

CW47 GPS Synchronized Time Reference with Integrated Antenna User Manual

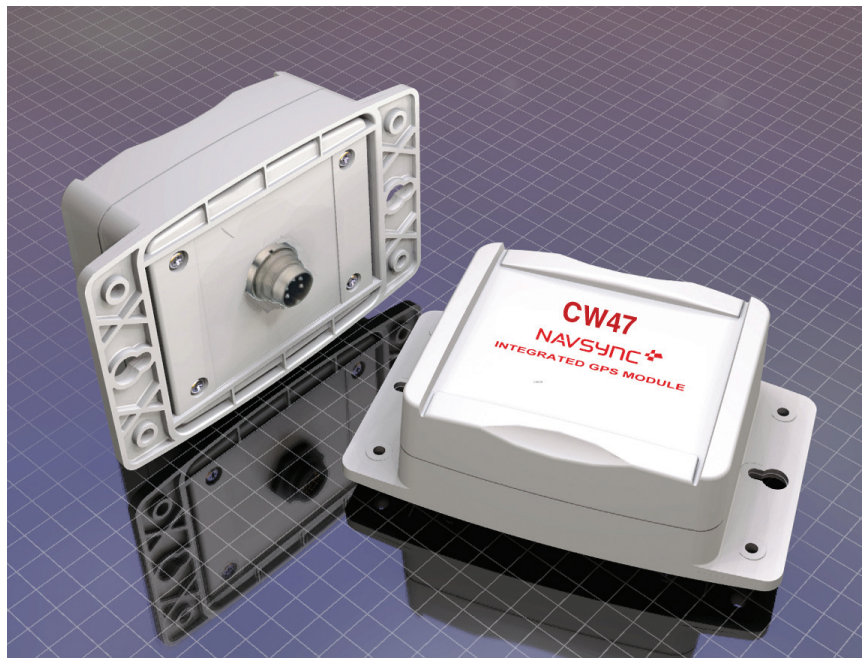


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1. DESCRIPTION

1.1 Introduction

The NavSync CW47 GPS synchronization timing reference is a fully integrated unit combining a CW25 GPS receiver, active GPS antenna, DC/DC converter, RS232 communications and G.703 E1 / T1 outputs – all packaged in a small, IP67 rated waterproof plastic housing. The CW47 unit delivers undisturbed Stratum 1 synchronization when locked to GPS telecom format G.703 E1 (2.048 Mbps) or T1 (1.544 Mbps) output. The CW25 GPS receiver in the CW47 unit, is designed specifically for acquiring and tracking satellites in weak signal areas such as under dense foliage and in severe urban areas. The unit delivers a G.703 E1 2.048 Mbps or a T1 1.544 Mbps output signal with different source impedance options such as 75 Ω or 120 Ω. The E1 version can also deliver a G.703 part 10 2.048 MHz clock signal. The CW47 is the perfect solution for precise timing and network synchronization needs, including broadband wireless applications. It provides a cost effective and independent timing source for any synchronization application.

Key Features of the CW47 include:

- Stratum 1 Time Source
- G.703 E1 2.048 Mbps Output
- G.703 E1 2.048 MHz Clock
- G.703 T1 1.544 Mbps Option
- IP67 Rated Waterproof Box
- 48v (36v to 72v) Power Supply
- Short Circuit Protected
- RoHS Compliant

Applications:

- Synchronizing Wireless Networks
- Synchronizing Remote Switch Sites

1.2 Block Diagram

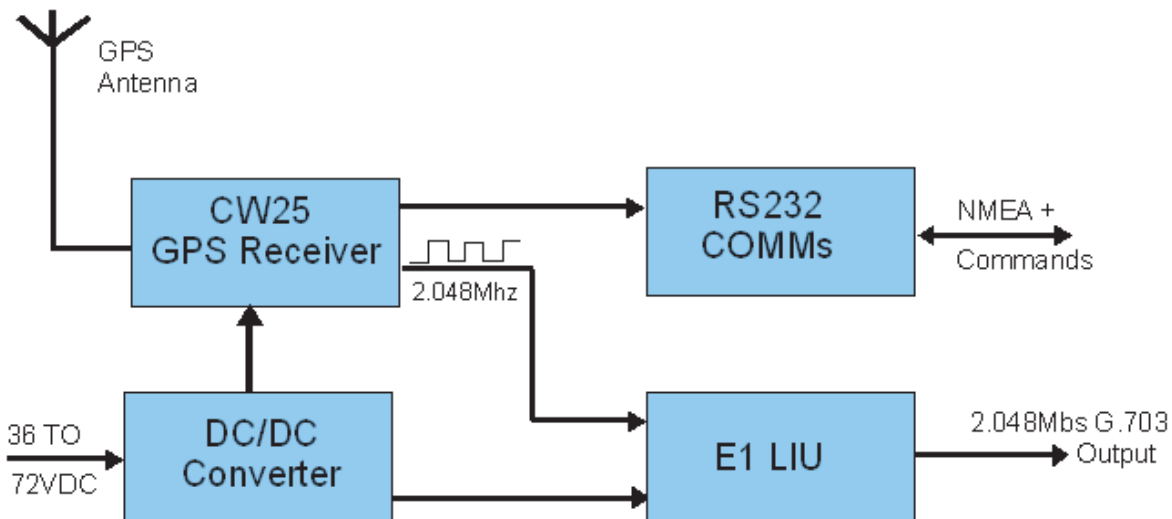


Figure 1 Block Diagram

2. CW47 GPS SENSOR SPECIFICATIONS

2.1 Performance

Module Rating		IP67
Physical	Supply Voltage	36.0-72.0 VDC (48VDC Typical)
	Operating Temp	-30°C to +80°C
	Storage Temp	-55°C to +85°C
	Humidity	5% to 95% non-condensing
	Max Velocity/Altitude	515ms-1/18,000m
Sensitivity	Acquisition/Tracking	-155dBm/-155dBm
Acquisition Time	Hot Start	Outdoor <2s Indoor (-155dBm): <5s
	Stand Alone (Outdoor)	
	Cold	<45s
	Warm	<38s
	Hot	<5s Re-acquisition: <0.5s (90% confidence)
Power	1 Fix per Second	1.5 Ω typically
Interfaces	Serial E1	RS232, programmable baud - up to 115200 (default 38400) G.703 2.048 Mbps clock signal (GPS driven) 120 Ω balanced (default) see Build Options Section
	Protocols	NMEA 0183, proprietary ASCII and binary message formats
	Receiver Type	12 parallel channel x 32 taps up to 32 point FFT. Channels, taps and FFT can be switched off to minimize power or simulate simpler designs.
General	Processor	ARM 966E-S on a 0.18 micron process at up to 120 MHz.

Table 1 CW47 Specification

CW47 Output Format

The standard CW47 output is a 120 Ω balanced 2.048 Mbs clock signal as per ITU-T G.703(E12). This output can be configured by a 2.048 MHz synchronization signal as per ITU-T G.703 (T12).

CW47 Build Options:

A 75 Ω unbalanced E1 version of the CW47 is also available, along with a T1-1.544Mbs version:

Option Description

1. Standard CW47, E1-2.048 Mbs G.703, 120 Ω balanced output
2. CW47 with E1, 2.048 Mbs G.703, 75 Ω unbalanced output
3. CW47 with T1, 1.544 Mbs G.703, DSX-1 (0 to 133 feet) output

3. CONNECTOR INFORMATION and PIN-OUT DESCRIPTIONS

3.1 Connector Information

The connector used on the CW47 module is a metal male socket. It has an IP67 environmental protection rating. The circular connector has a threaded joint according to IEC 60130-9/IEC 130-9. This is a Binder 423 series connector; part number 09-0173-90-08. A plastic protection cap hangs from this connector and can be mated to the metal connector, when the CW47 is outdoors with no cable attached.

Please note that the standard unit does not come with any mating cable, thus the customer can connect with any cable type or length required. A cable can be supplied with these units if requested. Please contact NavSync for more information.

A suitable mating connector can be bought from a number of manufacturers. A description of the mating part would be: IEC 60130-9/IEC 130-9 female 8 pole cable connector IP67 rated.

A list of compatible connector manufacturers is below along with part numbers. The manufacturers have other parts which will also mate other than the part numbers listed below.

Manufacturer	Series	Example Part Number
Binder	423 Series	99-5172-15-08
Lumberg	03 Series	0322-1 08-1
Amphenol	C 091 D	C091 31D008 100 2

These cable connectors should be wired using the numbering listed in Section 3.2.

