, Zip _____

THANK YOU FOR YOUR PARTICIPATION!