CW25
User Manual

Issue: 1.0

CW25

1. Introduction

The CW25 (CW25) is a small size GPS OEM module that has been specifically designed for use in weak signal GPS environments and for rapid integration into host systems, while maintaining all the features of a standard GPS solution, such as high accuracy.

Normal GPS systems cannot track satellites below –176 dBW (-146 dBm) however the CW25 can track down a further 10 dB resulting in tracking down to –186 dBW (-156 dBm). This makes it possible to track the person, asset or vehicle as they enter buildings, move under dense vegetation, or drive through dense urban canyons. Furthermore the CW25 can also acquire the satellites in these locations when using Network Assistance techniques, or pre-loaded information. In order to obtain this level of performance the CW25 uses an innovative GPS engine built into its BB25 IC, which enables the system to search in parallel 12288 time/frequency bins. Not only does this enable better sensitivity but also makes for very rapid acquisition of the satellites. At outdoor signal levels the time taken to obtain a 'hot' position fix is under 2 seconds.

With a size of just over an inch square (25 x 27 mm) the CW25 is specifically designed to be integrated with Communications devices such as GSM, CDMA, UMTS modems or any other communications medium. The CW25 is also optimised for the output of time/ frequency information.

Key Features of the CW25 include:

- Enables indoor use
    - -185 dBW acquisition and –186 dBW tracking
- Rapid Time To Fix
    - <2 second outdoors
    - <5 second indoors
- Standalone MCM module
    - No GPS knowledge required for hardware integration
- 25 mm x 27 mm x 4.2 mm

This document, provides information on the Hardware and Software elements of the CW25.

Key information includes:

- System Block Diagram
- Maximum Ratings

- Physical Characteristics
  - MCM Dimensions, castellation information
  - Solder Pad and placement information
- Signal Descriptions
- Special Features
- Application Information
  - Power supply modes
  - RF connections
  - Grounding
  - Battery Back-up
  - Over Voltage and Reverse Polarity
  - LED's

The CW25 is available in a number of standard software builds, depending on the application for which it is to be used. In special cases, the CW25 may be supplied with a slightly different hardware build. The specifications in the following sections refer to the standard builds.

2. SPECIFICATION

2.1 Performance

CW25 GPS RECEIVER SPECIFICATIONS[1]

Physical	Module dimensions	25mm (D) x 27mm (W) x 4.2mm (H)
	Supply voltages	3V3 (Digital I/O), 3V3 (RF), 1V8 (Core option), 3V (Standby Battery)
	Operating Temp	-40°C to +75°C
	Storage Temp	-55°C to +125°C
	Humidity	5% to 95% non-condensing
	Max Velocity / Altitude	515ms^{-1} / 18,000m (increased rating version available subject to export license)
	Max Acceleration / Jerk	4g / 1gs^{-1} (sustained for less than 5 seconds)
Sensitivity	Acquisition/Tracking	-185dBW / -186dBW
Acquisition Time	Hot Start with network assist	Outdoor: <2s Indoor (-178dBW): <5s
	Stand Alone (Outdoor)	Cold: <45s Warm: <38s Hot: <5s Re-acquisition: <1s (90%confidence)
Accuracy	Position: Outdoor / Indoor	<5m rms / <50m rms
	Velocity	<0.05ms^{-1}
	Latency	<200ms
	Raw Measurement Accuracy	Pseudorange <0.3m rms, Carrier phase <5mm rms
	Tracking	Code and carrier coherent
Power	1 fix per second	0.25W typically
	Coma Mode Current	<10mA
Interfaces	Serial	3 ports, CMOS levels; USB v1.1
	Multi function I/O	1PPS and Frequency Output

		Event Counter/Timer Input
		4 x GPIO (multi-function)
		2 x LED Status Drive
		I^2C, External Clock (on special build)
	Protocols	Network Assist, NMEA 0183,Proprietary ASCII and binary message formats
	1pps Timing Output	30ns rms accuracy, <5ns resolution
		User selectable pulse width
	Event Input	30ns rms accuracy, <10ns resolution
	Frequency Output	10Hz to 10MHz
	Receiver Type	12 parallel channel x 32 taps up to 32 point FFT.
General	Processor	ARM 966E-S on a 0.18µ process at up to 120MHz.

Table 1 CW25 Specification

Footnotes

1. The features listed above may require specific software builds and may not all be available in the initial release.

2.2 Recommended Ratings

Symbol	Parameter	Min	Max	Units
RF_3V3	RF Supply Voltage	+3.0	+3.6	Volts
DIG_3V3	Digital Supply Voltage	+3.0	+3.6	Volts
DIG_1V8	Digital Supply Voltage	+1.65	+1.95	Volts
VBATT	Battery Backup Voltage	+2.7	+3.5	Volts
ANT_SUPPLY	Antenna Supply Voltage	+3.0	+12	Volts

Table 2 Absolute Maximum Ratings

2.3 Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Units
RF_3V3	RF Supply Voltage	-0.3	+6.5	Volts
DIG_1V8	Digital Supply Voltage	-0.3	+2.0	Volts
DIG_3V3	Digital Supply Voltage	-0.3	+3.7	Volts
VBATT	Battery Backup Voltage	-0.5	+7.0	Volts

ANT_SUPPLY	Antenna Supply Voltage	-15	+15	Volts
DIG_SIG_IN	Any Digital Input Signal	-0.3	+5.5	Volts
RF_IN	RF Input	-15	+15	Volts
T_{STORE}	Storage temperature	-55	+150	°C
T_{BIAS}	Temperature under bias	-40	+100	°C
I_{OUT}	Digital Signal Output Current	-6	+6	mA

Table 3 Absolute Maximum Ratings

2.4 Block Diagram

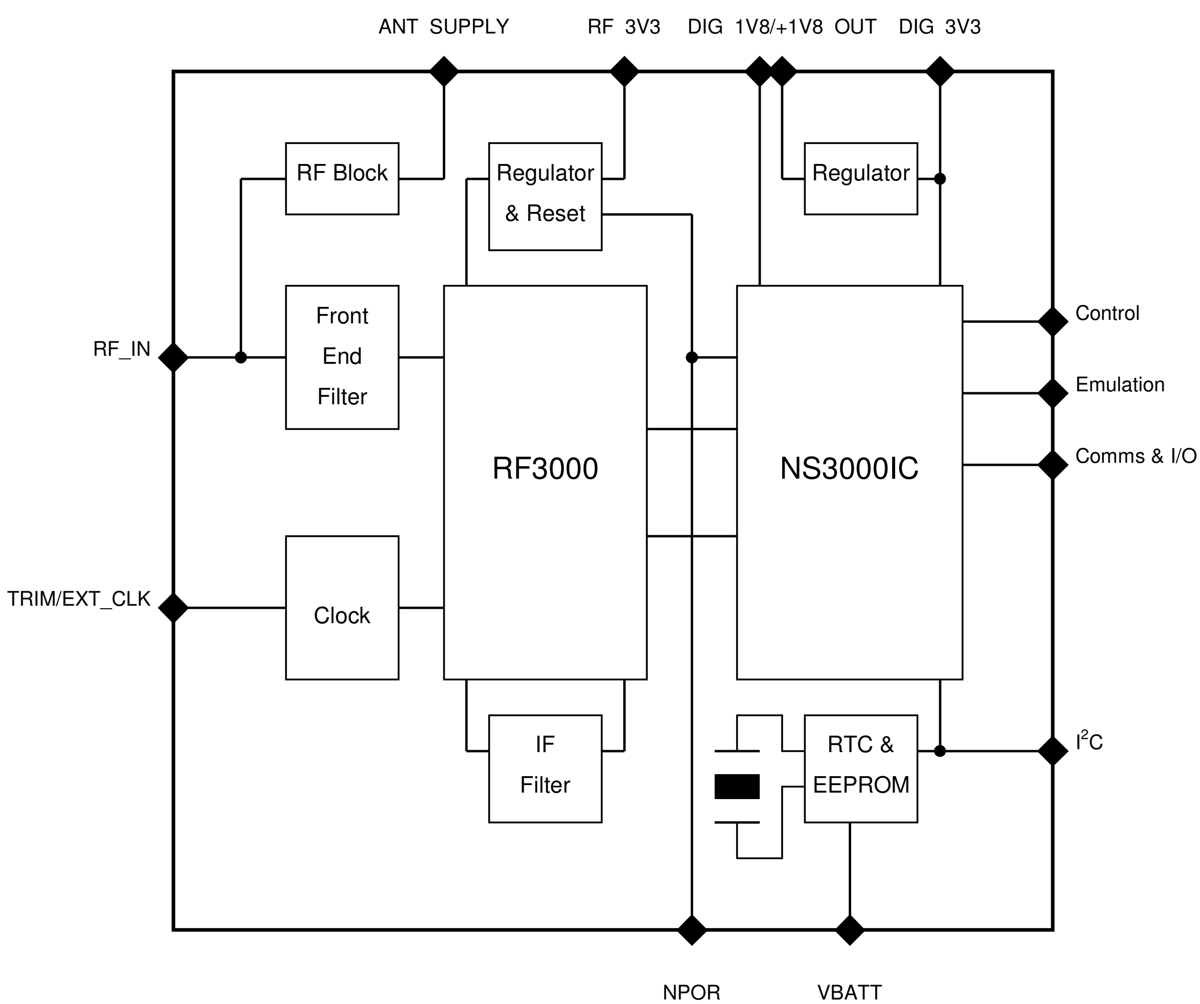


Figure 1 CW25 Block Diagram

3. PHYSICAL CHARACTERISTICS

The CW25 is a multi-chip module built on an FR4 fibreglass PCB. All digital and power connections to the MCM are via castellations on the 25 x 27 mm PCB. The RF connection is via castellations or an RF connector. The general arrangement of the CW25 is shown in the diagram below. Dimensions in mm (inches/1000).

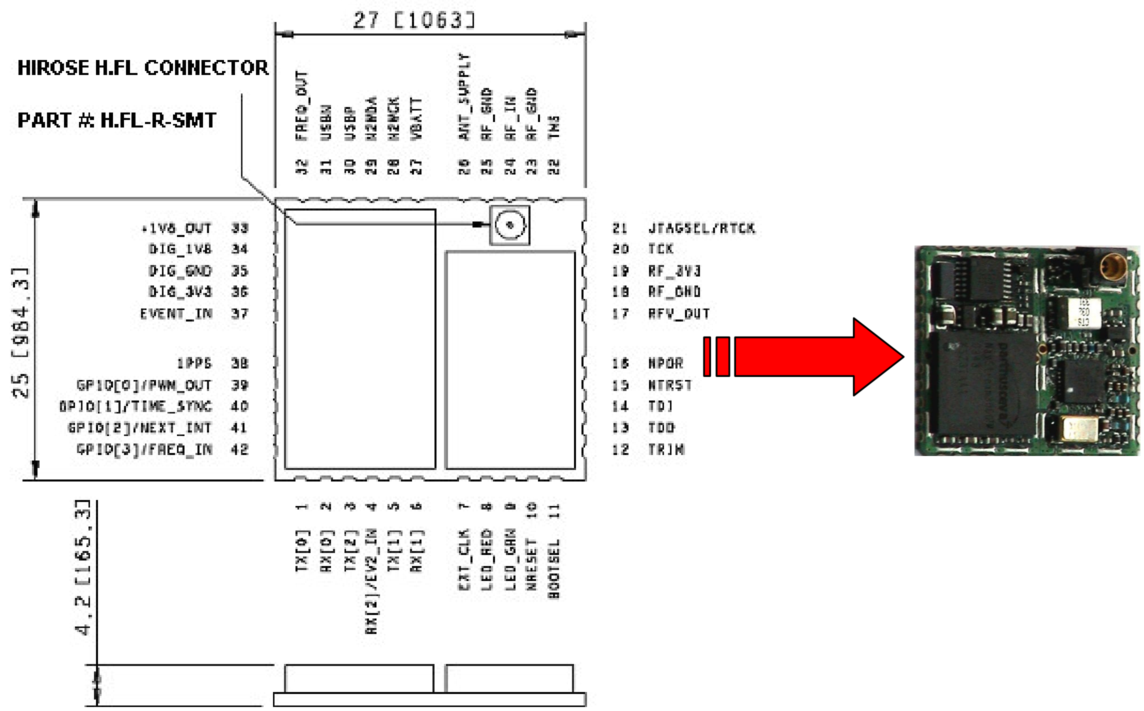


Figure 2 CW25 Form and Size

3.1 Physical Interface Details

The interface to the MCM is via 1mm castellation on a 2mm pitch. There are 42 connections in all. There is also an RF connector for connecting to the GPS antenna. The details of the interface connections are given below.

Pin	Function	Pin	Function
1	TX[0]	22	TMS
2	RX[0]	23	RF_GND
3	TX[2]	24	RF_IN
4	RX[2]/EV2_IN	25	RF_GND
5	TX[1]	26	ANT_SUPPLY
6	RX[1]	27	VBATT
7	EXT_CLK	28	N2WCK
8	LED_RED	29	N2WDA
9	LED_GRN	30	USBP
10	NRESET	31	USBN

11	BOOTSEL	32	FREQ_OUT
12	TRIM	33	+1V8_OUT
13	TDO	34	DIG_1V8
14	TDI	35	DIG_GND
15	NTRST	36	DIG_3V3
16	NPOR	37	EVENT_IN
17	RFV_OUT	38	1PPS
18	RF_GND	39	GPIO[0]/PWM_OUT
19	RF_3V3	40	GPIO[1]/TIME_SYNC
20	TCK	41	GPIO[2]/NEXT_INT
21	JTAGSEL/RTCK	42	GPIO[3]/FREQ_IN

Table 4 CW25 Signal List

3.2 MCM Dimensions

The figure below provides the dimensions of the positioning of the CW25 castellations. Dimensions in mm (inches/1000).

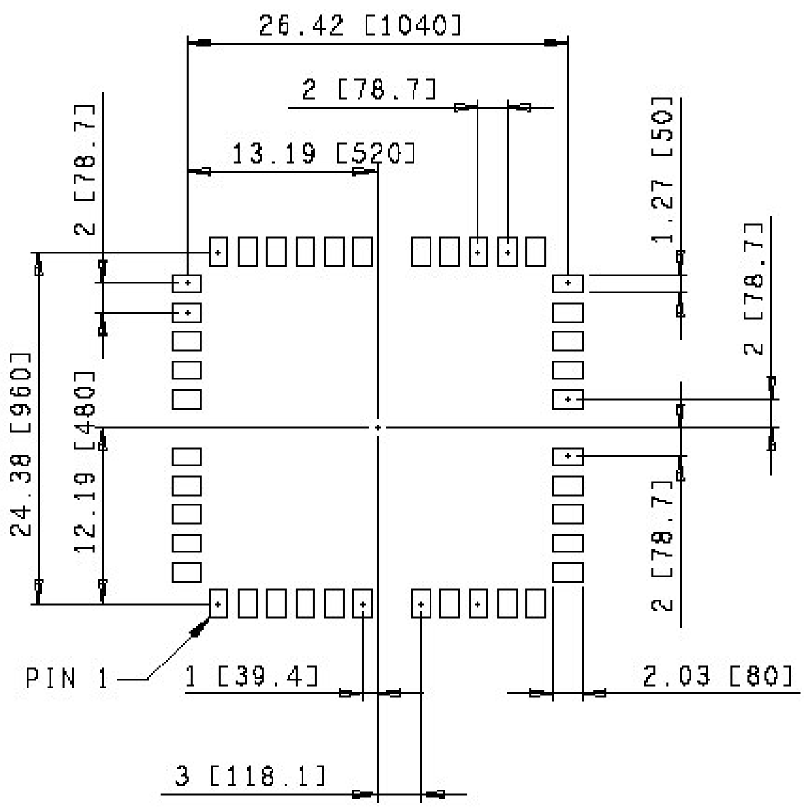


Figure 3 MCM Dimensions

3.3 Solder Pad Size and Placement

It is recommended that the footprint of the solder pad under each castellation be 2mm x 1mm, centred on the nominal centre point of the radius of the castellation. The castellations are gold plated and so are lead free. Note that if the RF_IN **connector** is being used, there should not be a pad or solder resist under the RF_IN castellation. If the RF_IN **castellation** is to be used, the pad should be shortened by 0.5mm underneath the CW25 and standard RF design practices must be observed. The diagram below shows the placement of the pads under the castellations.