3.2 Pin-Out Descriptions

Pin	NAME	Description
1	NC	Not Connected
2	RXD	RS232, Receive to GPS
3	GND	RS232, Reference for RS232 COMMS
4	TRING	Transmit TRING, G.703 E1 (T1) Output
5	TXD	RS232, Transmit from GPS
6	TTIP	Transmit TTIP, G.703 E1 (T1) Output
7	V-	Power input, Negative
8	V+	Power input, Positive

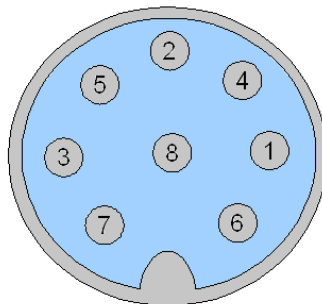


Figure 2 CW47 Connector Pins (looking into the connector)

4. OPERATION and QUICK START

4.1 Operation and Quick Start

1. Place or mount the CW47 unit where it has a good view of the sky. A pole mounting bracket is available for the unit. This bracket works for 89-120mm diameter poles (contact NavSync for other mounting options). See Appendix 4 for details.
2. Attach a suitable cable assembly to the unit. The cable must mate with the 8 way male IEC 130-9 socket on the CW47. A custom cable can be supplied if required, please contact NavSync for this.
The cable will provide the connection for:
 - DC power(36 to 72V), between Pin 7(NEGATIVE) and Pin 8 (POSITIVE).
 - RS232 interface (GPS TXD – Pin 5, GPS RXD – Pin 2, GND – Pin 3).
 - > This will enable the user to view the NMEA stream from the unit. The NMEA data gives information such as, the quality of satellite signal strengths, type of GPS fix acquired, long/lat position and time etc. A full description of these messages is in Section 8.2.1.
 - > The stream can be monitored using any terminal window utility or by using NavSync's graphical NS3Kview software.
 - > The default baud rate is 38400, with 8 bits no parity, with no handshaking.
 - > The user is able to issue commands to the CW47 unit. These commands can change the way the unit operates. The commands can reset/restart the unit (RSET), change which NMEA messages are outputted (U1OP) and the frequency of these messages, change the baud rate(U1CM) and can check/test to operational status of the LIU (LOOP,TMOD,STAT). See Section 8.3 for more details.
 - > These commands can be sent easily with the graphical NS3Kview software.
 - G.703 E1 output (TTIP-Pin 6, TRING-Pin4). This GPS driven G.703 2.048 Mbs is a 120 Ω balanced output. Graphs showing the quality of the performance of the recovered clock signal are in CW47 Product Brief.
3. Apply the DC voltage (36 to 72VDC).
4. The unit should power up and start to stream NMEA data. The default baud rate is 38400.
5. Wait for GPS 3-D fix. This occurs when 4 or more satellites are being tracked with navigation data received. Refer to the GPGSA and GPGSV for fix and satellite information. Refer to Section 8.2 for all GPS information on the streaming NMEA messages.
6. The G.703 2.048 Mbs (1.544 Mbs) output will now be available on the TTIP-TRING signals.

5. COMMUNICATIONS PROTOCOLS

Full descriptions of the communications protocols used by the CW47 can be found in Sections 8.2 and 8.3.

5.1 Port Configuration

The default baud rate on the standard CW47 version is 38400, this baud rate can be configured to another value using the \$PRTHS, U1CM command. See Section 9.2 for more details on this. The port is also configured to be: 8 bits no parity, with no handshaking

5.2 Output Format

The NMEA sentences are output in ASCII and described below.

5.2.1 NMEA Messages

There are two main types of sentence, 'Approved' and 'Proprietary.' All sentences start with \$ delimited with commas and ending with <CR><LF>. Approved sentences are recognized by the first 5 characters after the \$, which define both the kind of talker providing the information (2 characters, GP in the case of a GPS), and the type of information (3 characters).

Proprietary sentences are indicated by a P following the \$, as the first of the 5 characters, the next 3 indicating the manufacturer (from a listing of mnemonic codes), and the 5th character being selected by that manufacturer for the particular sentence structure. Proprietary sentences must conform to the general NMEA structures, but are otherwise undefined outside of the Manufacturers own documentation.

The following Approved messages are available from the CW47 receiver. Messages can be enabled/disabled by using the \$PRTHS, U1OP command in Section 6.4

Approved NMEA messages

GPGLL -	Geographic position - latitude longitude [enabled by default]
GPGGA -	Global positioning system fix data [enabled by default]
GPGSA -	GNSS DOP and active satellites [enabled by default]
GPGSV -	GNSS satellites in view [enabled by default]
GPRMC -	Minimum required sentence [enabled by default]
GPVTG -	Velocity and track over ground [disabled by default]
GPZDA -	Date and time [disabled by default]
POLYT -	NavSync proprietary time of day message [enabled by default]
POLYP -	NavSync proprietary status message [disabled by default]
POLYS -	NavSync proprietary satellite status message (GPGGA + GPGSV) [disabled by default]
POLYI -	NavSync proprietary net assist information message [disabled by default]

5.2.1.1 GPGLL - Geographic Position, Lat/Lon

Latitude and longitude, with time of position fix and status.

`$GPGLL,Latitude,N,Longitude,E,hhmmss.sss,Status,Mode*cs`

Name	Description
\$GPGLL	NMEA sentence header (Position Data)
Latitude	User datum latitude degrees, minutes, decimal minutes format (ddmm.mmmmmm)
N	Hemisphere 'N'= North, or 'S' = South
Longitude	User datum longitude degrees, minutes, decimal minutes format (dddmm.mmmmmm)
E	Longitude direction 'E'= East, or 'W' = West
hhmmss.sss	UTC time in hours, minutes, seconds and decimal seconds format.
Status	StatusV=navigation receiver warning, A=data valid
Mode	Mode indicator:A=Valid, Autonomous, D=Valid, Differential, E=Invalid, Estimated, N=Invalid, Not valid
Cs	Message checksum in hexadecimal

5. COMMUNICATIONS PROTOCOLS continued

5.2.1.2 GPGGA - GPS Fix Data

Time and position, together with GPS fixing related data.

*\$GPGGA,hhmmss.sss,Latitude,N,Longitude,E,FS,NoSV,HDOP,Altref,M,msl,M,DiffAge,DiffStation*cs*

Name	Description
\$GPGGA	NMEA sentence header (position data)
hhmmss.sss	UTC time in hours, minutes, seconds and decimal seconds format.
Latitude	User datum latitude degrees, minutes, decimal minutes format (ddmm.mmmmmm)
N	Hemisphere 'N'= North, or 'S' = South
Longitude	User datum longitude degrees, minutes, decimal minutes format (dddmm.mmmmmm)
E	Longitude direction: 'E'= East, 'W' = West
FS	Fix Status: <ul style="list-style-type: none"> 0 No Fix 1 Standard GPS 2 Differential GPS
NoSv	Number of satellites used in the position solution
HDOP	2-D Horizontal Dilution of Precision (0.00 to 99.99)
AltRef	Altitude (meters) above user datum ellipsoid
M	Units of height (meters)
msl	Mean Sea Level
M	Units of Mean Sea Level (meters)
DiffAge	Age of differential correction
DiffStation	Differential base station ID
cs	Message checksum in hexadecimal

5.2.1.3 GPGSA - GPS DOP and Active Satellites

GPS receiver operating mode, satellites used for navigation, and DOP values.

*\$GPGSA,Smode,FS,sv,sv,sv,sv,,,,,,,,,PDOP,HDOP,VDOP*cs*

Name	Description
\$GPGSA	NMEA sentence header (Satellite Data)
Smode	A= Automatic switching 2D/3D M=Manually fixed 2D/3D
FS	Fix Status: <ul style="list-style-type: none"> 1 No fix 2 2D GPS Fix 3 3D GPS Fix
sv	Satellites in use, null for unused fields (12 available fields)
PDOP	3-D position dilution of precision (0.00 to 99.99)
HDOP	2-D horizontal dilution of precision (0.00 to 99.99)
VDOP	Vertical dilution of precision (0.00 to 99.99)
cs	Message checksum in hexadecimal

5. COMMUNICATIONS PROTOCOLS continued

5.2.1.4 GPGSV - GPS Satellites in View

The number of satellites in view, together with each PRN, elevation and azimuth, and C/No value. Up to four satellite details are transmitted in one message, with up to three messages used as indicated in the first field.

`$GPGSV,NoMsg,MsgNo,NoSv{sv,elv,az,cno}{sv,elv,az,cno...}*cs`

Note: {} designate optional sections that appear only if there is satellite data.

Name	Description
\$GPGSV	NMEA sentence header (satellite data)
NoMsg	Total number of GPGSV messages being output
MsgNo	Number of this messages
NoSv	Number of satellites in view
sv	Satellites ID
elv	Satellite elevation angle (degrees)
az	Satellite azimuth angle (degrees)
cno	Satellite signal/Noise ration (dB/Hz)
cs	Message checksum in hexadecimal

5.2.1.5 GPRMC - Recommended Minimum Data

The 'Recommended Minimum' sentence is defined by NMEA for GPS/Transit system data.

`$GPRMC,hhmmss.sss,status,latitude,N,Hemisphere,longitude,E,spd,cmg,ddmmyy,mv,mvd,Mode*cs`

Name	Description
\$GPRMC	NMEA sentence header (Recommended Minimum Sentence)
hhmmss.sss	UTC time in hours, minutes, seconds.
status	Status:V=navigation receiver warning, A=data valid
Latitude	User datum latitude degrees, minutes, decimal minutes format (ddmm.mmmmmm)
N	Hemisphere: 'N'= North, or 'S' = South
Longitude	User datum longitude degrees, minutes, decimal minutes format (dddmm.mmmmmm)
E	Longitude direction: 'E'= East, 'W' = West
spd	Speed over ground (knots).
cmg	Course made good
ddmmyy	Date in day, month year format
mv	Magnetic variation
mvd	Magnetic variation direction
Mode	Mode indicator: D = Valid, Differential, A = Valid, Autonomous, E = Invalid, Estimated, N = Invalid, Not valid
cs	Message checksum in hexadecimal

5. COMMUNICATIONS PROTOCOLS continued

5.2.1.6 GPVTG - Course Over Ground and Ground Speed.

Velocity is given as course over ground (COG) and ground speed

*\$GPVTG,cogt,T,cogm,M,knots,N,kph,K,Mode*cs*

Name	Description
\$GPVTG	NMEA sentence header (speed and heading)
cogt	Course over ground (true)
T	True - fixed field
cogm	Course over ground (magnetic)
M	Magnetic - fixed field
knots	Speed over ground (knots)
N	Knots - fixed field
kph	Speed over ground (kph)
K	Kilometers per hour – fixed field
Mode	Mode Indicator:D = Valid, Differential, A = Valid, Autonomous, E = Invalid, Estimated, N = Invalid, Not Valid
cs	Message checksum in hexadecimal

5.2.1.7 GPZDA - UTC Time and Date

This message transfers UTC time and date. Since the latency of preparing and transferring the message is variable, and the time does not refer to a particular position fix, the seconds' precision is reduced to 2 decimal places.

*\$GPZDA,hhmmss.sss,dd,mm,yyyy,Int,Unsigned*cs*

Name	Description
\$GPZDA	NMEA sentence header (time and date)
hhmmss.sss	UTC time in hours, minutes, seconds.
dd	UTC day
mm	UTC month
yyyy	UTC year
Int Unsigned	Local zone hours
Int Unsigned	Local zone minutes
kph	Speed over ground (kph)
K	Kilometers per hour – fixed field
cs	Message checksum in hexadecimal

Proprietary NMEA Messages

5.2.1.8 POLYT - Time of Day

*\$POLYT,hhmmss.sss,ddmmyy,UTC_TOW,week,GPS_TOW,Clk_B,Clk_D,PG,LocalTTag,BAcc,TAcc,BLANK*cs*

Name	Description
\$POLYT	NavSync proprietary NMEA sentence header (position data)
hhmmss.sss	UTC time in hours, minutes, seconds and decimal seconds format.
ddmmyy	Date in day, month, year format.
UTC_TOW	UTC time of week (seconds with microseconds resolution)
week	GPS week number (continues beyond 1023)
GPS_TOW	GPS time of week (seconds with microseconds resolution)
Clk_B	Receiver clock bias (nanoseconds)
Clk_D	Receiver clock drift (nanoseconds/second)
PG	1PPS granularity (nanoseconds)
LocalTTag	Local receiver time-tag since start-up [msec]
BAcc	Bias accuracy
TAcc	Time accuracy
cs	Message checksum in hexadecimal

5. COMMUNICATIONS PROTOCOLS continued

5.2.1.9 POLYP- Position Data

*\$POLYP,hhmmss.sss,Latitude,N,Longitude,E,AltRef,FS,Hacc,Vacc,SOG,COG,V_vel,ageC,HDOP,VDOP,PDOP,GDOP,TDOP,GU,RU,DR*cs*

Name	Description
\$POLYP	NavSync proprietary NMEA sentence header (position data)
hhmmss.sss	UTC time in hours, minutes, seconds and decimal seconds format.
Latitude	User datum latitude degrees, minutes, decimal minutes format (ddmm.mmmmmm)
N	Hemisphere: 'N' = North, 'S' = South
Longitude	User datum longitude degrees, minutes, decimal minutes format (dddmm.mmmmmm)
E	Longitude direction: 'E' = East, 'W' = West
AltRef	Altitude (meters) above user datum ellipsoid.
FS	Fix Status: NF = No fix DR = Predictive dead reckoning solution DA = Predictive dead reckoning solution with DR aiding G1 = Partial GPS solution with DR aiding G2 = Stand alone 2D solution G3 = Stand alone 3D solution D1 = Partial differential GPS solution with DR aiding D2 = Differential 2D solution D3 = Differential 3D solution
Hacc	Horizontal (2 sigma) accuracy estimates (0 to 99999 meters)
Vacc	Vertical (2 sigma) accuracy estimates (0 to 99999 meters)
SOG	Speed over ground (knots) (0.000 to 999.999 knots)
COG	Course over ground (true) in degrees (0.00 to 359.99 degrees)
V_vel	Vertical (positive Up) velocity (m/s) (0.000 to 999.999 m/s)
ageC	Age of most recent DGPS corrections applied (seconds).(00.00 to 99.99 = none available)
HDOP	2-D horizontal dilution of precision (00.00 to 99.99)
VDOP	Vertical dilution of precision (00.00 to 99.99).
PDOP	3-D position dilution of precision (00.00 to 99.99)
TDOP	Time dilution of precision (00.00 to 99.99)
GU	Number of GPS satellites used in the navigation solution
RU	Number of GLONASS satellites used in the navigation solution
DR	Dead reckoning aiding status bits (in ASCII Hex) bit 0 Altitude position aiding applied bit 1 Vertical velocity aiding applied bit 2 (GPS-GLONASS) time difference aiding applied bit 3 External distance travelled input used bit 4 External speed input used bit 5 External track input used bit 6 External delta -track input used bit 7,8 Reserved for future use
cs	Message checksum in hexadecimal

5. COMMUNICATIONS PROTOCOLS continued

5.2.1.10 POLYS - Satellite Status

*\$POLYS,GT{,ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK},ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK}{,ID,s,AZM,EL,SN,LK}*cs*

Note: {} designate optional sections that appear only if there is satellite data

Name	Description
\$POLYS	NavSync proprietary NMEA sentence header (satellite data)
GT	Number of GPS satellites tracked
ID	Satellite PRN number (1-32)
s	Satellite status - = not used U = used in solution e = available for use, but no ephemeris
AZM	Satellite azimuth angle (range 000 - 359 degrees)
EL	Satellite elevation angle (range 00 - 90 degrees)
SN	Signal to noise ratio in (range 0 - 55 dB/Hz)
LK	Satellite carrier lock count (range 0 - 255 seconds) 0 = code lock only 255 = lock for 255 or more seconds
cs	Message checksum in hexadecimal

5.2.1.11 POLYI, Additional Information Message

*\$POLYI,JN,jammer,EXT{,efields},INT{,ifields},BLANK*cs*

Note: More than one {efield} or {ifield} may be present, each separated by commas.

Name	Description
\$POLYI	NavSync proprietary NMEA sentence header (additional information)
JN	Fixed descriptor field
jammer	Detected jammer to noise ratio [dB/Hz]
EXT	Fixed descriptor field, indicates the use of externally provided ancillary measurements e.g. received from network assistance. All comma separated fields following, up to the INT field descriptor, are externally provided measurements
efields	DIFF = Differential inputs TSYNC = Time synchronization CLKB = Clock bias FREQ = Frequency (of reference oscillator) HPOS = Horizontal position VPOS = Vertical position (altitude) VVEL = Vertical velocity DIST = Distance moved SPEED = Current speed TRACK = Current track DTRACK = Delta track (change in direction)
INT	Fixed descriptor field, indicates the use of internally provided ancillary measurements e.g. retrieved from non volatile memory. All comma separated fields following, are internally provided measurements
ifields	TSYNC = Time synchronization CLKB = Clock bias FREQ = Frequency (of reference oscillator) HPOS = Horizontal position VPOS = Vertical position (altitude) VVEL = Vertical velocity DIST = Distance moved SPEED = Current speed TRACK = Current track DTRACK = Delta track (change in direction)
BLANK	Reserved for future use
cs	Message checksum in hexadecimal

5. COMMUNICATIONS PROTOCOLS continued

5.3 Command Format *

The NavSync CW47 receiver has a unique set of proprietary commands. Commands will only be accepted on Port 1.

The commands to and from the unit have the following general formats:

`$PRTH<Q|S|R>,<id>,<msg fields>[*<checksum>]<cr><lf>`

Where:

<Q|S|R> is the single ASCII character as follows:

Q: Command, a query command to the CW47 receiver.

S: Command, requires the CW47 receiver to set system settings.

R: Response to a CW47 receiver, response to a \$PRTH query or an acknowledgement of a \$PRTH Set.

<id> is a 4 character command identifier.

<msg fields> are the message fields for the message and are all positional. Optional or unknown fields are shown as nulls (ie adjacent commas). Trailing commas to the end of a message (ie nothing but null message fields) are not required.

*<checksum> An optional checksum byte for checking accuracy defined as follows:

The checksum is displayed as a pair of ASCII characters, (0-9 and A-F inclusive) whose value represents the "HEX" value of the checksum byte. When used, it always appears as the last field of the sentence and is prefixed by field delimiter "*" (HEX 2A) instead of "," and followed by <CR><LF> (HEX 0D 0A). The checksum value is calculated by XOR'ing (exclusive OR'ing also known as Modulo 2 Sum) the 8 binary data bits of each valid data character in the sentence between the "\$" (HEX 24) and "*" (HEX 2A) characters.

The "\$" (HEX 24) and the "*" (HEX 2A) characters are not included in the checksum.

<cr><lf> are the ASCII codes 0Dh and 0Ah (carriage return and line feed) respectively.

Some commands use multiple sentences to transfer data: multiple sentence transfer shall be accomplished by means of 2 fields within the sentence for which this format is used:

t: Total number of sentences forming the data transfer (minimum value 1)

x: ID number of the current sentence ranging from 1 to t inclusive

Null fields within a command shall be interpreted as "use current value" where appropriate. Null fields must be delimited by adjacent commas when they exist between two non-null fields. If all trailing fields after a given field are null, further commas are not required.

**Note: For CW47, the standard CW25 commands include:*

VERS DYNA ITIM RSET INTM ILLH COMA FRQD IDNO ZONE

Unique command only to the CW47 includes:

LOOP, TMOD, RCL, SCLK

As well as the NMEA and UART configuration commands

UxOP, UxCM

The accuracy testing of INTM command is not yet implemented. Additional commands, some documented here, can be enabled with custom firmware. Further customization is also available. Please consult the factory for details.

5.3.1 PRTH<Q|R>, VERS: Software Version

Purpose

This message queries and responds with the current software version information.