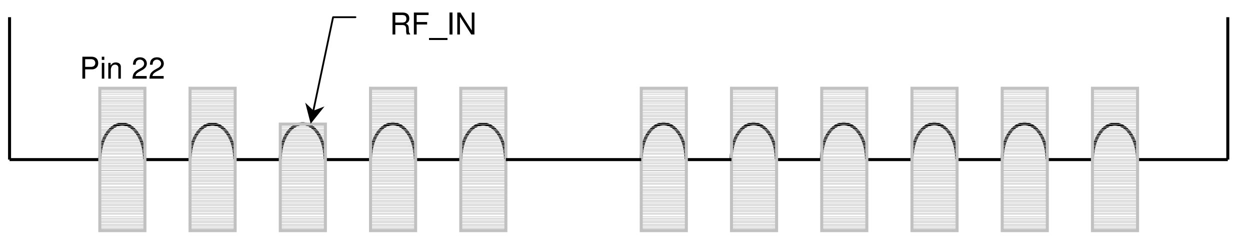


Figure 4 Solder Pad Size and Placement

4. SIGNAL DESCRIPTION

The signals on the CW25 are described in the table below. All Test, Control and I/O ports are CMOS 3.3V comp[atible unless specified otherwise.

4.1 Power Signals

RF_3V3	Type: Power	Direction: Input	Pin: 19
	The RF supply input. This 3.3V ± 10% input supplies the 2.9V LDO regulator in the RF section of the CW25. It is important that this supply is well filtered with no more that 50mV peak to peak noise with respect to RF_GND.		

RF_GND	Type: Power	Direction: Input/Output	Pins: 18, 23, 25
	The RF input ground. This is the return path for the RF_3V3 supply and the ground for the antenna feed. The RF_GND must be tied to the DIG_GND externally to the CW25.		

RFV_OUT	Type: Power	Direction: Output	Pin: 17
	The output from the LDO regulator (3.0V) that is powered by the RF_3V3 signal. This supplies the power to the RF subsystem of the CW25. This may also be used to power external RF components but care must be taken not to inject noise onto this signal. No more than an additional 30mA may be taken from this signal by external circuitry.		

ANT_SUPPLY	Type: Power	Direction: Input	Pin: 26
	The antenna supply voltage. This may be used to supply power to the RF_IN signal, for use by an active antenna. The maximum voltage should not exceed ±15V and the current should be limited to 50mA.		

DIG_3V3	Type: Power	Direction: Input	Pin: 36
	The digital supply input. This 3.3V ± 10% input supplies the I/O ring of the NS3000IC chip and the LDO regulator in the digital section of the CW25. It is important that this supply is well filtered with no more that 50mV peak to peak noise with respect to DIG_GND.		

DIG_1V8	Type: Power	Direction: Input	Pin: 34
	The 1.8V ± 5% digital core supply for the NS3000IC. This is normally connected directly to the +1V8_OUT signal. However, if an external 1.8V ± 5% is available, a lower overall system power consumption may be achieved by using an external supply.		

+1V8_OUT	Type: Power	Direction: Output	Pin: 33
	The 1.8V output from the LDO regulator that is powered by the DIG_3V3 signal. Normally, this is connected to the DIG_1V8 signal. This may also be used to power external logic but care must be taken not to inject noise onto this signal. No more than an additional 50mA may be taken from this signal by external logic.		

DIG_GND	Type: Power	Direction: Input/Output	Pin: 35
	The digital ground. This is the return path for the DIG_3V3 supply and the ground reference for all the digital I/O. The DIG_GND must be tied to the RF_GND externally to the CW25.		

VBATT	Type: Power	Direction: Input/Output	Pin: 27
	The battery backup supply. The CW25 has an on board Real Time Clock (RTC). This is powered from the VBATT signal. A supply of typically 3v (greater than 2.5V and less than DIG_3V3) should be applied to this signal. This signal can be left floating if not required. The input has a blocking diode and so rechargeable batteries will need an external charging circuit. Typically, a 1K resister in series with this signal and the external battery will provide an easy method of measuring the current consumption from VBATT during test.		

4.2 RF Signals

RF_IN	Type: RF	Direction: Input	Pin: 24
	The RF input signal. This attaches to the GPS antenna. Standard RF design rules must be used when tracking to this signal. This signal has an RF blocked connection to the ANT_SUPPLY signal. This is the same signal presented on the RF connector on the CW25. Only one antenna connection should be made. If the RF connector is to be used, then there should be no connection, even an unconnected pad, to this castellation.		

TRIM	Type: RF	Direction: Input	Pin: 12
	This signal trims the output frequency of the VCTCXO. This signal is normally left open. When floating, this signal is biased to the control voltage of the VCTCXO. Any noise injected into this signal will severely compromise the performance of the CW25. This signal should only be used in conjunction with specific application notes.		

EXT_CLK	Type: RF	Direction: Input	Pin: 7
	This signal normally has no internal connection in the CW25. In special builds of the CW25 that are not fitted with an internal VCTCXO, this input is the external clock input. The external clock is a 9MHz to 26MHz clipped sign wave input with an amplitude between 1V and 3V peak to peak. The return path for this signal is RF_GND.		

4.3 Emulation/Test Signals

TDI	Type: Test	Direction: Input	Pin: 14
	The Test Data In signal. This is the standard JTAG test data input. The signal return path is DIG_GND.		

TDO	Type: Test	Direction: Output	Pin: 13
	The Test Data Out signal. This is the standard JTAG test data output. The signal return path is DIG_GND.		

TCK	Type: Test	Direction: Input	Pin: 20
	The Test Clock signal. This is the standard JTAG test clock input. The signal return path is DIG_GND.		

TMS	Type: Test	Direction: Input	Pin: 22
	The Test Mode Select signal. This is the standard JTAG test mode input. The signal return path is DIG_GND.		

JTAGSEL/ RTCK	Type: Test	Direction: Input/Output	Pin: 21
	This is a dual function signal. When the NPOR signal is asserted (low), this signal is an input and selects the function of the JTAG interface. When high, JTAG emulation into the embedded ARM9 processor is selected. When low, the NS3000IC chip boundary scan mode is selected. The value on this signal is latched when NPOR de-asserts (goes high). When NPOR is de-asserted (high) and the JTAG emulation mode has been latched, this signal provides the return clock to the ARM Multi-ICE. Because the ARM9 functions off a single clock domain, the TCK has to be internally synchronised in the ARM9. This can cause a variable length delay in the validity of the TDO signal. The RTCK is a synchronised version of the TCK signal. The Multi-ICE uses the RTCK output signal to indicate when the TDO signal is valid. The signal return path is DIG_GND.		

NTRST	Type: Test	Direction: Input	Pin: 15
	The Test Reset signal. This is the active low JTAG test reset signal. The signal return path is DIG_GND.		

4.4 Control Signals

NPOR	Type: Control	Direction: Input/Output	Pin: 16
	The Power On Reset signal. This active low, open collector signal is the master reset for the CW25. The CW25 can be held in reset by asserting this signal. The signal can be used to reset external circuitry, but care must be taken to ensure no DC current is drawn from this signal as the internal pull-up resistor value is 100K.		

NRESET	Type: Control	Direction: Input/Output	Pin: 10
	The system reset signal. This active low, open collector signal is generated by the NS3000IC chip in response to the assertion of the NPOR. It may also be driven to reset the ARM9 processor in the NS3000IC without completely re-initialising the chip.		

BOOTSEL	Type: Control	Direction: Input	Pin: 11
	The boot select signal. The NS3000IC has four boot up modes, but only two are supported by the CW25. This signal is sampled when the NPOR is de-asserted. If the BOOTSEL signal is high or left floating, then the CW25 boots from its on-chip FLASH memory. If the BOOTSEL signal is pulled low, the CW25 boots from its on-chip ROM.		

4.5 I/O Signals

TX[0]	Type: I/O	Direction: Output	Pin: 1
	The transmit signal for UART 0. This is a standard UART output signal. The signal return path is DIG_GND.		

TX[1]	Type: I/O	Direction: Output	Pin: 5
	The transmit signal for UART 1. This is a standard UART output signal. The signal return path is DIG_GND.		

TX[2]	Type: I/O	Direction: Output	Pin: 3
	The transmit signal for UART 2. This is a standard UART output signal. The signal return path is DIG_GND.		

RX[0]	Type: I/O	Direction: Input	Pin: 2
	The receive signal for UART 0. This is a standard UART input signal. The signal return path is DIG_GND.		

RX[1]	Type: I/O	Direction: Input	Pin: 6
	The receive signal for UART 1. This is a standard UART input signal. The signal return path is DIG_GND.		

RX[2]/ EV2_IN	Type: I/O	Direction: Input	Pin: 4
	This is a dual mode signal. Normally, this is the receive signal for UART 2, a standard UART receive signal. Under software control, it can also be used as general purpose I/O or to detect events. It can be used to detect the timing of the leading edge of the start bit of the incoming data stream. The signal return path is DIG_GND.		

FREQ_OUT	Type: I/O	Direction: Input/Output	Pin: 32
	The frequency output signal. This is a complex signal which under software can provide any of either an NCO generated output frequency, a PWM signal, a GPS aligned EPOCH pulse or general purpose I/O signal. The signal return path is DIG_GND.		

1PPS	Type: I/O	Direction: Input/Output	Pin: 38
	The 1 pulse per second signal. This is normally a 1 pulse aligned with GPS time, but can under software control also provide general purpose I/O or an additional even input. The pulse width of the 1PPS is software selectable with a default of 100µs. The signal return path is DIG_GND.		

EVENT_IN	Type: I/O	Direction: Input/Output	Pin: 37
	The event input signal. This is normally an event timer or counter. Events are timed against GPS time. Under software control, this input can be used as an external 48MHz input for the USB interface or this input can also be used for general purpose I/O. The signal return path is DIG_GND.		

N2WCK	Type: I/O	Direction: Input/Output	Pin: 28
	The Navsync 2 Wire Clock signal. This is the open collector I^2C compatible clock signal for the 2 wire serial interface. The signal return path is DIG_GND.		

N2WDA	Type: I/O	Direction: Input/Output	Pin: 29
	The Navsync 2 Wire Data signal. This is the open collector I^2C compatible data signal for the 2 wire serial interface. The signal return path is DIG_GND.		

USBP	Type: I/O	Direction: Input/Output	Pin: 30
	The positive USB signal. The signal return path is DIG_GND.		

USBN	Type: I/O	Direction: Input/Output	Pin: 31
	The negative USB signal. The signal return path is DIG_GND.		

LED_RED	Type: I/O	Direction: Output	Pin: 8
	This is a dual function signal. Normally this signal is used to drive a red LED. Standard software builds use this signal to indicate GPS status. In special software builds, this signal can be used as GPIO. This signal has a 3.3V CMOS drive. A series limiting resistor is required to limit output current to ±5mA (typically 270 ohms). The signal return path is DIG_GND.		

LED_GRN	Type: I/O	Direction: Output	Pin: 9
	This is a dual function signal. Normally this signal is used to drive a green LED. Standard software builds use this signal to indicate GPS status. In special software builds, this signal can be used as GPIO. This signal has a 3.3V CMOS drive. A series limiting resistor is required to limit output current to ±5mA (typically 270 ohms). The signal return path is DIG_GND.		

GPIO[0]/ PWM	Type: I/O	Direction: Input/Output	Pin: 39
	The GPIO[0] signal. Primarily for general purpose I/O, this signal can also be programmed to provide either a frequency, PWM or EPOCH output. It can also be configured to form and external RC oscillator in combination with GPIO[3]. The signal return path is DIG_GND.		

GPIO[1]/ TIME_SYNC	Type: I/O	Direction: Input/Output	Pin: 40
	The GPIO[1] signal. Primarily for general purpose I/O, this signal can also be programmed to provide either an additional PPS output or a time synchronisation input to the GPS engine in the NS3000IC chip. The synchronisation pulse can be provided from an external source or can be generated by the on-board RTC. When generated by the onboard RTC, the synchronisation signal can be observed on this pin signal. The signal return path is DIG_GND.		

GPIO[2]/ NEXT_INT	Type: I/O	Direction: Input/Output	Pin: 41
	The GPIO[2] signal. Primarily for general purpose I/O, this signal can also be programmed to provide an interrupt event from an active low external input. The signal return path is DIG_GND.		

GPIO[3]/ FREQ_IN	Type: I/O	Direction: Input/Output	Pin: 42
	The GPIO[3] signal. Primarily for general purpose I/O, this signal can also be programmed to provide a frequency counter input. The frequency counter input has a Schmitt trigger and if used with GPIO[0] can be configured to form a temperature controlled oscillator. The signal return path is DIG_GND.		

5. Operating Modes

5.1 Stand Alone Operation

For stand alone operation the receiver will perform cold starts with no prior knowledge of position or GPS satellite data such as almanacs and ephemeris provided the antenna has a clear view of the sky to provide signal strengths of 35dB or higher. The receiver should be allowed to track satellites for a minumum period of 15 mintes to ensure all almanac information has been received. The GPS data is stored in the EEPROM memory fitted to the CW25. Once the receiver has been initialised and has current almanac and epheris data it may then be taken indoors for test with low level signals.

Hot starts (current ephemeris data held in EEPROM) can be performed with low level signals (indoors).

5.2 Net Assisted Operation

For network assisted operation the Navsync Network Assistance Base Station must be connected to an external antenna and be tracking all satellites in view. The network assistance data connection is provided by an RS232 link between port 3 on the network assistance base station and port 3 on the CW25.

With the network assistance base station connected the development system can be started in indoor or outdoor environments.

For more information on the Network Assistance data format please refer to section 7.4

6. Power Management

The CW25 GPS receiver is a low power module consuming less than 250mW for a 1Hz update of position. The receiver contains software to dynamically reduce power consumption wherever possible. Where channels and taps are not needed they are switched off. When the processor is not required it is put into a halt until interrupt state and the chips clock system is geared down to reduce power consumption. All of these things are performed automatically without any user configuration. If further power saving is required the receiver can be reprogrammed with smaller GPS configurations thereby permanently switching off portions of the GPS hardware and allowing the processor speed to be reduced, thereby saving power.