Query Format

`$PRTHQ,VERS[*checksum]<cr><lf>`

Response /Acknowledge Format

`$PRTHR,VERS,Build_Name,Version_Number,Version_Date,Version_Time,Serial_Num, BB_Release*checksum<cr><lf>`

Explanation of Parameters

Build_Name	Product name	Version_Number	software version number
Version_Date	Software	Build date in mmm_dd_yyyy format where Mmm is the three character abbreviation of the month name	
Version_Time		Software build time in hh:mm:ss format	
Serial_Num		Product serial number is current not implemented and always outputs "Serial_Num"	
BB_Release		Baseband version number	

5. COMMUNICATIONS PROTOCOLS continued

5.3.2 PRTH<Q|S|R>, DYNA: RECEIVER DYNAMICS

Purpose

This message sets, queries and responds to the receiver host dynamics and hence the maximum receiver tracking dynamics expected.

The degree of filtering performed by the navigation and timing Kalman filter is dependant on the selected receiver platform.

Query Format

\$PRTHQ,DYNA[*checksum]<cr><lf>

Set Format

\$PRTHS,DYNA,platform[*checksum]<cr><lf>

Response / Acknowledge Format

\$PRTHR,DYNA,platform*checksum><cr><lf>

Explanation of Parameters

platform receiver platform (integer, range 0 – 10)
0 = Fixed base station, timing and frequency modes etc
1 = Stationary, but unknown position
2 = Man pack / walking
3 = Automotive / land vehicle
4 = Marine
5 = Airborne, low dynamics (<1g) — Limit of CW47

Default for CW47 is 1 and changes to 0 after 10 minute location survey completed, maximum is 5.

5.3.3 PRTH<Q|S|R>, ITIM: INITIALIZE TIME AND DATE

Purpose

This message sets, queries and responds to the user initialized time and date. Two input options are available, one allowing a calendar date and GMT time to be input and the other a GPS week number and seconds of week.

The input date is acted upon regardless and is primarily used to set the GPS week inside the receiver. The time input will not be used if is set to zero, or if the receiver is currently tracking any satellites and therefore already has a good sub-millisecond knowledge of time.

If the time input is not used then the response message returns the values used or assumed instead of those input. The time RMS accuracy is used to decide how much importance to put on the input values and should be set with care.

Query Format

\$PRTHQ,ITIM[*checksum]<cr><lf>

Set Format

Using a GMT time format

\$PRTHS,ITIM,timeRMS,GMT,day,month,year,[hours],[minutes],[seconds] [*checksum]<cr><lf>

Using a GPS time format

\$PRTHS,ITIM,timeRMS,GPS,gps_week,[gps_time][*checksum]<cr><lf>

Response / Acknowledge Format

\$PRTHR,ITIM,timeRMS,GMT,day,month,year,hours,minutes,seconds,GPS, gps_week,gps_time*checksum><cr><lf>

Explanation of Parameters

time RMS	RMS accuracy of the input time-tag (seconds) (floating point, range 0 – 999999.0)
day	day of month (integer, range 1 – 31)
month	month of year (integer, range 1 – 12)
year	4 digit year (integer, range 1980 – 2047)
hours	hours of day (integer, range 0 – 23)
minutes	minutes of hour (integer, range 0 – 59)
seconds	seconds of minute (floating point, range 0 – 59.999)
gps_week	GPS week number, including pre GPS roll-over weeks, eg 1037 (integer, range 0 – 32768)
gps_TOW	GPS time of week in seconds (floating point, range 0.0 –604800.0)

5. COMMUNICATIONS PROTOCOLS continued

5.3.4 PRTH<Q|S|R>, RSET: RE-SET THE RECEIVER

Purpose

This message sets, queries and responds to a receiver re-set command with optional actions such as clearing specific data groups stored in the CW47 local EEPROM.

The data areas that can be cleared include satellite almanacs, ephemerides, network assist and receiver configuration parameters.

Note that “sleep” mode is not currently supported in the CW47 technology.

This command invokes a 2 second time-out prior to the reset being called.

Query Format

\$PRTHQ,RSET[*checksum]<cr><lf>

Set Format

\$PRTHS,RSET,{[option],[option],...}*checksum<cr><lf>

Response / Acknowledge Format

\$PRTHR,RSET,{[option],[option],...}*checksum<cr><lf>

A response option of NO, indicates that no reset command is currently activated.

Explanation of Parameters

Option

A list of character descriptors to indicate which, if any, of the optional actions are to be undertaken prior to the software re-sets.

”CONFIG” = clear the receiver configuration data stored in EEPROM.

”EPH” = clear the satellite ephemeris data stored in EEPROM.

”ALM” = clear the satellite almanac data stored in EEPROM.

”SLEEP” = Enter a “sleep” mode, still to be defined.

5.3.5 PRTH<Q|S|R>, INTM: INTERMITTENT OPERATION PARAMETERS

Purpose

This message queries, sets and respond with the fix interval, run duration, run interval, horizontal and vertical accuracy masks for intermittent operation. Once the receiver has met the required horizontal and vertical accuracy masks it will go to sleep until the next run interval. The receiver will also go to sleep if no fix or the accuracy masks have not been met within the run duration.

Query Format

&PRTHQ, INTM [*checksum]<cr><lf>

Set Format

\$PRTHS, INTM, Fix_Interval, Run_Duration, Run_Interval, Horizontal_Acc_Mask, Vertical_Acc_Mask[*checksum]<cr><lf>

Response / Acknowledge Format

\$PRTHR, INTM*checksum<cr><lf>

Explanation of Parameters

Fix_Interval	Interval in ms between adjacent fixes
Run_Duration	Maximum time in ms to attempt to obtain fix. Must be greater than Fix_Interval and is 0 for continuous operation
Run_Interval	Time interval in ms between waking to obtain a fix. Must be greater than Run_Duration
Horizontal_Acc_Mask	Required horizontal accuracy in meters before run completes. Zero disables vertical accuracy testing.
Vertical_Acc_Mask	Required vertical accuracy in meters before run completes. Zero disables vertical accuracy testing.

5. COMMUNICATIONS PROTOCOLS continued

5.3.6 PRTH<Q|S|R>, ILLH: INITIALIZED LAT, LONG, HEIGHT POSITION

Purpose

This message sets, queries and responds to the initialized geodetic position (latitude, longitude, ellipsoidal height and antenna height above the reference marker) in the receiver's current user datum.

The position RMS accuracy is used to decide how much importance to put on the input values and should be set with care.

Query Format

\$PRTHQ,ILLH[*checksum]<cr><lf>

Set Format

\$PRTHS,ILLH,LatDeg,LatMin,LatSec,LatH,LonDeg,LonMin,LonSec,LonH,EllHt,AntHt,posRMS [*checksum]<cr><lf>

Response / Acknowledge Format

\$PRTHR,ILLH,LatDeg,LatMin,LatSec,LatH,LonDeg,LonMin,LonSec,LonH,EllHt,AntHt,posRMS* <checksum><cr><lf>

Explanation of Parameters

LatDeg	Latitude degrees (floating point, range ±90.0)
LatMin	Latitude minutes (floating point, range ±59.999999)
LatSec	Latitude seconds (floating point, range ±59.99999)
LatH	Latitude hemisphere (char 'N' or 'S')
LonDeg	Longitude degrees (floating point, range ±90.0)
LonMin	Longitude minutes (floating point, range ±59.999999)
LonSec	Longitude seconds (floating point, range ±59.99999)
LonH	Longitude hemisphere (char 'E' or 'W')
EllHt	Height of the reference marker above the current user datum reference ellipsoid in meters (floating point, range ±18,000.0)
AntHt	Height of the antenna phase center above the reference marker height defined by EllHt above in meters (floating point, range ±18,000.0)
posRMS	RMS accuracy of the input position (meters) (floating point, range 0 - 999999.0)

Note that since the degree, minutes and seconds fields will accept floating point values then a decimal degree value, or an integer degree, decimal minute value can be input directly by setting the minutes and seconds fields to zero as appropriate (eg 52.12345678,0,0,N or 52,14.123456,0,N).

5.3.7 PRTH<Q|S|R>, COMA: COMA MODE

Purpose

This message sets, queries and responds coma mode. Coma mode puts the receiver to sleep for a predetermined period of time.

Query Format

\$PRTHQ,COMA[*checksum]<cr><lf>

Set Format

\$PRTHS,COMA,Period[*checksum]<cr><lf>

Response / Acknowledge Format

\$PRTHR,COMA,Period* <checksum><cr><lf>

Explanation of Parameters

Period The period in milliseconds that the receiver will sleep.

5.3.8 PRTH<Q|S|R>, FRQD: FREQUENCY OUTPUT SELECT

Purpose

This message sets, queries and responds the frequency output. Outputs the requested frequency out of the CW25 receiver to the E1 LIU. The frequency is set at the default 2.048Mhz and should not be modified, doing so would stop the LIU from operating correctly.

Query Format

\$PRTHQ,FRQD[*checksum]<cr><lf>

Set Format

\$PRTHS,FRQD,Frequency[*checksum]<cr><lf>

Response / Acknowledge Format

\$PRTHR,FRQD,Frequency* <checksum><cr><lf>

Explanation of Parameters

Frequency The frequency in Megahertz that the receiver will output. CW47 defaults to 2.048 MHz

5. COMMUNICATIONS PROTOCOLS continued

5.3.9 PRTH<Q|S|R>, MMSV: MIN & MAX SATELLITES FOR A POSITION SOLUTION

Purpose

This message sets, queries and responds to the minimum and maximum number of satellites the receiver will use for a position solution. Increasing the minimum number of satellites will improve the accuracy achieved when sufficient satellites are available, but may reduce the time when a solution can be produced. Reducing the maximum number of satellites may reduce the accuracy of the position solution, but will decrease the amount of processing power required for the solution.

Note that setting the maximum satellites to less than 4 will prevent the receiver from performing a 3D position solution. Likewise setting the minimum number of satellites greater than 3 will prevent the receiver performing a 2-D, altitude fixed solution.

The maximum must be greater than or equal to the minimum number of satellites.

Query Format

\$PRTHQ,MMSV[*checksum]<cr><lf>

Set Format

\$PRTHS,MMSV,[min_NSV],[max_NSV][*checksum]<cr><lf>

Response / Acknowledge Format

\$PRTHR,MMSV,min_NSV,max_NSV*checksum<cr><lf>

Explanation of Parameters

min_NSV Minimum satellites used for a position / time solution (integer, range 0-12)
max_NSV Maximum satellites used for a position / time solution (integer, range 0-12)

5.3.10 PRTH<Q|S|R>, DRLM: DEAD RECKONING LIMIT

Purpose

This message sets, queries and responds to the limit for the forward predictive dead reckoning, after the last valid fix (epochs). The dead reckoning will progress at constant velocity for the first half of this period and then reduce to a standstill during the second half.

Note that since this value has units of epochs, it will have a different effect on a 1Hz CW47 receiver to that on a 2Hz, 5Hz or 10Hz CW47 receivers.

Query Format

\$PRTHQ,DRLM[*checksum]<cr><lf>

Set Format

\$PRTHS, DRLM,DR_Limit[*checksum]<cr><lf>

Response / Acknowledge Format

\$PRTHR, DRLM, DR_Limit*checksum<cr><lf>

Explanation of Parameters

DR_Limit Number of epochs to dead reckon for (integer, range 0 –32768)

5.3.11 PRTH<Q|S|R>, ELVM: SATELLITE ELEVATION MASK

Purpose

This message sets, queries and responds to the satellite elevation mask angle below which satellite data will not be used in the navigation and time solution.

Query Format

\$PRTHQ,ELVM[*checksum]<cr><lf>

Set Format

\$PRTHS,ELVM,nvElevMask[*checksum]<cr><lf>

Response / Acknowledge Format

\$PRTHR,ELVM,nvElevMask*checksum<cr><lf>

Explanation of Parameters

nvElevMask The navigation and time solution elevation mask angle in degrees (integer, range 0 –90).

5. COMMUNICATIONS PROTOCOLS continued

5.3.12 \$PRTH<S|Q,R>, LOOP; CW47 LOOP BACK

Loop Command is Setting the E1 LIU in the Following Loop Modes:

1. Local loop. Loops back the LIUs transmit data only, to the receive section of the LIU device.
2. Analogue loop. Loops back the LIUs transmit data, clock and carrier, to the receive section of the LIU device.
3. No loop. No loop-back to receive LIU section. It represents the default settings

General Loop Command Format:

```
$PRTH<SIQ>,LOOP,<LOCALIANALOGUEINO_LOOP><CR><LF>
```

General Reply Format:

```
$PRTHR,LOOP,<LOCALIANALOGUEINO_LOOP ><CR><LF>
```

5.3.13 \$PRTH<S|QR>, TMOD; CW47 TRANSMIT MODE

Transmit command is setting the E1 LIU in the following transmit modes:

1. Transmit PRBS
2. Transmit alternating ones and zeros
3. Transmit unframed all ones

General Transmit Mode Command Format:

```
$PRTH<SIQ>,TMOD,<PRBSZERO_ONESIALLONES><CR><LF>
```

General Reply Format:

```
$PRTHR,TMOD,< PRBSZERO_ONESIALLONES ><CR><LF>
```

5.3.14 \$PRTHQ, STAT, RCL; CW47 LIU STATUS

Status command polls the status of the LIU RCL (Receive Carrier Loss) and PBEO (PRBS Bit Error Output) lines. The command is useful and to be used in conjunction with different loop back and transmit modes for in field or manufacturing debug.

General status query of the E1 LIU RCL and PBEO lines:

General Format:

```
$PRTHQ,STAT<CR><LF>
```

General Reply Format:

```
$PRTHR,STAT,RCL=<HIGHLOW>,PBEO=<HIGHLOW><CR><LF>
```

The default loop mode for DS21348 is "no loop mode" while the transmit mode is "Transmit PRBS".

Example Command:

```
$PRTHQ,STAT<CR><LF>
```

Example Reply:

```
$PRTHR,STAT,RCL=HIGH,PBEO=HIGH*37
```

PBEO is HIGH, if out of synchronization

RCL is HIGH, when there is a receive carrier loss

EG. If analog loop back is enabled and PRBS is transmitting, then both the RCL and PBEO should be LOW (no carrier loss is detected or no PRBS error is detected). With the default, no loop, both of these will be HIGH (no carrier or no data being received, as the RTIP and RRING pins of the of the LIU are unconnected).

5.3.15 \$PRTH<S|QR>SCLK; 2.048 MHz Synchronization Signal Output

The output can be configured, to change the output from a 2.048 Mbps to a 2.048 MHz synchronization signal as per ITU-T G.703 (T12). The user should know that once a cold start (config) command is given to the unit the output will return back to the default output (2.048Mbps).

General Format:

```
$PRTH<SIQIR>,,SCLK,<HIGHLOW> <CR><LF>
```

General Reply Format:

```
$PRTHR,SCLK,<HIGHLOW> <CR><LF>
```

Example Query Command:

```
$PRTHQ,SCLK<CR><LF>
```

Example Reply:

```
$PRTHR, SCLK,SCLK,LOW *37
```

Here the output is the default 2.048Mbs G.703 signal

Example Set- Enable 2.048Mhz Output

```
$PRTHS, SCLK,HIGH <CR><LF>
```

6. NMEA and UART CONFIGURATION DETAILS

This section describes how the NMEA and UART output can be configured for different refresh rates, contents and baud rates.

- **NMEA Output Configuration (i.e. output frequency) Query:**
\$PRTHQ, U1OP
- **NMEA Output Configuration (i.e. output frequency) Set:**
\$PRTHS, U1OP
- **UART Configuration (i.e. baud rate) Query:**
\$PRTHQ, U1CM
- **UART Configuration (i.e. baud rate) Set:**
\$PRTHS, U1CM

6.1 NMEA Configuration Query (\$PRTHQ, UxOP):

The command takes the form "\$PRTHQ,UxOP" where x is a port number. The port number will always be 1 on the CW47.

The remainder of the strings is of the form "\$PRTHR,UxOP,GLL=1,GSV=4,PLT=1" where x is the port number for which the information was requested. The specific contents supported are dependent on the NMEA sentences supported by the system. Only the settings which are to be altered need to be listed. A NMEA checksum of the form "*4D" is appended to the output string.

The list of currently supported NMEA sentences is as shown below. To turn a sentence output off completely, specify zero as the duration for that command. Subsequent commands may reassign an output period to sentences disabled in this way, effectively re-enabling the output sentence. This command also supports a shortcut by means of an "ALL" specifier. When this is encountered, the period specified is applied to all sentences. An example of this is shown below, where every message output on port 1 will be printed at a 5-second period with the exception of the GPRMC sentence, which will be output every second, and the POLYT sentence, which will be disabled.

```
$PRTHS, U1OP, ALL=5, RMC=1. PLT=0
```

An example response string is shown below. In this example, all sentences are output every second, except GPGSV, which is output every three seconds, and POLYT, which is not output at all (i.e. the sentence output is disabled).

```
$PRTHR,U1OP,GLL=1,RMC=1,VTG=1,GGA=1,GSA=1,GSV=3,PLT=0,PLP=1,PLS=1,PLI=1*0C
```

6.2 NMEA Configuration Set (\$PRTHS,UxOP):

The command takes the form "\$PRTHS,UxOP,GLL=2,GGA=4,GSV=0" where x is a port number. On the CW47 platform, the port number is always between 1 and 3 inclusive.

The remainder of the string is of the form "GLL=1,GSV=4,PLT=1". The specific contents supported are dependent on the NMEA sentences supported by the system. Only the settings which are to be altered need to be listed. A NMEA checksum of the form "*4D" is appended to the output string.

The list of currently supported NMEA sentences are as shown above for the query command. To turn a sentence output off completely, simply specify zero as the duration for that command. Subsequent commands may reassign an output period to sentences disabled in this way, effectively re-enabling the output sentence. This command also supports a shortcut by means of an "ALL" specifier. When this is encountered, the period specified is applied to all sentences. An example of this is shown below, where every message output on port 1 will be printed at a 5-second period with the exception of the GPRMC sentence, which will be output every second, and the POLYT sentence, which will be disabled.

```
$PRTHS,U1OP,ALL=5,RMC=1,PLT=0
```

6. NMEA and UART CONFIGURATION DETAILS continued

6.3 UART Configuration Query (\$PRTHQ, UxCM):

The command takes the form "\$PRTHQ,UxCM" where x is a port number. On the CW47 platform, the port number is always between 1 and 3 inclusive.

The response string is of the form "\$PRTHR,UxCM,38400,38400,N,1" where x is the port number for which the information was requested. The remainder of the string, "38400,38400,N,1" represents the port Tx baud rate, Rx baud rate, parity and stop bits respectively. A NMEA checksum of the form "**4D" is appended to the output string.

Although the format of the command supports the use of different Rx and Tx baud rates, this is not currently supported by the CW47 platform. Consequently, the Rx and Tx baud rates returned will always be identical.