6.1 Coma Mode

For battery powered applications which need to reduce the power consumption it is possible to switch the receiver into Coma mode. This configures the RF front end into sleep mode, switches off internal peripherals and places the processor in a sleep state waiting for an interrupt. Power consumption is typically reduced to <30mW.

Coma mode is initiated through the COMA serial command, details of which can be found in section 7.3.9.

Care must be taken in the implementation of the CW25 to ensure power consumption is minimised. All input pins without bias resistors have potential to float mid rail and consume power during coma mode. The GPIO pins default as inputs and do not have bias resistors. Care must be taken to ensure that the pins have external bias resistors off board to ensure they are not left floating. It is recommended that all unterminated Test, Control and I/O ports are pulled high or low as appropriate (making note of the active state of some ports e.g. BSEL), with typically 100k ohms.

7. COMMUNICATIONS PROTOCOLS

Full descriptions of the communications protocols used by the CW25 can be found in section 7.2 & 7.3.

7.1 Port Configuration

There are three serial ports avaialble on the CW25, these are configured as follows

Port	Baud Rate	Function
1	38400	NMEA
2	38400	Debug
3	38400	Network Assistance

All ports are configured as 8, bits no Parity, with no handshaking.

7.2 Output Format

There are two types of messages that can be output from the CW25 receiver, these are split into NMEA sentences and Debug messages. Both types of outputs are ASCII strings.

7.2.1 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 recognised 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 with the general NMEA structures, but are otherwise undefined outside of the Manufacturers own documentation.

The following Approved messages are available from the CW25 receiver.

GPGGA - Global Positioning System Fix Data

GPGSA - GNSS DOP and Active Satellites

GPGSV - GNSS Satellites in View

GPRMC – Minimum required sentence

POLYA – GPGGA with additional estimated accuracy

POLYP – Navsync proprietary status message

POLYS – Navsync Proprietary satellite status message (GPGGA + GPGSV)

POLYI - Navsync Proprietary net assist information message

7.2.1.1 GLL, Geographic position, Lat/Lon.

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

$*GPGGA*, *Latitude , N ,Longitude , hhmmss.ss,Status*cs*

Name	Description
`$GPGGA`	NMEA sentence header (Position Data)
`Latitude`	User datum latitude degrees, minutes, decimal minutes format (ddmm.mmmmm)
`N`	Hemisphere 'N'= North, or 'S' = South
`Longitude`	User datum longitude degrees, minutes, decimal minutes format (dddmm.mmmmm)
`E`	Longitude Direction 'E'= East, or 'W' = West
`hhmmss.ss`	UTC Time in hours, minutes, seconds. and decimal seconds format.
`Status`	Status V=navigation receiver warning, A=data valid
`cs`	Message checksum in hexadecimal

7.2.1.2 GGA, GPS fix data.

Time and position, together with GPS fixing related data (number of satellites in use, and the resulting HDOP, age of differential data if in use, etc.).

$*GPGGA*, *hhmmss.ss , Latitude , N ,Longitude , E , FS , NoSV , HDOP , Altref , m , msl , m, DiffAge , DiffStation*cs*

Name	Description
`$GPGGA`	NMEA sentence header (Position Data)

hhmmss.ss	UTC Time in hours, minutes, seconds. and decimal seconds format.
Latitude	User datum latitude degrees, minutes, decimal minutes format (ddmm.mmmmm)
N	Hemisphere 'N'= North, or 'S' = South
Longitude	User datum longitude degrees, minutes, decimal minutes format (dddmm.mmmmm)
E	Longitude Direction 'E'= East, or 'W' = West
FS	Fix Status: 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 (00.0 to 99.9)
AltRef	Altitude (metres) above user datum ellipsoid.
m	Units of height (metres)
DiffAge	Age of differential correction
DiffStation	Differential base station ID
cs	Message checksum in hexadecimal

7.2.1.3 GSA, 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: 0 No fix 1 Standard GPS 2 Differential GPS

sv	Satellites in use, null for unused fields
HDOP	2-D Horizontal Dilution of Precision (00.0 to 99.9)
VDOP	Vertical Dilution of Precision (00.0 to 99.9).
PDOP	3-D Position Dilution of Precision (00.0 to 99.9)
cs	Message checksum in hexadecimal

7.2.1.4 GSV, GPS Satellites in View.

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

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

Name	Description
$GPGSV	NMEA sentence header (Satellite Data)
NoMsg	Total number of GPGSV messages being output
MsgNo	Number of this message
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

Number of messages (maximum 3)

7.2.1.5 RMC, Recommended Minimum data.

The 'Recommended Minimum' sentence defined by NMEA for GPS/Transit system data. The use of a checksum field is mandatory.

*$GPRMC,hhmmss,status,latitude,N,longitude,W,spd,cmg,ddmmyy,mv,*cs*

Name	Description
$GPRMC	NMEA sentence header (Recommended Minimum Sentence)

hhmmss	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.mmmmm)
N	Hemisphere 'N'= North, or 'S' = South
Longitude	User datum longitude degrees, minutes, decimal minutes format (dddmm.mmmmm)
E	Longitude Direction 'E'= East, or 'W' = West
spd	Speed over ground (knots).
cmg	Course made good
hhmmss	Date in Day, Month Year format
mv	Magnetic variation
cs	Message checksum in hexadecimal

7.2.1.6 VTG, 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*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	kph – fixed field

`cs`	Message checksum in hexadecimal

7.2.1.7 POLYT, Time of Day

$POLYT,hhmmss.ss,ddmmyy, UTC_TOW ,week, GPS_TOW ,Clk_B , Clk_D ,PG,cs

```
$POLYT,123456.00,250299,123456.00,0978,123456.00,123456,123.456,28,cs
```

Name	Description
`$POLYT`	Navsync Proprietary NMEA sentence header (Position Data)
`hhmmss.ss`	UTC Time in hours, minutes, seconds. and decimal seconds format.
`ddmmyy`	Date in day, month, year format.
`UTC_TOW`	UTC Time of Week (seconds)
`week`	GPS week number (continues beyond 1023)
`GPS_TOW`	GPS Time of Week (seconds)
`Clk_B`	Receiver clock Bias (nanoseconds)
`Clk_D`	Receiver clock Drift (nanoseconds/second)
`PG`	1PPS Granularity (nanoseconds)
`cs`	Message checksum in hexadecimal

7.2.2 POLYP, Position Data

$POLYP,hhmmss.ss, Latitude ,N, Longitude ,E, AltRef ,FS,Hacc,Vacc, SOG , COG , Vvel ,ageC,HDOP,VDOP,PDOP,TDOP,GU,RU,DR,cs

```
$POLYP,123456.00,5214.12345,N,00056.12345,W,00138.80,G3,0002,0002,021.21,1
80.00,+003.96,99.9,01.1,01.6,01.9,01.7,07,00,00,cs
```

Name	Description
`$POLYP`	Navsync Proprietary NMEA sentence header (Position Data)
`hhmmss.ss`	UTC Time in hours, minutes, seconds.

	and decimal seconds format.
Latitude	User datum latitude degrees, minutes, decimal minutes format (ddmm.mmmmm)
N	Hemisphere 'N'= North, or 'S' = South
Longitude	User datum longitude degrees, minutes, decimal minutes format (dddmm.mmmmm)
E	Longitude Direction 'E'= East, or 'W' = West
AltRef	Altitude (metres) 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 9999 metres)
Vacc	Vertical (2 sigma) accuracy estimates. (0 to 9999 metres)
SOG	Speed Over Ground (knots) (000.00 to 999.99 knots)
COG	Course Over Ground (true) in degrees (000.00 to 359.99 degrees)
V_vel	Vertical (positive Up) velocity (m/s) (000.00 to 999.99 m/s)
ageC	Age of most recent DGPS Corrections applied (seconds). (00.0 to 99.9 = none available)
HDOP	2-D Horizontal Dilution of Precision (00.0 to 99.9)
VDOP	Vertical Dilution of Precision (00.0 to 99.9).
PDOP	3-D Position Dilution of Precision (00.0

	to 99.9)
GDOP	4-D Geometric Dilution of Precision (00.0 to 99.9)
TDOP	Time Dilution of Precision (00.0 to 99.9)
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 usee
cs	Message checksum in hexadecimal

7.2.2.1 POLYU, UTM Position Data

This message is only available in enhanced software versions.

$POLYP,hhmmss.ss, Easting ,E, Northing ,N,

AltMSL ,FS,Hacc,Vacc, SOG , COG , Vvel, ZageC, HDOP ,VDOP ,PDOP ,TDOP ,GU ,RU ,DR ,cs

```
$POLYP,123456.00,1234567.123,W,1234567.123,N,00138.80,G3,0002,0002,021.21,
180.00,+003.96,99.9,01.1,01.6,01.9,01.7,07,00,00,cs
```

The $POLYU is a UTM (Universal Transverse Mercator projection) version of the $POLYP sentence.

7.2.2.2 POLYG, Local Grid Position Data

This message is only available in enhanced software versions.

$POLYP,hhmmss.ss, Easting ,E, Northing ,N, AltMSL ,FS,Hacc,Vacc, SOG , COG , Vvel ,ageC,HDOP,VDOP,PDOP,TDOP,GU,RU,DR,cs

```
$POLYP,123456.00,1234567.123,W,1234567.123,N,00138.80,G3,0002,0002,021.21,
180.00,003.96,99.9,01.1,01.6,01.9,01.7,07,00,00,cs
```

The $POLYG is the same as the $POLYU sentence, except that the UTM position has been shifted to a Local Grid position by applying a Easting, Northing and Height offsets. The position output will be exactly the same as the UTM position if the Local Grid has not been defined.

7.2.2.3 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,...,cs

```
$POLYS,05,03,U,103,56,48,99,23,U,225,61,39,99,16,
U,045,02,41,99,26,U,160,46,50,32,30,-,340,04,50,
00,cs
```

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 dBHz)
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

7.2.2.4 POLYI, Additional Information Message

$POLYI,JN,jammer,EXT,efields,INT,ifields,cs

$POLYI,JN,12,EXT,HPOS,VPOS,INT,CLKB

Name	Description
$POLYI	Navsync Proprietary NMEA sentence header

	(Additional Information)
`JN`	Fixed descriptor field
`jammer`	Detected Jammer to Noise Ratio [dBHz]
`EXT`	Fixed descriptor field, indicates the use of externally provided ancilliary measurements e.g. received from Network Assistance. All comma seperated efields following, up to the INT field descriptor, are externally provided measurements
`efields`	DIFF = Differential Inputs TSYNC = Time sychronisation 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 ancilliary measurements e.g. retrieved from non voilatile memory. All comma seperated efields following, up to the INT field descriptor, are internally provided measurements
`ifields`	TSYNC = Time sychronisation 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)

7.2.3 Debug Messages

The debug messages were implemented for internal testing purposes, but may be useful for advanced users requiring more information than is available through the standard NMEA output messages.

The messages were designed to be displayed on a terminal, which recognises the HOME character (ASCII 11) and clear screen (ASCII 12). This mode is supported in NS3Kview by switching the NMEA monitor window to debug mode, see section 13.11.5. To display information on a terminal use a VT-100 emulation, this will allow the information to be display static on the screen, rather than being scrolling text.

Each information page can be commanded by sending $x<cr><lf>, where x is the page number. A list of the most commonly used debug pages is listed by sending $1<cr><lf> as shown below.

```
Screens 11,52

NV_RAM =       4980
NA_RAM =       3288
Stacks =       3968
dsp_SD =      12240
```

The above example shows that debug screens 11 and 52 are available. The additional information details the amount of memory used within the systems for Non volatile memory, Network Assistanmce data, Stacks and DSP data memory.

To display any of the avaialble debug screens simply type $x<cr>, where x is the screen number e.g. $11<cr>

Each of the above information pages is detailed below. The debug information is not limited to the above list and special debug pages may be available depending on the software within the receiver. Any additional pages specific to software versions are not described in this manual.

7.2.3.1 Navigation and Timing Summary ($11)

```
Navigation Summary Page  12x32x32x16 CW25 1.741 May 10 2004 15:03:41
Time  140533.70       3840 1270  137133.708 1    15     0 -569556.04 -675.87
Geod    52 14 58.28304 N    1  9 21.20855 E   209.19  161.75    s-----------
Local      921.146   -15325.118       83.187    0.009    0.007  193.89   0.015
Acc   5 5 1 0    34   101   106    95    95  0.24  0.15    1.70   2.43   2.97
ExtT  0   0.000   0.000   0   0.000000   0.000   0   0.000   0.000
APA   0   0.000   0.000   0.000  VVA  0   0.000   0.000   0.000 dy 2 T0     0
Sigs   1.569   1.235   0.000   0.100   0.003   0.006 EC    0    0    0  JN  0
VarF   0.011   0.007   0.000   0.072   0.002   0.007 S 1 I  1.024 cr 0  ts  0
Reset  0 93   48        13 0 QB 022        13 ST 1 SUB_MS    SP 10  FF   48.5
SV 11 64 1B8C 15 35  0  4403 228 13 144   -4.041 10    0.033 10 1  -2589  99    4     6   2
SV 32 64 104A  6 31  0   444   x -9  -0    0.000 00    0.000 00 0   -830  99  106  3945   3
SV  4 64 1B8C 15 46  0  4425 132 50 297    1.764 10    0.023 10 1   3034  99    4     6   2
SV  5  0 1000  1  0  0     0   x -9  -0    0.000 00    0.000 00 0      0  91  106  3945   6
SV  6 64 101A  6 30  0    19   x -9  -0    0.000 00    0.000 00 0   1181  99  106  3945   6
SV  7 64 198C 15 39  0  4653  45 31 242    0.481 10    0.032 10 1   -999  99    4     6   1
SV 20 64 1B8C 15 48  0  5029 184 56  81   -0.853 10    0.022 10 1   -830  99    4     6   1
SV 13 64 1B8C 15 45  0  4317  55 44 202    2.546 10    0.034 10 1   3961  99    4     6   2
```

```
SV 25 64 1B8C 15 37  0  3156   x -9  -0    0.000 00    0.000 00 0   -543  99  106  3945   4
SV  3 54 101A  6 30  0    33   x -9  -0    0.000 00    0.000 00 0   2174  99  106  3945   5
SV  1 64 1B8C 15 48  0  4141 208 72 120    0.168 10    0.032 10 1   1171  99    4     6   3
SV 16 63 101B  6 30  0   273   x -9  -0    0.000 00    0.000 00 0   1178  99  106  3945   7
THE_END         42 HC    0   0   0   2
EEPROM read   -------- -------- -------- -------- -------  -----   0x0000   0
EEPROM write  e--e--e- --e-e--- ---ea--- -------- ---H---  -----   0x0000   0
```

Software Configuration and version: channels x taps x FFT points, Software version and date

Time tag information: UTC time in hhmmss.ss format, Software time tag (seconds since switch on), Week number, time of week, Fix time (number of seconds with 3D fix), No fix time (number of seconds without 3D fix, Clock bias in metres, Clock drift in metres.