6.4 UART Configuration Set (\$PRTHS,UxCM)

The command takes the form "\$PRTHS,UxCM,57600,57600,N,1" where x is a port number. On the CW47 platform, the port number is always between 1 and 3 inclusive.

The remainder of the string, "57600,57600,8,N,1" represents the port Tx baud rate, Rx baud rate, parity and stop bits respectively.

Although the format of the command supports the use of different Rx and Tx baud rates, this is not currently supported by the CW47 platform. Consequently, the Rx and Tx baud rates must always be specified to be the same value. In addition, the CW47 platform does not currently support the use of parity, or of stop bit settings other than 1 stop bit. The supported baud rates are: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, and 230400.

If a command is issued which is badly formatted or does not adhere to these constraints, it will be discarded. This command is intended for use with the NMEA port(s) only. Caution should be exercised when using this command to change the baud rate on other ports, since data may be lost during the configuration change.

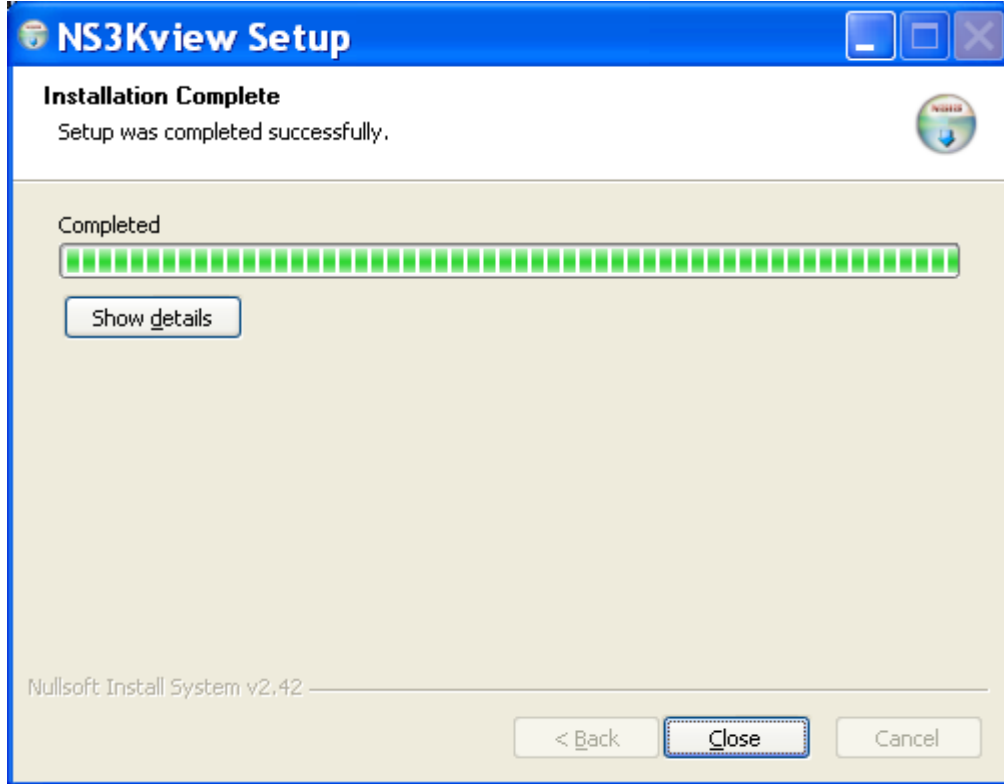
It should be noted that these commands allow the system to be configured at 1200 baud, while requesting that the full set of NMEA sentences be output each second. Such configurations will result in NMEA corruption since the output NMEA data rate exceeds the underlying baud rate.

APPENDIX 1

NMEA Viewer – NS3Kview - Installation and Set-up

1.1 Graphical NS3Kview Software Installation

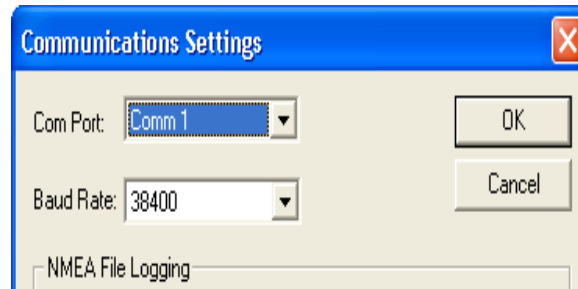
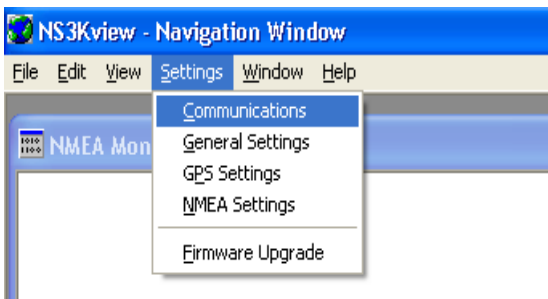
1. Execute the “NS3KviewInstaller.exe” installation file, by double clicking. This file can be found on the NavSync CD or www.navsync.com
2. Follow the on-screen instructions to complete installation



3. The graphical NS3Kview software shortcut will be available from the computers desktop.

1.2 Graphical NS3Kview Software Communication Setup for the CW47

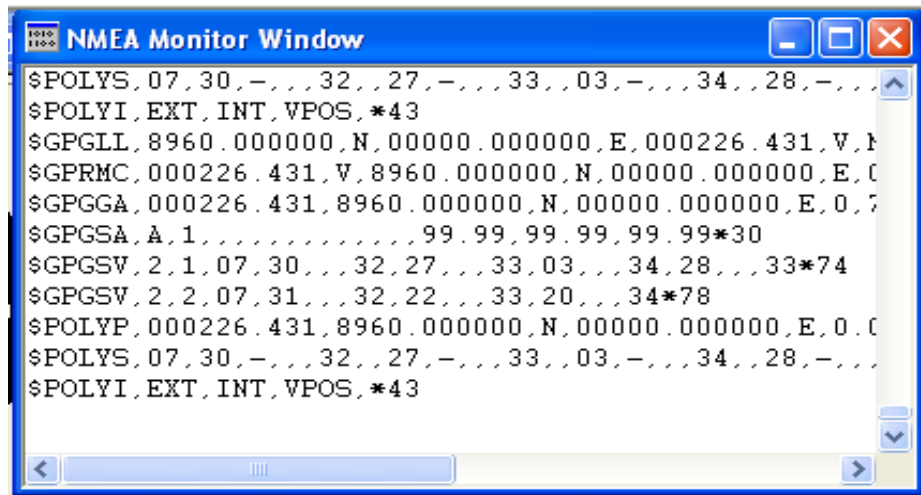
- Double click the NS3Kview desktop icon to run utility.
- Click “Settings” and then “Communications”.



- For the CW47, the baud rate is 38400. Select the com port that is connected to the CW47.

APPENDIX 1 continued

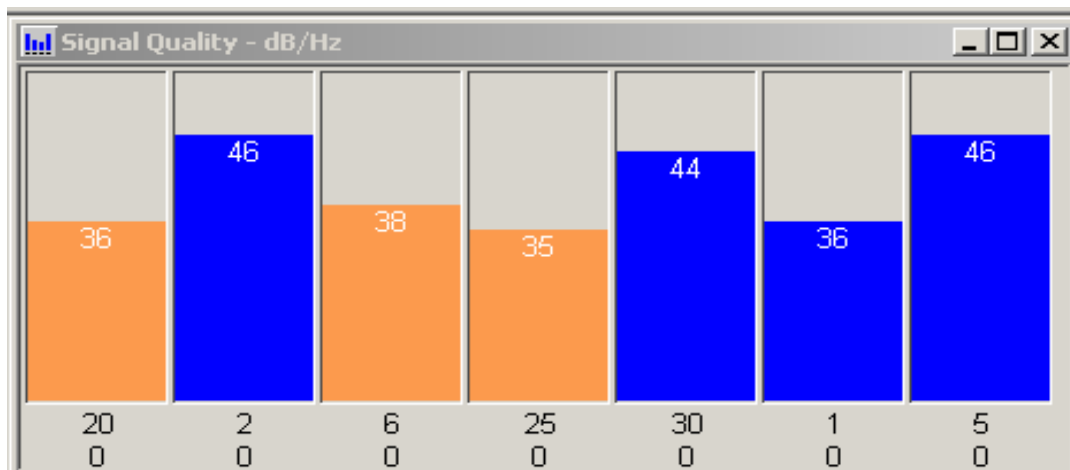
- With the unit powered on, you should see data streaming in the 'NMEA Monitor Window', as below.



```
$POLYS,07,30,-,32,27,-,33,03,-,34,28,-,  
$POLYI,EXT,INT,VPOS,*43  
$GPGLL,8960.000000,N,00000.000000,E,000226.431,V,M  
$GPRMC,000226.431,V,8960.000000,N,00000.000000,E,0.0  
$GPGGA,000226.431,8960.000000,N,00000.000000,E,0.7  
$GPGSA,A,1,,,,,,,,,,,,,99.99,99.99,99.99*30  
$GPGSV,2,1,07,30,,32,27,,33,03,,34,28,,33*74  
$GPGSV,2,2,07,31,,32,22,,33,20,,34*78  
$POLYP,000226.431,8960.000000,N,00000.000000,E,0.0  
$POLYS,07,30,-,32,27,-,33,03,-,34,28,-,  
$POLYI,EXT,INT,VPOS,*43
```

1.3 Checking for 3D Lock on NS3KView

- Once streaming bars will appear in the window called signal quality.
- These bars indicate the satellites in view and the signal strength from these satellites.
- A 3D lock is obtained when four or more satellites turn blue, as seen below:



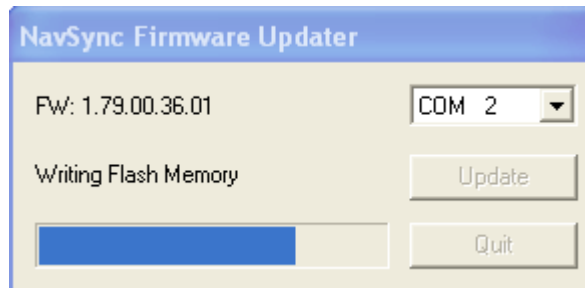
APPENDIX 2

CW47 Programming Instructions

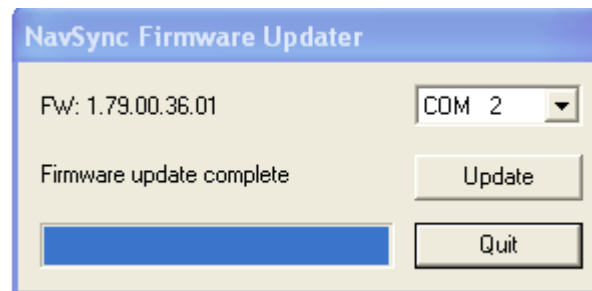
If a firmware update for the CW47 is required, NavSync will provide the programming utility, "NavSync Firmware Updater". The programming utility will contain the new firmware image.