Geod: Latitude, Longitude, Ellipsoidal altitude, Mean sea level altitude

Local: Local grid E,N,U (from initial position), Ground speed, Vertical velocity, Track

Acc: GPS Fix, Fix OK flag, Differential flag, Estimated horizontal accuracy (m), Estimated vertical accuracy (m), Estimated position accuracy (m), Estimated time accuracy (m), Estimated speed accuracy (m/s), Estimated frequency accuracy (m/s), HDOP, VDOP, PDOP

Ext T: External input data e.g. from network assistance

Altitude Position Aiding (APA): APA required flag, APA used flag, Measurement, Variance, Residual, Residual quality

Sigs: Instantaneous pseudorange residuals, Accumulated pseudorange residuals, Pseudorange edit count, Instantaneous doppler residuals, Accumulated doppler residuals, Doppler edit count, Instantaneous delta-range residuals, Accumulated delta-range residuals, Delta-range edit count.

Var F:

Reset: Kalman reset flag, Last reset type, Number of solutions since last Kalman reset, Total number of resets, Number of solutions since last Kalman Q boost, Week number set flag, Time set flag, Sufficient position flag, Skip check flag, Time to first fix, Time to first fix – ION definition

Satellite Information: Satellite ID, Tracking status (not described), Measurement status, Signal strength (C/No), Mean signal strength, Lock counter, IODE, Elevation angle, Satellite used in solution flag, Pseudorange residuals, Pseudorange residuals OK flag, Pseudorange residuals edit flag, Doppler residuals, Doppler residuals OK flag, Doppler residuals edit flag, Delta-range residuals, Delta-range residuals OK flag, Delta-range residuals edit flag

EEPROM Read & EEPROM Write: Non volatile data usage. The characters shown indicate what data has been read or is written to the EEPROM. a = almanac, e=ephemeris, B=Both (almanac and ephemeris), T=Time, P=Position, H=Height

7.2.3.2 RF & AGC data ($52)

```
DSP_RF_AGC

   1   1  18   0  AGC & Offset Mode, Current Value
       0       0   95339  130237   94423       0       0  AGC_counters
     0.0     0.0    29.7    40.6    29.5     0.0     0.0  AGC_counters (%)
     0.2  DC offset (%)
```

AGC: AGC & Offset Mode 1=Auto, 0=Off, Current value of AGC (0-32)

AGC counters: Shows a table of 7 columns, each column indicates the number of times each level has been encountered in the last integration period. The columns indicate levels –3, -2, -1, 0, +1, +2, +3. For the example shown above only three levels are being used so all counts are either –1, 0 or +1.

AGC Counters %: Shows the AGC counters as a percentage. For a 3 level system the optimum AGC setting should have approximately 27%in +1 and –1 and 46% in 0, this represent a Gaussian distribution.

DC Offset: Shows the amount of inbalance in the measured signal. Ideally the DC offset should be zero, but will show a slight DC offset of up to a few percent due to the adjustment resolution in the RF front end.

7.3 Command Format

The Navsync CW25 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:

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

S: Command, requires the CW25 receiver to Set system settings.

Q: Command, a Query command to the CW25 receiver.

R: Response, an CW25 receiver or 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.

7.3.1 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 CW25 receiver to that on a 2Hz, 5Hz or 10Hz CW25 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)

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

Purpose

This message Sets, Queries and Responds to the initialised 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 metres (floating point, range ±18,000.0)
AntHt	Height of the antenna phase centre above the reference marker height defined by *EllHt* above in metres (floating point, range ±18,000.0)
posRMS	RMS accuracy of the input position (metres) (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 and 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).

7.3.3 PRTH<Q|S|R>,ITIM: INITIALISE TIME AND DATE

Purpose

This message Sets, Queries and Responds to the user initialised 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).

7.3.4 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 a 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)

7.3.5 PRTH<Q|S|R>,MCNO: MINIMUM SIGNAL CNO

Purpose

This message Sets, Queries and Responds to the satellite tracking minimum signal to noise ratio (C/No) required for inclusion into the navigation solution.

Query Format

$PRTHQ,MCNO[*checksum]<cr><lf>

Set Format

$PRTHS,MCNO,*min_CNO*[*checksum]<cr><lf>

Response / Acknowledge Format

$PRTHR,MCNO,*min_CNO**<checksum><cr><lf>

Explanation of Parameters

min_CNO	the minimum satellite tracking C/No required for inclusion into the navigation solution (integer, range 0 – 60 dBHz).

7.3.6 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)
6	= Airborne, Medium dynamics <2g)
7	= Airborne, High dynamics (<4g)
8	= Airborne, Very High dynamics (<8g)
9	= Drone, Missile dynamics (<16g)

10 = Pure least squares mode (ie semi-infinite dynamics assumed)

7.3.7 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 CW25 DASIC battery backed memory area, or entering a "sleep" mode.

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

Note that "sleep" mode are not currently supported in the CW25 technology.

This command invokes a 2 second time out prior to the reset being invoked so that there are two chances (on a 1Hz build) of seeing the acknowledgement message first.

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-set.
"CONFIG" = clear the receiver configuration data in battery backed RAM.
"EPH" = clear the satellite ephemeris data in battery backed RAM.
"ALM" = clear the satellite almanac data in battery backed RAM.
"SLEEP" = enter a "sleep" mode, still to be defined.

7.3.8 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).

7.3.9 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.

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

Purpose

This message Sets, Queries and Responds the Frequency Ouput. Outputs the requested frequency from the GPIO(0) port as detailed in section 10.

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 (10Hz – 10MHz) that the receiver will output. e.g. for 10kHz = 0.010 0 = switch digital frequency off.

7.4 Network Assistance Input

The CW25 uses network assistance data to allow acquisition and tracking of GPS satellites in low signal levels. The network assistance data is base on the TIA/EIA/IS-801 specification as using the the CDMA network. The format used is a ASCII version of the data to allow the contents of the messages to be displayed on a terminal. The data format is that used by the Navsync Network Assistance Base Station Simulator.

This section defines the transport mechanism for transferring the CDMA GPS messages in serial form from the Base Station Simulator in TIA/EIA/IS-801 format. As only a subset of the whole message set defined in TIA/EIA/IS-801 is required, this section defines the format for each of the required messages and provides references to the relevant section of TIA/EIA/IS-801.

Three messages are required:

Base Station response, Provide Location Response message (TIA/EIA/IS-801 section 4.2.4.2 page 4-51)

Base Station response, Provide GPS Almanac message (TIA/EIA/IS-801 section 4.2.4.2 page 4-41)

Base Station response, Provide GPS Ephemeris message (TIA/EIA/IS-801 section 4.2.4.2 page 4-44)

The messages should be sent out in the order Provide Location Response, Provide GPS Almanac, Provide GPS Ephemeris. The messages are variable length and the inclusion or exclusion of various sub-fields are identified by flags within the messages. If all of the data for a message is not valid then the message should be omitted. If any of the data for a message is valid then the message should be sent.

The message syntax is specified in BNF (Backus-Naur-Form).

7.4.1 Message Definition

MessageSet ::= <MessageLine>*

MessageLine ::= <Header><MsgHexOctets><Footer>

Header ::= <GSMHeader> | <CDMAHeader>

CDMAHeader ::= #CDMA,<CDMAType>,<CDMAMessageType>

CDMAType ::= 0 Note: 0 specifies TIA/EIA/IS-801 format.
Other values reserved for future use

CDMAMessageType ::= 0 | 1 | 2 Note: 0 = Provide Location Response
1 = Provide GPS Almanac
2 = Provide GPS Ephemeris

MsgHexOctets ::= <HexOctet>... message data ...<HexOctet>

The data content of the MsgHexOctets data is defined in section 2 of this document.

Footer ::= &<Checksum><CR><LF>

Checksum ::= HexOctet Note: Lower 8 bits of the addition of all characters between the starting # and the & before the checksum (non-inclusive).

CR ::= ASCII carriage return character
LF ::= ASCII line feed character

7.4.2 The CDMA Message

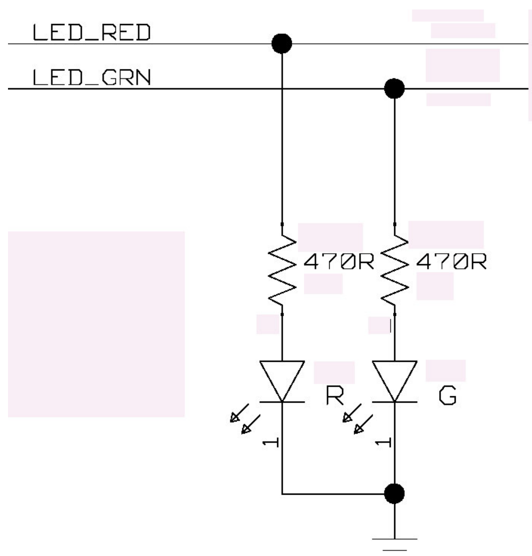
The CDMA message data is contained in the MsgHexOctets field of the top level message format defined above.

Each CDMA message consists of a message header block followed by a message data block. The message header block is fixed size and identifies the type of CDMA message and the size of the message data block, while the message data block contains the message data and is of variable size.

8. LED Interface

There are two output ports designed to drive external LED's, namely LED_RED and LED_GRN (pins 8 & 9 respectively).

Normally this signal is used to drive a green and red LED external to the module. Standard software builds use these signal to indicate GPS status. This signal has a 3.3V CMOS drive. A series limiting resistor is required to limit output current to ±5mA (typically 470 ohms). The signal return path is DIG_GND.



The LEDs are used to indicate the operating state of the GPS receiver. An initial long flash indicates the GPS fix mode.

RED - No Fix, 1pps Invalid

RED and GREEN - Dead Reckoning, 1pps valid

GREEN - GPS Fix, 1pps valid

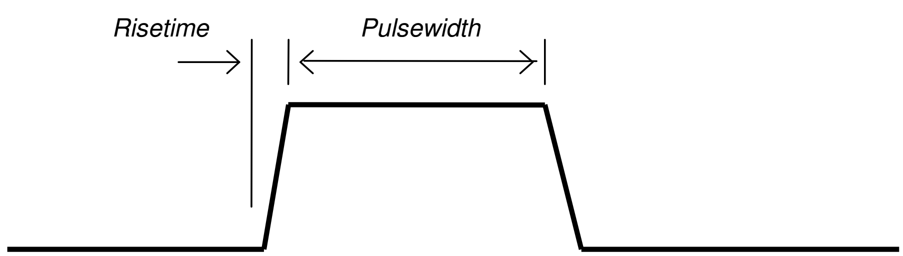
Each long flash may be followed by up to 12 shorter GREEN or RED flashes. Each GREEN or RED short flash indicates a satellite being tracked. A GREEN LED indicates a satellite being tracked and used in the time or position solution and an RED LED a satellite being tracked but not used in the solution.

When the GPS receiver is held in reset state (the reset button pushed in) all the LEDs are switched ON.

9. Time Pulse Interface

The time pulse interface outputs a precise pulse with respect to UTC time. Typically this is a 1pps signal. The time pulse is output on 1PPS port (pin 38). The signal is active high with the rising edge synchronous (+/- 30ns) to the UTC second and has a width of 100us.

For the 1pps to be valid the receiver must have a valid position fix and have received the UTC-GPS seperation paramater downloaded from the satellite, this may take up to 12.5 minutes from a cold start.



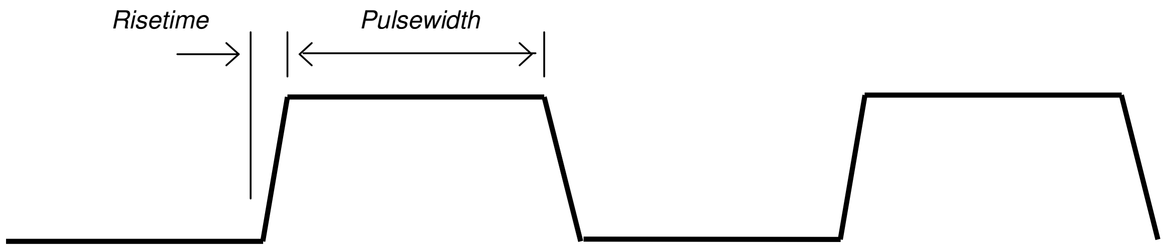
Pulse width:	100 µSec
Risetime:	maximum 10 nSec (2 metre std. lead)
Synch. to UTC:	rising edge +/- 30 nSec (GDOP , 3.0, no S/A)
Output:	+ 3.3V Volt nominal (V_{high} > 3.0 v at 6mA out, V_{low} < 0.33 v at 6mA sink)

10. Frequency Output

The CW25 is capable of producing a user selected frequency in the range 10Hz to 10MHz.

The frequency is output on GPIO(0) port (pin 39). The frequency is configured using the FRQD command as detailed in section 7.3.10.

Thye frequency is only valid when the receiver has a valid 2D position fix or better.



Pulse width:	50 ns minimum (10MHz)
Duty Cycle:	50:50
Risetime:	maximum 10 ns (2 metre std. lead)
Output:	+ 3.3V Volt nominal (V_{high} > 3.0 v at 6mA out, V_{low} < 0.33 v at 6mA sink)

11. APPLICATION HINTS

The following are a list of application hints that may help in implementing system based on the CW25.

11.1 Power Supply

The power supply requirements of the CW25MCM can all be provided from a single 3.3V supply. To simplify system integration on-board regulators provide the correct voltage levels for the RF and oscillator (2.9V or 3.0V) and low voltage digital core (1.8V). In power sensitive applications it is recommended that the DIG_1V8 supply is provided from a high efficiency external 1.8V source e.g. switch mode power supply, rather than the on-board linear regulator.

If the source impedance of the power supply to the CW25 is high due to long tracks, filtering or other causes, local decoupling of the supply signals may be necessary. Care should be taken to ensure that the maximum supply ripple at the pins of the CW25 is 50mV peak to peak.

11.2 RF Connection

The RF connection to the CW25 can be done in two ways. The preferred method is to use standard microstrip design techniques to track from the antenna element to the RF_IN castellation,. This also allows the systems integrator the option of designing in external connectors suitable for the application. The user can easily fit an externally mounted MCX, SMA or similar connector, provided it is placed adjacent to the RF_IN castellation. If the tracking guidelines given below are followed, the impedance match will be acceptable. The diagram below shows how this could be achieved. In this diagram, the centre via of the RF connector is presumed to be plated through with a minimal pad top and bottom. The PCB material is assumed to be 1.6mm thick FR4 with a dielectric constant of 4.3. Two situations are considered; one with no ground plane and one with a ground plane on the bottom of the board, underneath the RF connector. In both cases there is no inner layer tracking under the RF connector.

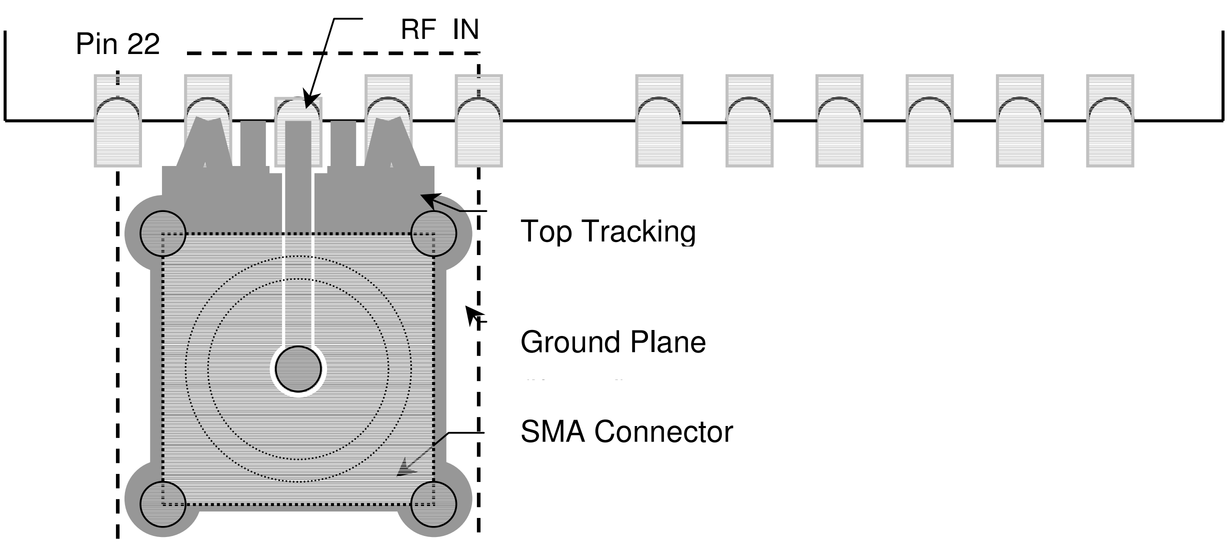


Figure 5 RF Tracking Example

The widths of the RF_IN track and the associated gaps are given in the table below.

Scenario	**Track Width** (1/1000 Inch)	**Gap Width** (1/1000 Inch)
Without ground plane	37	6
	56	8
With ground plane	32	6
	43	8

Table 5 RF Track & Gap Widths

Alternatively, the user can attach the antenna to the Hirose H.FL-R-SMT using a flying lead fitted with a suitable plug.

11.3 Grounding

In connecting the CW25 into a host system, good grounding practices should be observed. Specifically, ground currents from the rest of the system hosting the CW25 should not pass through the ground connections to the CW25. This is most easily ensured by using a single point attachment for the ground. There must also be a good connection between the RF_GND and the DIG_GND signals. Whilst there is not a specific need to put a ground plane under the CW25, high energy signals should not be tracked under the CW25. It is however recommended that a ground plane be used under the CW25. In this case, the following would be an example of the pattern that may be used.

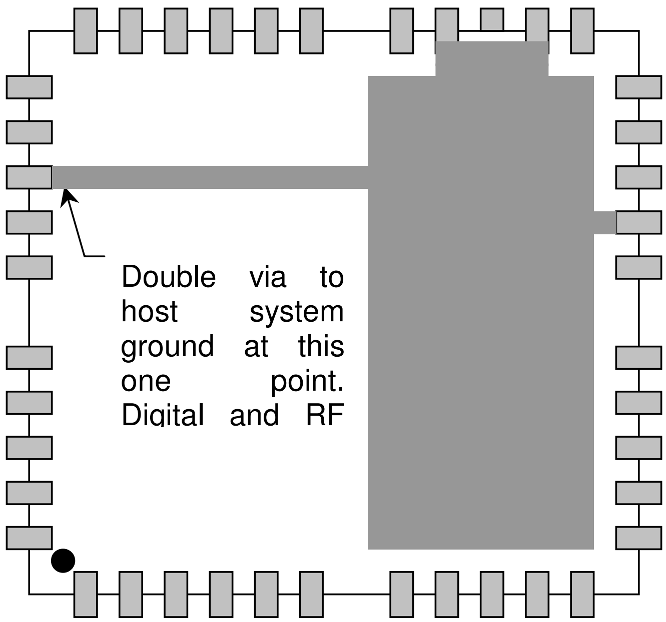


Figure 6 Grounding the CW25 with a ground plane

11.4 Battery Backup

The CW25 has an on-board real time clock (RTC). This is used to store date and time information whilst the CW25 is powered down. Having a valid date and time speeds the time to first fix (TTFF), allowing the CW25 to meet its quoted TTFF specification. The CW25 relies on an external power source to power the RTC (VBATT) when the DIG_3V3 is not present. If the user application does not require the warm or hot fix performance, or the required information is provided by network assistance, there is no need to provide the VBATT signal. The VBATT signal must be greater than 2.6V and less than DIG_3V3 + 0.6V. Typically, a 3V lithium primary cell or a high capacity “supercap” will be used. The CW25 has an internal blocking diode, so if a “supercap” or rechargeable battery is used, an external charging circuit will be required.

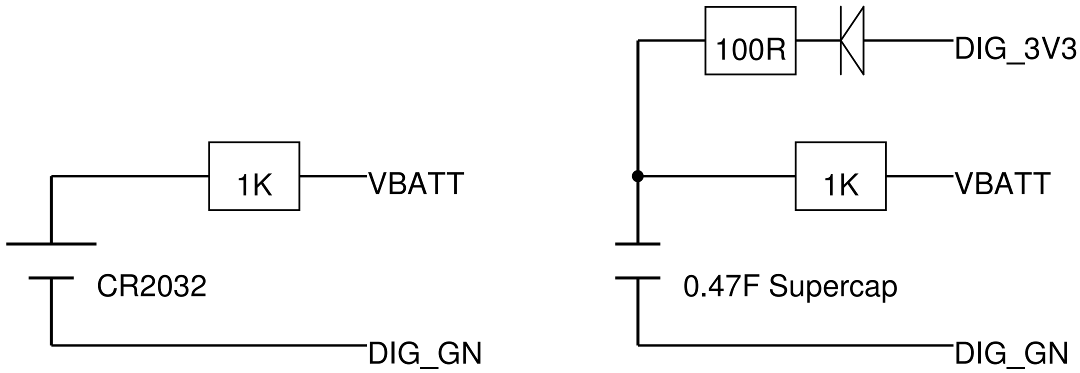


Figure 7 Typical VBATT Supplies

The 1K resistor is recommended at it limits current in the VBATT circuit and provides an easy way to measure the current in the VBATT signal. The 100R limits the inrush current into the “supercap”.

11.5 Over Voltage & Reverse Polarity Protection

The CW25 contains no over voltage or reverse polarity protection. The CW25 should be handled as a CMOS component, with full antistatic handling precautions. Any fault condition that results in the maximum limits being exceeded may irreparably damage the CW25.

11.6 LEDs

There are two connections on the CW25 specifically intended to drive status LEDs. The LED_RED and LED_GRN signals should be connected, via suitable current limiting resistors, to the anodes of low current LEDs whose cathodes are connected to DIG_GND. The outputs are standard 3.3V CMOS and the current drawn should be limited to 5mA per output. Using a 270 ohm resistor provides a suitable current limit. If appropriately coloured LEDs are attached to these signals, other documentation (eg. user manuals) that refers to these status LEDs will be correct. If LEDs are not required, these signals can be left open. These signals may be connected to other logic if required.

11.7 Reset Generation

The power on reset for the CW25 is generated on-board. It is generated by the regulator for the RF section. This signal is an active low, open collector signal and is presented on the NPOR castellation. If it is desired to extend the power on reset signal or provide a manual reset for the CW25, this signal can be driven from an open collector source at any time. The nPOR signal of the NS3000IC, to which the NPOR castellation is connected, has a Schmitt trigger input. This means that there are no constraints on the rise time of the NPOR signal.

There is a second reset signal on the CW25, the NRESET signal. NRESET is also an active low open collector signal. This signal is generated by the NS3000IC in response to the NPOR signal. It can also be generated under software control. Asserting the NRESET signal from an external open collector source will reset the ARM9 in the NS3000IC without resetting the whole chip. Generally, this signal will be left open.

11.8 Boot Options

The CW25 has two boot modes. These are selected by the state of the BOOTSEL signal when the NPOR signal goes inactive (high). Normally, BOOTSEL is left open so that a pull-up bias in the NS3000IC will keep that signal high. When BOOTSEL is high, the CW25 boots from the FLASH that is internal to the NS3000IC. If BOOTSEL is tied low, the CW25 boots from the ROM internal to the NS3000IC. This ROM has a boot loader that polls the serial ports and I^2C bus for boot code. This mode of operation requires special user handling and should only be used in conjunction with specific application notes.

11.8.1 Flash Programming

The CW25 contains 128k Flash memory internal to the BB25IC which hold the module firmware. The Flash is reprogrammable in the field by means of a ROM bootloader utility. To run the bootloader the unit must be powered up with the BSEL line set to the correct state. A loader program and batch file are provided to transfer the firmware binary image file to the module. To reprogram the module follow the instructions below:

1) With the module powered down, connect the BSEL pin to GND

2) Connect any of the CW25 serial ports to COM1 of your PC.

3) Power the unit up. The CW25 should start by outputting a stream of 'Z' characters at 38400 baud. You might like to check this out via a terminal program. If after about 20 seconds the re-programming step (4) hasn't started, the stream of 'Z''s will stop and the existing CW25 firmware will run.

4) Just after the unit has been powered, and while the 'Z''s are being, run "download.bat" batch file from a Console window. You can edit this batch file to use a PC port other than COM1 if you prefer. You should see:

CW25 FILE Up/DownLoader ver 1.0
<C> Navsync Inc 2003

loader - loader.hex
baud_rate - 38400
comm - com1
Addr - 0x060000
binary file - CW25.bin
debug_mode - 2
Reset the board and then ENTER key

5) Hit <Enter> and you will see:
Start waiting for BootRom
Then after a few seconds you should then see:
BootRom loader found
After about 7-10 seconds you should see
S-Record loader sent
Then you will see a stream of dots going across the screen as the firmware is being downloaded.

Once the download has finished you will see:

Image download Passed
Process finished

If errors are encountered during the upgrade procedure simply reset the module and start the procedure again.

12. CW25 Development System

The CW25 Development System comprises the CW25 Development Module, and the peripherals that support its operation all packed into a convenient case. The CW25 Development System includes:

- CW25-EM Development Module
- Interface Accessories
  - RJ-45 Breakout Adaptor
  - DB9 to DB9 PC Cable
  - USB - Type A to Mini Type B
- Power Supply (universal) with 2M cable to 2.1 mm power socket and local mains plug.
- Magnetic Patch Antenna, ideal for use in automotive applications, with a 3M lead.
- Manuals provided on CD
  - CW25 MCM, Development System
  - Drivers
  - Software
- Packing Case

12.1 CW25 Development Module

The CW25-DM is a stand-alone GPS system housed in a metal box, allowing simple interfaces to the host systems, such as a PC. Internally the NS-20 MCM is mounted on an CW25-CB (carrier board). The CW25-CB is then mounted on an adaptor interface (CW25-AI) card, before being mounted on the CW25-DM board. Please refer to the separate documentation on the CW25-CB and the CW25-AI for more information.

12.1.1 General Arrangement

The diagram below shows the internal make-up of the CW25-DM.

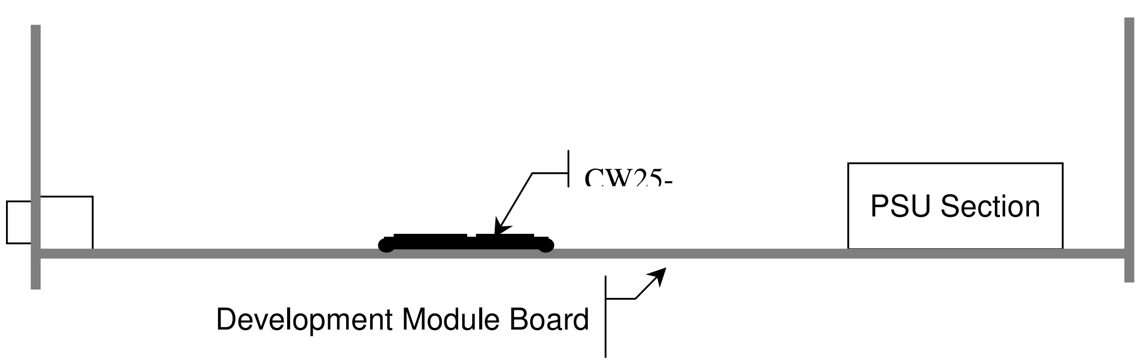


Figure 8 CW25 Development Module (Internal View)

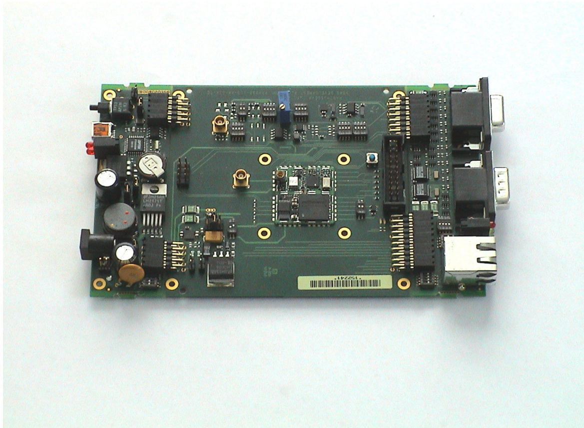


Figure 9 CW25 Development Module Board & Enclosure

12.1.2 External Interfaces

The CW25-DM has a number of user interfaces. Most of the user interfaces are external, but the JTAG interface is internal and requires that the case top be removed to expose the 20 pin boxed header used to attach the Multi-ICE or similar JTAG cable. There are other test points available once the case top is removed.

The external interfaces include:-

- DB9F (Port 1)
- DB9F (Port 2)
- RJ45 (Port 0, 1PPS & Power Input/Output)
- Power Input
- RF Input

12.1.2.1 DB9F

The two DB8F connectors provide two RS-232C interfaces to the host system. These interfaces are three wire only and do have any handshake signals. These connectors are intended for 1 to 1 connection to a standard PC serial port. Pin 2 is the output, pin 3 is the input and pin 5 is the 0V return. The connector nearest the centre of the case is port 1.

12.1.2.2 RJ-45

The external RJ-45 on the CW25-DM provides:

- RS-422 Comms Port (port 0)
- 1 Pulse per Second (RS-422 levels)
- Power (input/output)

The table below shows the functions on the RJ-45 interface.

RJ-45 Signal	Function
1	1PPS positive output (PPSP)
2	1PPS negative output (PPSN)
3	Comms port 0 positive input (RXDP)
4	Comms port 0 positive output

	(TXDP)
5	Comms port 0 negative output (TXDN)
6	Comms port 0 negative input (RXDN)
7	Positive power input/output
8	0V power return

Table 6 RJ-45 Function Details

12.1.2.3 Power Input

The 2.1mm power socket accepts 9VDC to 32VDC. The centre pin is positive. The centre pin connects to pin 7 of the RJ-45.