Follow the steps below:

1. The CW47 will need to be powered on and streaming the computers com port.
2. Execute the received file by double-clicking it.
3. Select the com port, which the CW47 is connected. No other applications, other than the NavSync Firmware Updater, should be connected to this port.
4. Click "Update".
5. The flash programming should begin.



6. When the programming is complete (as below), click "Quit".



7. The unit will restart and NMEA data should be available again.
8. Check the version with the command: \$PRTHQ,VERS<cr><lf>. The version number should be the same as the number in the NavSync firmware updater utility. See Appendix 1 on how to do this using graphical NS3Kview software.

APPENDIX 3

GPS Information

GLOBAL POSITIONING SYSTEM (GPS)

The Global Positioning System (GPS) is a military satellite based navigation system developed by the U.S. Department of Defence, which is also made freely available to civil users.

Civilian use of GPS is made available at the user's own risk, subject to the prevailing DOD policy or limitations, and to individuals understanding of how to use the GPS.

In today's satellite constellation there are a minimum of 24 operational satellites (plus several operational spares) in 6 orbital planes, at an altitude of about 22,000 km. The GPS system can give accurate 3-D position, velocity, time, and frequency, 24 hours a day, anywhere around the world. GPS satellites transmit a code for timing purposes, and also a 'navigation message', which includes their exact orbital location and system integrity data. Receivers use this information, together with data from their internal almanacs, to precisely establish the satellite location. The receiver determines position by measuring the time taken for these signals to arrive. At least three satellites are required to determine latitude and longitude if your altitude is known (e.g. a ship at sea), and at least a fourth to obtain a 3-D fix.

GPS Positioning and Navigation

The CW47 receiver needs to be able to see at least 4 satellite vehicles (SV's) to obtain an accurate 3-D position fix. When travelling in a valley or built-up area, or under heavy tree cover, it can be difficult to acquire and maintain a coherent satellite lock. Complete satellite lock may be lost, or only enough satellites (3) tracked to be able to compute a 2-D position fix or even a poor 3D fix due to insufficient satellite geometry (i.e. poor DOP). Inside a building or beneath a bridge, it probably will not be possible to update a position fix. The receiver can operate in 2-D mode if it goes down to seeing only 3 satellites by assuming its height remains constant. But this assumption can lead to very large errors, especially when a change in height does occur. A 2-D position fix is not to be considered a good or accurate fix; it is simply "better than nothing".

The receiver's antenna must have a clear view of the sky to acquire satellite lock. It is the location of the antenna that will be given as the position fix. If the antenna is mounted on a vehicle, survey pole, or backpack, allowance for this must be made when using the solution.

To measure the range from the satellite to the receiver, two criteria are required: signal transmission time, and signal reception time. All GPS satellites have several atomic clocks that keep precise time and these are used to time-tag the message and control the transmission sequence of the coded signal.

The receiver has an internal clock to precisely identify the arrival time of the signal. Transit speed of the signal is a known constant (the speed of light), therefore: $\text{time} \times \text{speed of light} = \text{distance}$.

Once the receiver calculates the range to a satellite, it knows that it lies somewhere on an imaginary sphere whose radius is equal to this range. If a second satellite is then found, a second sphere can again be calculated from this range information. The receiver will now know that it lies somewhere on the circle of points produced where these two spheres intersect.

When a third satellite is detected and a range determined, a third sphere would intersect the area formed by the other two. This intersection occurs at just two points. The correct point is apparent to the user, who will at least have a very rough idea of position. A fourth satellite is then used to synchronize the receiver clock to the satellite clocks.

In practice, just 4 satellite measurements are sufficient for the receiver to determine a position, as one of the two points will be totally unreasonable (possibly many kilometers out into space).

This assumes the satellite and receiver timing to be identical. In reality, when the CW47 receiver compares the incoming signal with its own internal copy of the code and clock, the two will no longer be synchronized. Timing error in the satellite clocks, the receiver, and other anomalies, mean that the measurement of the signals transit time is in error. This effectively, is a constant for all satellites, since each measurement is made simultaneously on parallel tracking channels. Because of this, the resultant ranges calculated are known as "pseudo-ranges".

To overcome these errors, the CW47 receiver then matches or "skews" its own code to become synchronous with the satellite signal. This is repeated for all satellites in turn, thus measuring the relative transit times of individual signals. By accurately knowing all satellite positions, and measuring the signal transit times, the user's position can be accurately determined.

Utilizing its considerable processing power, the CW47 receiver rapidly updates these calculations from satellite data to provide a real time position fix.

APPENDIX 3 continued

Standard Positioning Service (SPS)

Civil users worldwide are able to use the SPS without restriction or charge.

Dilution Of Precision (DOP) is a measure of the satellite geometry, and is an indicator of the potential quality of the solutions. The lower the numerical value, the better the potential accuracy (for example, a PDOP below 3 indicates good satellite geometry). For 3-D positioning, fluctuations in DOP can be harmful to the solution, especially in kinematic/dynamic modes.

The following DOP terms are computed by CW47:

HDOP	Horizontal Dilution of Precision	(Latitude, Longitude)
VDOP	Vertical Dilution of Precision	(Height)
TDOP	Time Dilution of Precision	(Timing errors)
PDOP	Position Dilution of Precision	(3-D positioning)
GDOP	Geometric Dilution of Precision	(3-D position & Time)

Estimated accuracy = DOP x measurement accuracy

While each of these terms can be individually computed, they are formed from co-variances, and are not independent of each other. For example, a high TDOP will cause receiver clock errors that will eventually result in increased position errors. Horizontal accuracy figure of 95% is the equivalent to 2RMS (twice root-mean-square), or twice the standard deviation radial error.

Similarly, for vertical and time errors, a figure of 95% is the value of 2 standard deviations of vertical or time error.

Root-mean-square (RMS) error is the value of one standard deviation (67%) of error.

Circular Error Probability (CEP) is the value of the radius of a circle, centred at a position containing 50% of the position estimates. Spherical Error Probability (SEP) is the spherical equivalent of CEP, which is centred at a position containing 50% of the position estimates.

CEP and SEP are not affected by large errors, which could make the values an overly optimistic measurement. These probability statistics are not suitable for use in a high accuracy positioning system. The CW47 reports all accuracy's in the form of a standard deviation (RMS) value.

Precise Positioning Service (PPS)

This service is only available to authorized users with cryptographic equipment and special receivers. Access is limited to the U.S. and allied military, U.S. Government agencies, and selected civil users specifically approved by the U.S. Government.

APPENDIX 4

Bracket Installation

Bracket contains:

Fasteners:

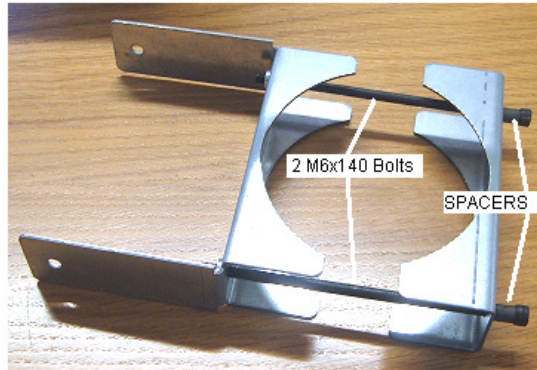
- 4 M3x10 Socket Cap Screws (No1)
- 2 M6x10 Socket Cap Screws (No2)
- 2 M6x140 Socket Cap Screws (No3)
- 2 M6 Spacers

Bracket Pieces:

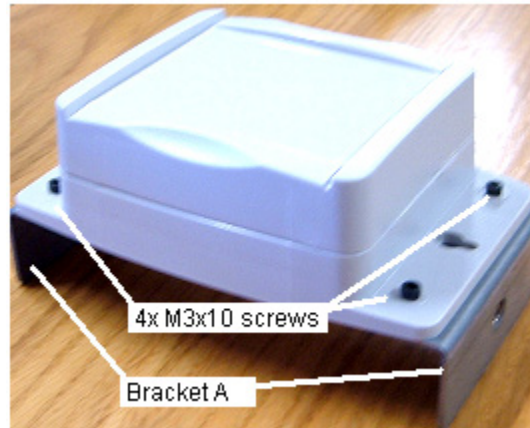
- 2 80x30mm Brackets (A)
- 1 145x150mm Bracket (B)
- 1 45x154mm Bracket (C)

Installation steps:

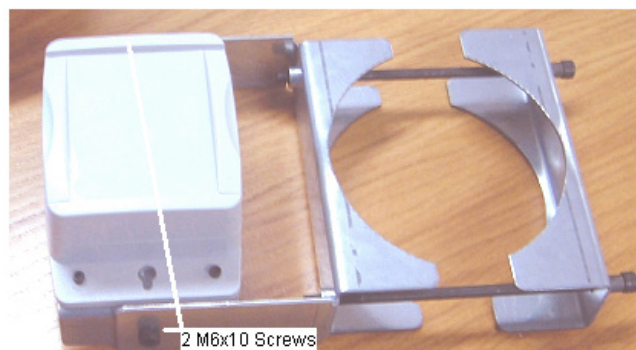
1. Fix bracket Pieces B +C to the pole with the two long screws (No. 3). Spacers can be used, if needed, for the smaller pole diameters.