12.1.2.4 RF Input

The TNC connector provides the RF input to the embedded CW25. There is a 5V DC bias on the antenna connection intended to power an active antenna. Care should be taken not to draw more than 35mA from the RF input connector.

12.1.3 Internal Interfaces

The internal interfaces include:-

- JTAG
- Test Points
- CW25-AI Connectors

12.1.3.1 JTAG

The CW25-DM board has a 20 pin boxed header which connects directly to an ARM multi-ICE to allow emulation into the NS3000IC in the CW25. It can also be used to access the boundary scan chain in the NS3000IC. The diagram below details the signals on the JTAG header.

Function	PIN NUMBER		Function
+3V3	1	2	+3V3
NTRST	3	4	GND
TDI	5	6	GND
TMS	7	8	GND
TCK	9	10	GND
JTAGSEL/RTCK	11	12	GND
TDO	13	14	GND
n/c	15	16	GND
n/c	17	18	GND
n/c	19	20	GND

Figure 10 JTAG Header Details

For multi-ICE use, simply connect the emulator cable to the header. To use the boundary scan, a cable should be made that ties the JTAGSEL/RTCK signal to GND.

12.1.3.2 Test Points

The CW25-DM board has a 40 way open header that provides access to the additional signals available on the CW25. The diagram below details the signals on the test header.

Function	PIN NUMBER		Function
GND	1	2	n/c
ANT_SUPPLY	3	4	n/c
n/c	5	6	nGRN_LED
+3V3	7	8	+3V3
n/c	9	10	EVENT_IN
n/c	11	12	N2WCK
N2WDA	13	14	nRED_LED
RX[2]/EV2_IN	15	16	TX[2]
n/c	17	18	RX[1]
TX[1]	19	20	BOOTSEL
PPSP	21	22	PPSN
NTRST	23	24	TXDP
TXDN	25	26	TDI
RXDP	27	28	RXDN
TDO	29	30	FREQ_OUT
GPIO[0]/PWM	31	32	TMS
GPIO[2]/nEXT_INT	33	34	GPIO[1]/TIME_SYNC
TCK	35	36	n/c
nEXT_RES	37	38	JTAGSEL/RTCK
VBATT	39	40	GPIO[3]/FREQ_IN

Figure 11 Test Header Details

12.2 Interface Accessories

12.2.1 RJ-45 Breakout Adaptor

The RJ-45 breakout adaptor provides easy access to all the signals on the RJ-45 connector. It comprises two 4-way screw terminal blocks. The RJ-45 breakout adaptor is an un-boxed FR4 PCB approximately 25mm x 55mm. The diagram below shows the general arrangement of the RJ-45 breakout adaptor.

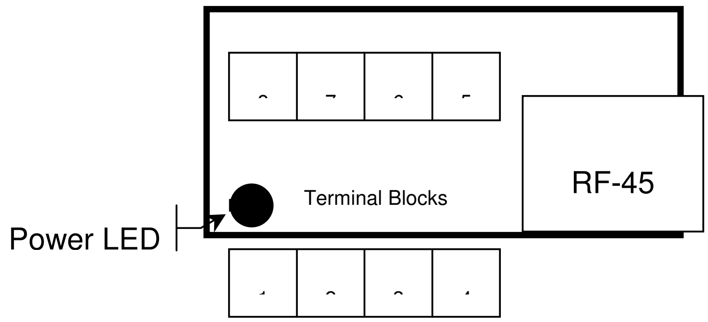


Figure 12 RJ-45 Breakout Adaptor General Arrangement

The pinout of the terminal blocks match the pinout of the RJ-45.

12.3 Operation

For basic operation simply follow these basic steps:

12.3.1 Connect the Antenna

The antenna is connected using the TNC connector on the side of the CW25-DM. If the antenna has a different connector, a suitable adaptor will be required. The CW25-DM provides a 5VDC bias on the antenna to power active antennas. An antenna other than the one provided may be used, but care should be take to ensure that it does not draw more than 35mA from the CW25-DM.

12.3.2 Connect the Power

The universal power supply included with the system should be used to power the CW25-DM. Connect this to the 2.1mm socket on the side of the CW25-DM. If an alternate power supply is used, it should provide 9VDC to 32VDC with the centre pin being positive.

12.3.3 Connect to a Computer

Before connecting to the computer for the first time, the supplied software needs to be installed. This is done by inserting the CD that came in the system and following the instructions that then come up on the screen. Only the Windows® family of operating systems is supported. The supplied software has been tested with Windows 98, ME, 2000 and XP. Once the software is installed, connect the CW25-DM to a computer.

12.3.3.1 Serial Connection

The simplest way to connect to a computer is to use the serial cable supplied with the system to attach the CW25-DM to a serial port on the computer. Attach the serial cable between Port 2 on the adaptor and a spare serial port on the computer.

12.3.3.2 USB Connection

The CW25-AI in the CW25-DM contains a USB (V1.1) to serial converter. To use this USB port, the CW25-DM must be opened up and a mini USB to type A cable used to connect from the CW25-AI to a USB port on the computer. The USB power select switch on the CW25-AI must be set for self powered operation. Bus powered operation must not be used initially as the power drawn by the CW25-DM can exceed that available for bus powered operation. Provided the CW25-DM is powered up, the computer should automatically recognise the USB port as a serial port and at it to the computer's list of available ports. The USB to serial converter accesses the CW25-DM via port 2, so connection should not be made to both port 2 and the USB port.

12.3.4 Start the Software

Once the CW25-DM is connected, the software can be started and operated in accordance with the user manual provided on the system CD.

13. NS3Kview

13.1 Disclaimer

In no event shall Navsync be liable for any loss of profit or any other commercial or private damage, including but not limited to special, incidental, consequential or other damages, resulting from or in any way connected with the use of this software. Navsync specifically disclaims any other warranties expressed or implied, including but not limited to the implied warranties of merchantability and fitness for a particular use.

13.2 Distribution

You are hereby licensed to make as many copies of the NS3Kview software and documentation as you wish; give exact copies of the original version to anyone; and distribute the NS3Kview software and documentation in its unmodified form via electronic means. There is no charge for any of the above.

You are specifically prohibited from charging, or requesting donations, for any such copies, however made; and from distributing the software and/or documentation with other products (commercial or otherwise) without prior written permission.

13.3 Installing NS3Kview

The software is supplied on a CD-ROM and is very simple to install.

Insert the CD-ROM into your CD-ROM drive and view the disk contents. Open the NS3Kview folder and run the SETUP.EXE program, this will guide you through the installation process. The software is normally installed into the Program Files\Navsync directory but may be installed into any directory you choose.

The program is self contained and requires no proprietary library files (DLL's).

13.4 Introduction

NS3Kview is a general purpose utility for monitoring the output from a GPS receiver especially the Navsync CW25 receiver. The software is designed to run under Windows 95/98 & NT operating systems.

NS3Kview uses the serial protocol from the National Marine Electronics Association (NMEA) version 2.20. NS3Kview is setup as a listener and will show information by interpreting the following sentences:

GPGGA - Global Positioning System Fix Data

GPGSA - GNSS DOP and Active Satellites

GPGSV - GNSS Satellites in View

GPRMC – Minimum required sentence

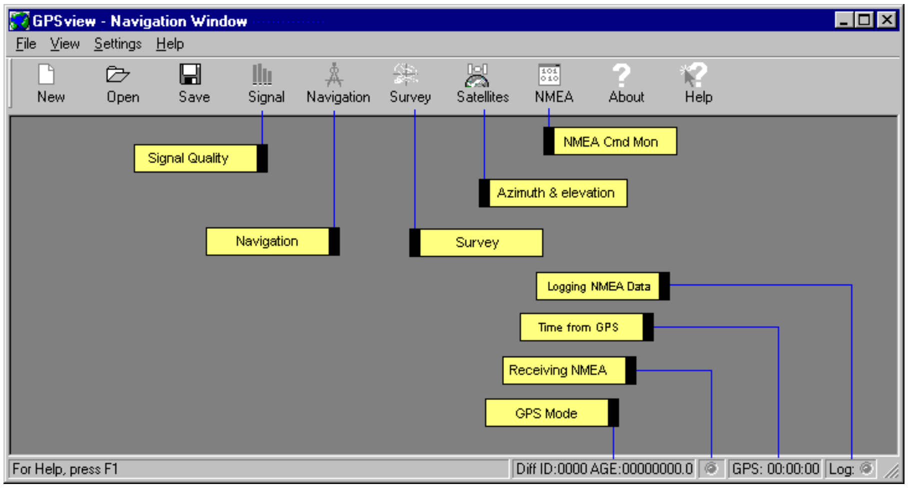
POLYA – GPGGA with additional estimated accuracy

POLYP – Navsync proprietary status message

POLYS – Navsync Proprietary satellite status message (GPGGA + GPGSV)

NS3Kview is not navigation based software, but a statistical analyst software package that can report position errors, antenna obstructions and log NMEA data to a file. It is not necessary to have a GPS receiver connected to the computer to acquire data. Using captured NMEA data, NS3Kview will process through the data as if were connected to a GPS receiver.

For a quick start and more information, go to section 13.6 Getting Started



13.5 Using NS3Kview

NS3Kview has four major windows. Signal Quality, Navigation, Survey, Azimuth and Elevation. By clicking on the tool-bar or on the correct window under the VIEW menu option, these windows will enable or brought into focus. Each window has its own abilities and functionality. Some windows like the Survey window have pop-up menus that you can enable by using the right mouse button.

See Also

Signal Quality Window, Navigation Window, Survey Window, Azimuth & Elevation Window

13.6 Getting Started

NS3Kview has two modes of operation. The first, where NS3Kview communicates with a GPS receiver and second where NS3Kview reads NMEA sentences from a file. For NS3Kview to communicate with a GPS receiver, the GPS receiver must have ability to send NMEA data sentences. Currently the valid NMEA sentences supported are as follows:

GPGGA - Global Positioning System Fix Data

GPGSA - GNSS DOP and Active Satellites

GPGSV - GNSS Satellites in View

GPRMC – Minimum required sentence

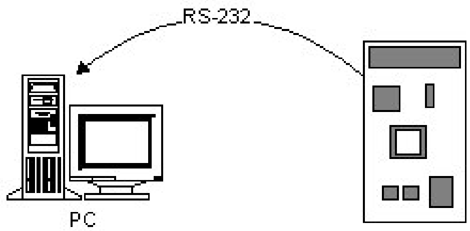
POLYA – GPGGA with additional estimated accuracy

POLYP – Navsync proprietary status message

POLYS – Navsync Proprietary satellite status message (GPGGA + GPGSV)

13.6.1 Connecting NS3Kview to a GPS receiver

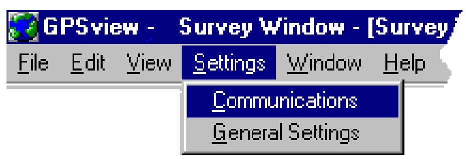
First step is to connect the GPS receiver to the computer.



The CW25 Evaluation Kit comes complete with serial cables to connect your GPS receiver to the PC. Connect the matching cable between Port 1 (RJ45) on the Evalutaion Kit and COM1 (or other as desired) on the PC.

NS3Kview must be configured to use the correct communication port of the PC. Select the Communication option under the Settings menu and set the Comm Port to the same port the GPS receiver is connected to.

If no GPS receiver is present, NS3Kview has the ability to read a text file containing NMEA messages, demo mode. This is also accessed from the Communications Settings Dialog box.



The default communication settings for Port 1 of the CW25 and CW25 receivers is 38400 baud, 8 data bits, 1 stop bit and no parity. NS3Kview will remember these communications settings and upon program start, will start listening for NMEA sentences.

13.6.2 NMEA File Logging

NS3Kview will also log all the NMEA sentences it receives to a file. This feature is also found in the Communication Settings Dialog. By checking the **Enable Logging** check box and setting the file name using the button to the right of the file name, a log file will be opened and NMEA data will be saved to that file.

This file can be used in playing back the data through the demo mode option. See below.

13.6.3 Running NS3Kview in Demo Mode

If no GPS receiver is present, then NS3Kview will run in a demo mode of operation using a NMEA text file as input. NS3Kview provides a default file NMEA.TXT. This file has about five hours of data collected. Other NMEA text files may be used if desired. The NMEA.TXT file is provided for demonstration purpose and can be deleted.

To run NS3Kview in demo mode:

1. Select the Communications Dialog through the ‘**Settings**’ menu. Click on Communications.

2. Check the '**Enable Demo Mode**' check-box.

3. Click on the '**Browse**' button.

4. Select '**NMEA.txt**' file and click on Open. The file name will now read in the NMEA Capture File edit box.

5. Click on **OK**

NOTE:

When NS3Kview is in demo mode and reading a file, it reads the file at a very fast rate and ignores time. One minute of acquired data will read in a few seconds. This will allow a time laps view of the captured data.

13.7 Signal Quality Window

The Signal Quality Window uses the GPGSV NMEA message to extract the signal to noise ratio (SNR C/No) which is specified as a number from 0 - 99 dB. Depending on the number of satellites in view, the number of SNR bars will vary. At the top of each SNR bar, the raw SNR value is displayed. Full scale is considered any SNR value of 50 dB or above. At the bottom of each bar shows the satellite ID.

The signal quality bar will change its color depending if the satellite is used in the navigation solution returned by the GPGSA NMEA message. If the satellite is not used in the position fix solution, the signal quality bar will be in gray. If the satellite is used in the solution, the signal quality bar will be blue.

SNR values may vary for different GPS manufactures. Please see below for more details.

13.7.1 SNR (C/No) Values

Not all GPS receiver manufactures return the same SNR values for a given location or antenna. The NMEA specification for these values states that the value must fall between 0 and 99 dB. Navsync receivers will return a value between 30 and 55 while others receivers may return a value between 0 and 35. It may be a good idea to observe the GPS receivers SNR values to see where they fall.

13.7.2 Signal Quality Properties

13.7.2.1.1 Upper and Lower Threshold

It may be necessary to adjust the minimum and maximum thresholds of the SNR values so they will yield a reasonable signal quality bar. By setting these values, the signal quality bar will adjust itself accordingly. To change the settings click the right hand mouse button when pointing to the SNR window. Select the properties option and enter in the required minimum and maximum values.

13.7.2.1.2 Auto Track

The Auto Track option will self adjust the thresholds. When Auto Track is enabled, the Upper Threshold and Lower Threshold are equated to the Observed Maximum and Minimum values. When in doubt on SNR values, use this function.

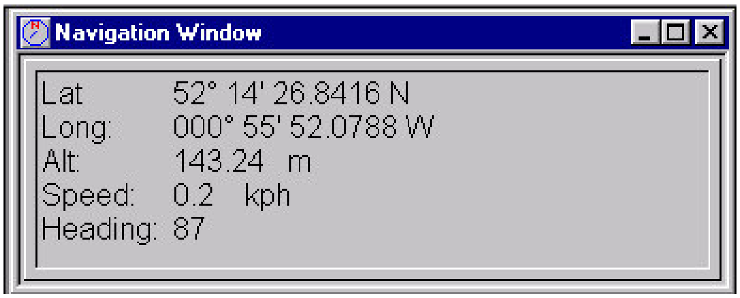
13.7.2.1.3 Observed Minimum/Maximum

Shows the minimum and maximum values of the SNR values from the GPS receiver. To reset these values, use the right mouse button in the Signal Quality window and select the Reset Observed Min/Max menu item.

13.8 Navigation Window

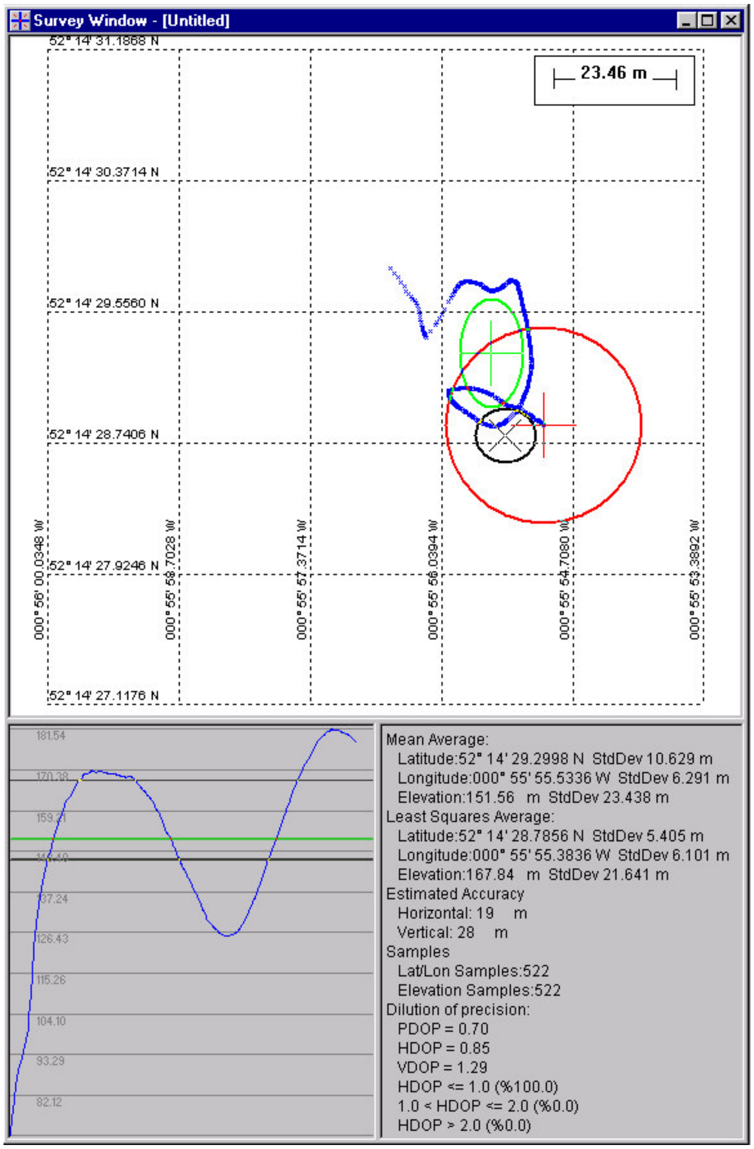
The Navigation Window shows the current Longitude, Latitude and Altitude or elevation, speed and heading. These values will update each time the GPS receiver sends the GPGGA or POLYP messages. The size of the font used is proportional to the window size. To change the font size, simply change the size of the window.

The speed units are dependent on the units of measure configurable under General Settings. When metric is selected, the speed is displayed in kph or in mph when statute is selected.



13.9 Survey window

The Survey Window is one of the more interesting windows of NS3Kview. This window will log latitude, longitude and altitude displaying data graphically. The latitude, longitude display contains a scale in meters/feet as well as position grids in degrees.



The Survey Window is split into three frames. The first, at the top, is the Survey Frame. Here, a plot of past position history is displayed graphically and is known as paths. These paths can be saved to disk and viewed at a latter time.

The frame directly below the Survey Frame is the Altitude Frame. This frame simply plots the altitude.

To the right of the Altitude Frame is the Position Statistics frame. Displayed here are position average and Dilution of precision or DOPs.

13.9.1 Statistical Data

NS3Kview has the ability to average position and altitude displaying the data. NS3Kview uses two methods of averaging, standard running average (sum of the data / samples) and a curve fitting or a Least Squares best fit method. These averages are both displayed graphically in the Survey frame and in text in the Statistics frame.

The standard deviation shows how much the position is moving around. Graphically, the standard deviation is displayed in the Survey Frame and the Elevation Frame. For a normal curve, 68.27% (one sigma) of the cases are included within the areas (the thick circles in the Survey Frame and between the two thick black lines in the Elevation Frame) on the graph. Using the standard deviation is a good way to see how the effects of SA (Selective Availability) has on position. Smaller numbers of standard deviations indicates that SA may be turned down.

It is also possible to display the estimated accuracy of the GPS solution provided this information is available. The Navsync proprietary POLYP and POLYA messages include an estimated horizontal accuracy field in meters. When the estimated accuracy display is enabled the horizontal estimated accuracy is displayed as a circle around the current position. This option can be switched on or off from the popup or main menu.

13.9.2 Mouse

By moving the mouse over the survey frame, the latitude and longitude are displayed at the bottom of the main application window. Clicking the **left** mouse button will place a distance marker where the current mouse position is used as a distance measurement. The distance is also displayed at the bottom the application main window.

Using the **right** mouse button, a command menu is enabled. This is the same as the Survey Settings in the Survey menu bar. The following options may be selected:

13.9.3 Auto Scale

In normal operation the window will automatically scale to show the complete scatter plot, this can be turned on and off by selecting the **Auto Scale** option, if the Auto Scale option is switched off, when the current position goes outside of the graphical display it will not be rescaled.

13.9.4 Zoom In & Zoom Out

To zoom in to a particular area of the survey window select the **Zoom In** option and to enlarge the displayed area select the **Zoom Out** option. The zoom functions will use the cursor position when the right mouse key was selected as the central point for the zoom function. If the zoom functions are selected from the main menu rather than the popup menu the current position is used as the central point

13.9.5 Pan

The **Pan** option moves the current cursor position to the centre of the survey window, the scale remain the same.

13.9.6 Refresh Screen

Occasionally the survey screen can become corrupted, especially if other windows and dialog boxes are positioned on top of it. To clean up the display select the **Refresh Screen** option of the popup menu.

13.9.7 Properties

See section 13.9.9 Survey Window Properties for more information.

13.9.8 Printing

The survey window supports printing and print previewing. Both the survey path and the altitude are included in the printing. To print a survey plot, make sure the survey window is selected. You can do this by clicking your mouse anywhere on the survey window. Next, select Print from the file menu. Follow the instructions in the dialog boxes which follow.

13.9.9 Survey Window Properties

The survey window has several items that can be configured. Below is a description of these items and how they can be configured. The items that reflect the display of the survey plot also are applied to printing.

13.9.9.1 Position Plot Tab

13.9.9.1.1 Enable Position Acquisition

When disabled, the survey window will stop acquiring position fixes.

13.9.9.1.2 Validate each position using GSA - Fix Available

When enabled, each position fix is validated using the GPGSA or POLYP NMEA sentence. The GPGSA and POLYP sentences have a parameter that indicates that the position from the GPS receiver is valid.

Plot indicator

The **Large** and **Small** radio buttons set the size of each position sample.

When the **Use Lines** check box is selected, a line is drawn between each position sample.

13.9.9.2 Position Average Tab

13.9.9.2.1 Lat/Lon Average HDOP Threshold

The HDOP parameter is used to weight or place a threshold on each position fix for averaging. The threshold value will allow all Latitude and Longitude position fixes with the HDOP less than or equal to the threshold to be used in the averaging solution.

13.9.9.2.2 Lat/Lon Average VDOP Threshold

The VDOP applies to only the elevation. The VDOP Threshold will allow only the elevation samples less than or equal to the specified threshold value to be used in the averaging solution.

Both these parameters are extracted from the GPGSA NMEA sentence.

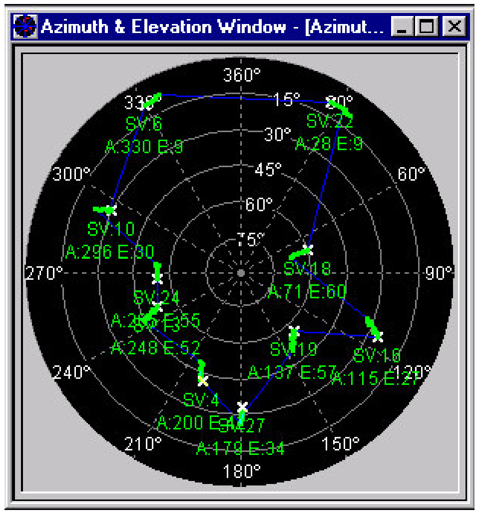
13.9.9.3 Printing Tab

13.9.9.4 Comments

Text in this field will be printed as annotations. Up to 511 characters may be used including carriage returns.

13.10 Azimuth & Elevation Window

Like the Signal Quality Window, the Azimuth & elevation Window will use the GPGSV NMEA message or the POLYS message to extract azimuth and elevation for each satellite that is in view. Each satellite is identified by its satellite number with the azimuth as the letter ‘A’ and elevation by the letter ‘E’.



The color of the text for each satellite indicates whether the satellite is used in the position solution. When the text is in green, the satellite is used in the solution. When the text is in red, the satellite is not used in the solution.

13.10.1 Physical Elevation Mask Angle

In stationary applications it is necessary to place the antenna where it can get a clear view of the sky. Sometimes there are obstructions to the antenna and knowing the effect on the tracking of satellites is essential. The Azimuth and Elevation Window has the ability to show graphically the elevation mask angle. Using the information from the SNR and solution status, a graphical representation of the mask angle is built. This may take as long a 24 hours of tracking.

13.10.2 Printing

The Physical Elevation Mask Angle data can be saved to disk and printed. Saving the mask data will allow viewing of the data at a later date. The Auto Load feature will load the previously saved mask data upon returning to NS3Kview application program. See the Azimuth and Elevation Properties for more information.

Printing consists of an azimuth and elevation plot of the physical mask angle, together with the satellite paths. This is useful when analysing an antenna installation and its physical obstructions.

13.10.3 Azimuth & Elevation Properties Dialog

The Azimuth and Elevation Window will show the Physical GPS elevation mask angle using a blue line. This is a way for stationary stations to check for obstructions to the GPS antenna. To calculate the physical elevation mask, NS3Kview will look at both the signal quality (SNR) and the solution flag and check if they fall within the criteria of a valid satellite. A valid satellite is when the SNR value is larger than the SNR Threshold and that the solution flag is set to true.

Not all GPS receivers will return the exact SNR value for a given position and antenna. Each manufacture has their own way of calculating this value which can vary. The NMEA specification does specify that the SNR (C/No) will fall between 0 and 99 dB. For Navsync GPS receivers it has been observed that the SNR value will fall between 30 and 55 where 30 is loss of signal and 55 shows highest signal quality.

For more information in SNR values, please see SNR (C/No) Values.

13.10.3.1 Physical GPS Mask Angle Tab

13.10.3.1.1 SNR Threshold

By setting the SNR threshold, the physical elevation mask angle can be detected and plotted. When this value is set to a high SNR value, the elevation mask may be more apparent in less time.

13.10.3.1.2 Comment

When printing the elevation mask angle graph, this comment will be displayed at the top of the page. This is a good place to describe the plot and add notes.

13.10.3.2 Auto Load Tab

13.10.3.2.1 Enable Auto Load

Sometimes it is desirable to have a mask file load automatically when the Azimuth and Elevation window is opened. The Enable Auto Load check will enable loading of a Physical Mask Angle file the next time the Azimuth and Elevation is re-opened. Use the Browse button to specify a file to load.

13.11 NMEA Command Monitor

The NMEA Command Monitor window shows all NMEA data sentences received from the GPS receiver. Although NS3Kview only responds to specific NMEA sentences, the command monitor window will show all sentences.

Using the right mouse button, a command menu is enabled. This is the same as the Command Monitor Settings in the NMEA Command Monitor menu bar. The following options may be selected:

13.11.1 Start Log File

This command will enable NMEA logging. Logging is a application level command and logging will continue even the NMEA command Monitor window is closed. NMEA logging can also be found in the Communications Dialog. See Getting Started for more information.

13.11.2 Close Log File

If a log file is enabled, then selecting this menu option will close the file.

13.11.3 Pause

Pauses the NMEA Command Monitor. This has no effect on NMEA logging.

13.11.4 Erase Screen

This menu option simply erases the NMEA Command Monitor window. This command has no effect on NMEA logging.

13.11.5 Debug Monitor

Enables the debug monitor mode. ***In this mode NMEA messages are not decoded***. This debug mode is intended for displaying special debug messages available from the Navsync range of GPS receivers. These messages are output in ASCII format with a HOME character at the start of each message. When set to debug monitor mode the NMEA Command Monitor Window will recognize the HOME character and start each message at the beginning of the window. When the Debug Monitor is first selected a command is sent to the receiver asking it to display the menu debug page. Note, the receiver has to be previously configured to output the debug messages before using the debug monitor mode, alternatively the correct command can be typed in by the user through this interface.

Any keyboard input in the NMEA command Monitor window is sent to the GPS receiver.

13.12 New Dialog

From the File menu, select New. Here you can open one of many different NS3Kview windows.

13.13 Communications Settings

Here you can set-up the communications interface. The default communications parameters for the three port of the Navsync CW25 Development Kit is 38400 baud, no parity, 8 data bits, 1 stop bit.

For more information on communication set-up, see section 13.6 Getting Started.

13.13.1 NMEA File Logging

At times it is desirable to log NMEA data for use at a later time. Select the **Enable Logging** check box will instruct NS3Kview to log all NMEA sentences to a file. Use the ... button to select the destination for the log file. NMEA logging can also be selected through the NMEA Command Monitor Window.

13.13.2 Demo Mode

Demo Mode or NMEA data play-back will read a text file for NMEA data sentences. Checking the **Enable Demo Mode** check box will command NS3Kview to read a text file instead of reading the communication port. A file is included for demonstration purposes. Selecting the **Browse** button will allow you to select your own NMEA text file.

The rate that NS3Kview will read the file can be controlled by setting the wait and delay values. Note that individual NS3Kview windows will update at a maximum of 100 ms and any intervals shorter than 100ms, data may be discarded. Example, the Survey Window will read the NMEA data processing every 100ms while the Signal Quality Window will read the NMEA data processing every second. Of course this depends on the processing power of the target computer.

See Also

Getting Started, NMEA Command Monitor

13.14 General Settings

The general settings dialog allows the user to set-up various parameters for NS3Kview.