2. Fix the two small bracket pieces (A) to the CW47 unit, using the four small screws (No. 1).



3. Attach the CW47-bracket assembly to the pole assembly using the two medium size screws (No. 2). Adjust position of CW47, with these two screws, such to optimize the sky-view.



APPENDIX 5

Glossary

2D	Two-Dimensional
3D	Three Dimensional (i.e. including altitude)
AGC	Automatic Gain Control
Almanac	Data transmitted by each satellite, and which provides the approximate orbital information of all the GPS satellites constellation (i.e. a 'timetable').
Antenna	Also called 'Aerial', the device for receiving the radio signals.
ASCII	A standard digital format for alpha-numeric characters (American Standard Code for Information Interchange).
Baud	Serial digital communication speed units (bits per second).
BIT	Built in Test
CDU	Control-Display Unit
CEP	Circular Error Probability
Channel	The satellite tracking unit of a GPS receiver. One channel may track more than one satellite, by multiplexing, but for best performance each satellite should be continuously tracked by a dedicated channel so more than one channel is often integrated into a receiver.
CMOS	A type of semiconductor fabrication process (Complementary Metal Oxide Semiconductor), resulting in low power. CMOS devices require static protection during handling.
C/No	Carrier to Noise ratio (a measure of signal quality)
COM Port	Communication port, e.g. PC serial communication ports COM1 etc.
CONUS	Continental United States
CPU	Central Processing Unit (usually the microprocessor)
CTS	Clear to Send (serial communication handshaking)
Datum	The reference shape of the Earth's surface used in the construction of a map or chart. Usually chosen for a 'best fit' over the area of interest and thus the Datum for various parts of the world may differ.
Delta range	Small changes in range between a satellite and the receiving antenna.
DOD	US Department of Defense
DOS	Disk Operating System.
DOP	A DOP (Dilution of Position) is a figure which represents the purely geometrical contribution of the satellites' positions to the total position error budget. Low values of a DOP (1 - 5) mean that the calculated position should be good whilst higher DOP values indicate a greater uncertainty in the determined position. Good DOP values are obtained when satellites are well spaced geometrically, whilst poor values result from available satellites all being visible in similar directions. When the DOP value is excessive (e.g. > 100) then neither stand-alone nor differential positions should be used.
DR	Dead Reckoning - a means of estimating present position based on a known starting position updated by applying distance and direction of the user's movements.
DSR	Data Set Ready (serial communication handshaking)
DTR	Data Terminal Ready (serial communication handshaking)
ECEF	Earth Centered Earth Fixed.
Ellipsoidal	Height as defined from the Earth's centre by a reference
Height	ellipsoid model (see Datum)
EMI/EMS/EMC	Electromagnetic Interference (emitted from equipment), Susceptibility (to interference from other equipment), and Compatibility (EMI + EMS)
EPS	Emergency Power Supply, only for maintaining the RTC data in the RAM when the equipment is powered down
ENU	East North Up (the order of listing co-ordinates)
Ephemeris	Similar to Almanac, but providing very accurate orbital data of each individual satellite and transmitted by the satellite concerned
Firmware	Program resident within the receiver.
GDOP	Geometrical Dilution of Precision
Geoid	The Mean Sea Level surface of the Earth
Geoid/Ellipsoid	Difference between the Mean Sea Level and the separation mathematical model used to define a datum, at the point of interest

APPENDIX 5 continued

Glossary continued...

GHz	Gigahertz, one thousand MHz (i.e. 10^9 Hz)
GMT	Greenwich Mean Time (similar to UTC)
GPS	Global Positioning System
GPS time	Time standard for the GPS system (seconds are synchronous with UTC)
Hex	Denotes a number in hexadecimal format
HDOP	Horizontal Dilution of Precision
IC	Integrated Circuit
ICD	Interface Control Document
I/O	Input - Output
IODE	Issue of Data Ephemeris
IRQ	Interrupt Request
Kalman Filter	Mathematical process used to smooth out measurement errors of pseudo-ranges and carrier phases of tracked satellites. For example '8 states' refers to filtering of position and time (i.e. x, y, z and t) and the rate of change of each
knot	Nautical mile per hour
L1	The 1575.42 MHz frequency radiated by GPS satellites
L-band	The band of radio frequencies between 1 and 2 GHz
Lithium	A metallic element (used in batteries)
LMT	Local Mean Time
mA	Milliamp (of current)
Macro	Text containing frequently used operations which can be executed as a single command (DM only)
MHz	Megahertz, i.e. one million cycles per second
mph	Miles per Hour
MSL	Mean Sea Level = geoidal height = 0
MIL-STD	Military Standard
Multiplexing	A receiver channel can track multiple satellites by switching rapidly between them so as to gather all data transmissions
NMEA	National Marine Electronics Association
NMEA 0183	A serial communication standard defining hardware compatibility, message formats, and a range of standard messages
OTF	On-The-Fly carrier phase ambiguity resolution. The ability to resolve integer carrier phase ambiguities in real-time while moving
n.mile	International Nautical Mile (1852 meters; 6076.1 feet, 1.15 statute miles)
ns, nSec	Nanosecond, one thousandth of a microsecond (i.e. 10^{-9} second)
PC	Personal Computer (IBM compatible)
PCB	Printed Circuit Board
P-code	The Precise (or Protected) GPS code - not available to civil users
PDOP	Position Dilution of Precision, including horizontal and vertical components
pps, PPS	Pulse per Second, and Precise Positioning Service
PRN	Pseudo-Random Noise code unique to each satellite's message and therefore used to identify each satellite
Pseudo Range	The apparent measured 'straight line' distance from a satellite to the receiving antenna at any instant in time, including any errors caused by satellite clocks, receiver clocks, refraction of the radio waves, etc.
PSU	Power Supply Unit
RAM	Random Access Memory
Real Numbers	Numbers which may have decimal point and fractional component
Resolution	Smallest separation of two display elements
RF	Radio frequency
RFI	Radio Frequency Interference
RMS	Root Mean Square

APPENDIX 5 continued

Glossary continued...

RPS	Relative Positioning System
RS232	Serial communication hardware standard (+/- 12v nom.)
RS422	A serial communication hardware standard (differential)
RTCM	Radio Technical Committee for Maritime Services
RTC	Real-time Clock (maintaining approximate time when unit is off)
RTK	Real Time Kinematic
RTS	Request to Send (serial communication handshaking)
RXD	Receive Data (serial communication to Data Terminal or 'DTE' from Data Communication Equipment or DCE')
S/A	Selective Availability - imposed by the DOD to limit the GPS performance available to civil users.
SEP	Spherical Error Probability
SMA	Miniature threaded coaxial connector.
SPS	Standard precision Service
SSR	Solid State Recorder
SV	Satellite Vehicle
TNC	A standard threaded coaxial connector
TSPI	Time Space Position Information
TTL	Transistor-transistor Logic (family of digital electronic components)
TTFF	Time to First Fix
TXD	Transmit Data (serial communication from Data Terminal or 'DTE' to Data Communication Equipment or 'DCE')
us, uSec	Microsecond (u is frequently used for the Greek μ symbol denoting 'micro', one millionth part, 10^{-6})
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
UART	Universal Asynchronous Receiver-transmitter (used in serial communications)
VDOP	Vertical Dilution of Precision
WGS	World Geodetic System (a world-wide Datum, GPS works in WGS84 which has superseded WGS72)

APPENDIX 6

Contact Details

For further details and hotline support please contact:

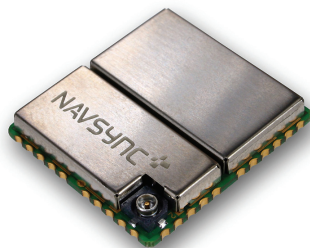
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CW47 User Manual



APPENDIX 7

Additional GPS Information

U.S. Coast Guard Navigation Center

Civilian GPS service notices, general system information, and GPS outage reporting:
www.navcen.uscg.gov

U.S. Naval Observatory

General USNO information and links to USNO timing and other useful sites:
www.usno.navy.mil

NavSync GPS Homepage

www.NavSync.com

General GPS Information and links to other useful GPS sites:

USAF GPS Wing
www.losangeles.af.mil

National Marine Electronics Association (NMEA)

For information on the NMEA protocol specification:
www.nmea.org

General GPS Information

Glossary of GPS terms:
www.gpsworld.com/resources/glossary.htm

Revision	Revision Date	Notes
R00	05/05/09	Initial Release
R01	06/03/09	Appendix 4 added
R02	09/08/09	Communication Protocol Revisions
R03	05/25/11	Specification Updates

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