13.14.1 Units of Measure

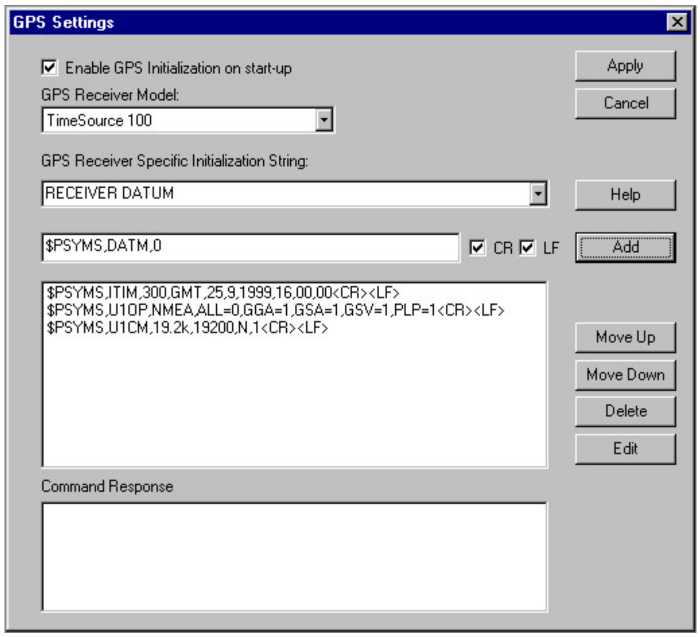
Here you can select metric or statute units. Any values that reflect altitude or distance will be affected.

13.15 GPS Settings

The GPS Settings dialog allows the user to configure the receiver to output their NMEA sentences, or initialise it with time and position etc. At this time, GPS receivers supported are the CW25 , NS100, NS1000 and any generic receivers which accept ASCII initialisation commands. Future versions of NS3Kview will support more GPS receivers.

To configure a receiver, type in the required command and select the Carriage Return (CR) and Line Feed (LF) options as applicable (The CW25 requires both these options to be set). Select the '**Add**' button to add this command to the list. Up to 10 commands can be added to the list. Once you have entered the required commands select the '**Apply**' button to send these commands to the receiver.

If you have selected a Navsync CW25 receiver in the GPS Receiver Model a list of the more commonly used commands will be displayed above the command entry box



Selecting an option from the list of commands will display a sample of the command in the command entry box. This can then be edited to have the correct data and then added to the list with the '**Add'** button. To see details of these message formats select the '**Help**' button, this will show the specification for each message.

To Edit a command which has already been entered into the command list highlight the command and select the '**Edit**' button. This removes the command from the list and places it in the command entry box, edit the command as required and when modified select the '**Add**' button to add it back to the list.

Navsync's **CW25** receiver acknowledges commands by returning a $PRTHR message corresponding to the command sent. These messages are decoded by NS3Kview and displayed in the Command Response window. These can be checked against the commands sent to the receiver to see if all commands have been accepted. To become familiar with the messages, send a few commands to the receiver and observe the responses.

To automatically send initialisation commands when NS3Kview is started, select the Enable GPS initialisation on start-up button.

13.16 NMEA Settings

The NMEA Settings Dialog will enable or disable processing of individual NMEA sentences. To disable processing of specific sentence, select the sentence in '**Include**' list box and click on the → button. To enable processing of a specific sentence, select the sentence in the **Exclude**' box and click on the ← button.

13.17 GPS LED Indicator

This LED indicates that there are NMEA sentences received by NS3Kview. When the LED blinks green, a NMEA sentence is received. When the LED is grey, no sentences have been received within 10 seconds.

13.18 NMEA Logging LED

The NMEA Logging LED indicates that the NMEA logging is enabled. When the LED blinks red, active logging is enabled. See section 13.6 Getting Started for more information.

14. GPSplan

14.1 Disclaimer

In no event shall Navsync be liable for any loss of profit or any other commercial or private damage, including but not limited to special, incidental, consequential or other damages, resulting from or in any way connected with the use of this software. Navsync specifically disclaims any other warranties expressed or implied, including but not limited to the implied warranties of merchantability and fitness for a particular use.

14.2 Distribution

You are hereby licensed to make as many copies of the GPSplan software and documentation as you wish; give exact copies of the original version to anyone; and distribute the GPSplan software and documentation in its unmodified form via electronic means. There is no charge for any of the above.

You are specifically prohibited from charging, or requesting donations, for any such copies, however made; and from distributing the software and/or documentation with other products (commercial or otherwise) without prior written permission.

14.3 Installing GPSplan

The software is supplied on a CD-ROM and is very simple to install.

Insert the CD-ROM into your CD-ROM drive and view the disk contents. Open the GPSplan\Software Vx.x folder and run the SETUP.EXE program, this will guide you through the installation process. The software is normally installed into the Program Files\Navsync directory but may be installed into any directory you choose.

14.4 Introduction

GPSplan is a GPS satellite prediction program which calculates and graphically displays satellite constellation information for any point in the world.

It uses Yuma format almanacs to calculate satellite motion over a full 24 hour period.

A copy of a Yuma Almanac is included with the software. Each almanac is valid for up to 1 month and should then be updated with the latest almanac.

New almanacs are available from the internet

ftp://ftp.navcen.uscg.mil/GPS/almanacs/yuma/

and also downloadable from NavSymm XR5 and Sharpe receivers.

14.5 New features

GPSplan V1.1 will decode both the old and new (post week 1024 rollover) YUMA almanac formats.

14.6 Using the Software

GPSplan is extremely easy to use and can give you a prediction of satellite availability for anywhere in the world with only 6 mouse clicks.

14.6.1 Loading the Almanac File

Before any calculations can be made a Yuma format almanac must be loaded. To load an almanac file select File, Open, from the main menu and select the almanac file

e.g. \Program Files\Navsync\Yuma994.txt.

When the program has loaded a valid almanac file it will display the almanac parameters in the main window.

14.7 Calculate Satellite Plan

After loading an almanac file select the **Calculate, Satellite Plan** option from the main menu (or click on the abacus button). A new window is displayed asking for user position information. Enter the required position, time, and minimum satellite elevation for the satellite plan. If you are not certain of you latitude and longitude press the **MAP** button. This will display a world map which will allow you to select your position by simply clicking on the correct position on the map. Press **OK** when you have completed your selection and the correct coordinates will now be shown on the User Position window. When you have completed entering the data select the **OK** button.

Congratulations you have now calculated your first satellite plan! A Combined view window is displayed which shows you the satellite availability and DOPs for position and date entered.

14.8 Viewing the results

Five graphical views of the results are available:

- DOPS
- Satellite Visibility
- Sky Plot
- Combined View
- Number of Satellites Visible

These views can be displayed one at a time by selecting **View** from the main menu and selecting the view required, or by clicking on the speed buttons on the status bar. Each of the graphs can be customised to give you the view you require. On the linear graphs sets of 'handles'(small arrows) on the axes of the graphs can be used to zoom in to a particular part of the data. Simply select the handle and drag it along the graph axis. On views with more than one graph the relative height of the graphs can also be changed. Move the cursor between the graphs and it will change to a symbol looking like an equals sign with an arrow through it. Drag this symbol up or down to change the height of the graphs.

The time shown on the base of the each graph is UTC (GMT) for the date entered.

To zoom in to a particular time on the sky plot view use the start and stop time scroll controls. Simply select the required start and stop time and press the **REDRAW** button.

When you have finished with a particular view press the **OK** button or close the window with the cross in the top right hand corner.

14.8.1 DOPS view

The DOPS view shows the 'All in view' Dilution of Precision plots. This is the effect that the satellite geometry has on the accuracy of the GPS solution. It is split into four plots, PDOP (position), HDOP (horizontal), VDOP (vertical)& TDOP (time). Some other GPS planning programs give you the DOP of the best four satellites, but in today's world of multi-channel receiver it is better to know the true effect of satellite geometry rather than a limited selection of available satellites.

14.8.2 Satellite Visibility

The Satellite Visibility view shows which satellites are visible and the elevation angle of the satellite. The shaded section at the bottom of the elevation angle graph corresponds to the elevation mask angle entered in the User Position window. The satellite becomes 'visible' and is displayed in the top graph when it rises above the elevation mask.

The colour of the two graphs match so to see which elevation plot corresponds to which satellite simply look at the same time on the X axis and match the colour.

When displaying the Satellite Visibility view the graphs can only display 25 satellites (50 total) this may mean that all satellites are not shown in this view if more than the optimum 24 GPS satellites are operational.

14.8.3 Number of satellites visible

The Number of Satellites Visible view shows how may satellites are visible above the elevation mask entered by the user during the 24 hour period. Due to the display limitations very narrow peaks and dips may not be shown on the full 24 hour view. If you zoom in to a particular area you may notice the pattern change very slightly.

14.8.4 Combined View

The combined view incorporates a graph from each of the above three views. It is useful to be able to see how satellite availability can affect the DOPS.

14.8.5 Sky Plot

The sky plot view is different from the other views in that it is polar plot. The centre of the view is the sky directly above the users head. Compass points show the direction. The three concentric circles correspond to 0, 30 & 60 degrees elevation. This plot is very useful if an GPS antenna is being positioned at a fixed site with limited visibility. The plot will highlight areas where no satellites are seen e.g. Due North.

Therefore better performance may be achieved if the antenna is positioned so that any physical obstructions are due north and therefore not blocking out any satellites.

14.9 Printing the results

Each of the graphical views has a print button associated with it. Adjust the view to your liking as detailed in section 14.8 and press the PRINT button.

14.10 Contact Information

If you have any questions, comments, bug reports etc. please contact us at the Email address below.

gpsplan@Navsync.com

15. 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.

However, the U.S. Department of Defence deliberately degrades signals from the constellation of GPS satellites by applying errors in the form of Selective Availability (SA), thereby reducing the accuracy obtainable by civilian GPS receivers. DoD policy is to set the level of SA degradation to give a horizontal accuracy of 100 metres (95% of the time). Most of the effects of SA can be eliminated by utilising Differential GPS (DGPS) techniques.

15.1 GPS positioning and navigation

The CW25 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, you will experience difficulty acquiring and maintaining 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). Note also, that 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. Remember always, it is the location of the antenna which 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 which keep precise time and these are used to time-tag the message (i.e. code the transmission time onto the signal) and to 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: time x speed of light = 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 synchronise 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 kilometres out into space).

This assumes the satellite and receiver timing to be identical. In reality, when the CW25 Receiver compares the incoming signal with its own internal copy of the code and clock, the two will no longer be synchronised. 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 CW25 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.

Utilising its considerable processing power, the CW25 Receiver rapidly updates these calculations from satellite data to provide a real time position fix. Memory options allow storage of navigation and position data for subsequent post-processing or post-mission analysis, all within a single unit.

15.2 Standard positioning service (SPS)

Civil users world-wide are able to use the SPS without restriction or charge. Accuracy of the system is intentionally degraded by the DoD through the application of Selective Availability (SA). This degradation is achieved by the system deliberately broadcasting extra errors into the satellite orbit information, and by 'dithering' the satellite clocks.

A predicted accuracy for the SPS has been published in the 1994 Federal Radio navigation Plan as:-

- 100 metre horizontal accuracy
- 156 metre vertical accuracy
- 340 nanosecond time accuracy

The figures refer to 95% position fix accuracies, expressing the value of two standard deviations of radial error from the actual **antenna** position, this position being an estimate made under specified satellite elevation angle and PDOP conditions.

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 the SHARPE XR6-RPS:

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 which 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 CW25 reports all accuracy's in the form of a standard deviation (RMS) value.

15.3 Precise positioning service (PPS)

This service is only available to authorised 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.

16. ILD Network Assist Message Format

This section defines the ILD (Indoor Location Demonstrator) format Network Assistance Base Station messages output from a Navsync Basestation.

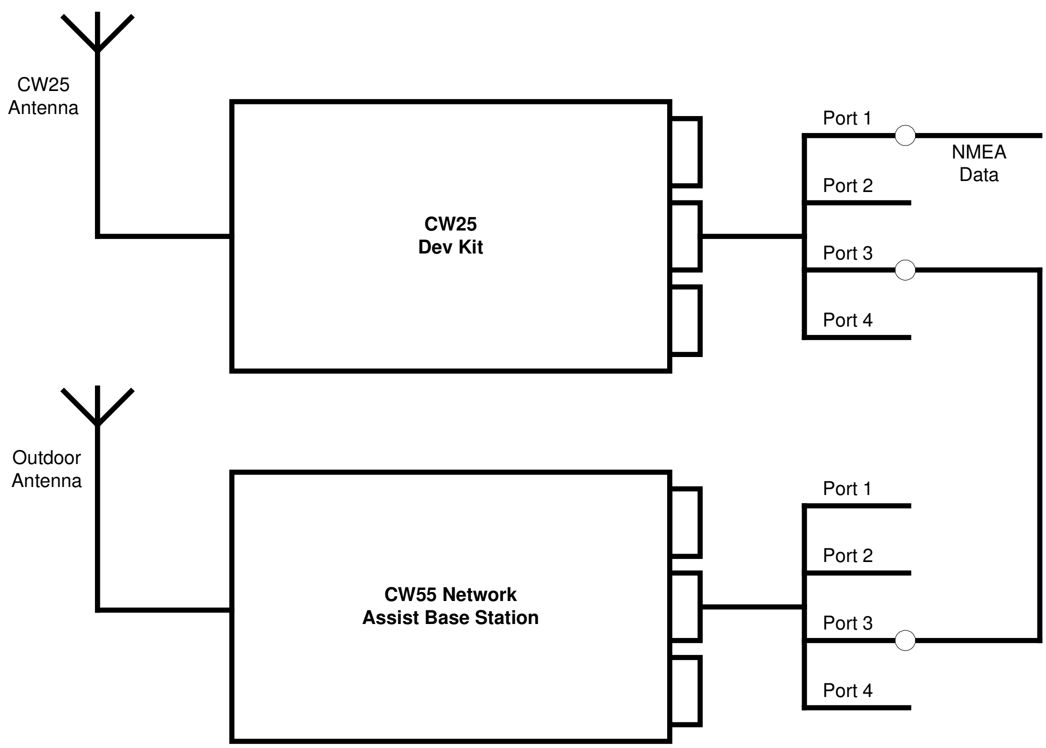
These messages are suitable for use as a Network Assistance input to the CW25 reciever module.

These messages are a series of ASCII comma separated messages which are output from UART3 of the CW25 based ILD Base Station Receiver at 38400,8,N,1.

Each message starts with a # character and ends with a <CR><LF>.

Prior to the end of the message there is an & character followed by an 8-bit accumulative checksum of all bytes in-between the # and & characters in represented in ASCII hexadecimal.

For simplicity, the messages which contain data normally transmitted in the GPS satellite's Navigation Messages, contain the data formatted and scaled as closely as possible to it. These are also very close to the data structures that are used at the NS3K and XG4K API interfaces and hence minimizes the data manipulation in the user application code outside the GPS_Core API interface.



#WTP, Week, Time, Position Message

This message is output every seconds provided the ILD Base Station has obtained a valid accurate 3D GPS fix in the last 60 minutes. This long 60 minute time-out enables a Base Station to be initialized outdoors, and then taken indoors to initialize an ILD Mobile receiver (eg via a wire link) without having to maintain lock on satellites itself.

This message does not contain any position uncertainty estimates, corresponding to the known cell size, as these are added at the mobile end for demonstrator systems. This message will be superseded by new #TIM and #LOC messages for any end user products that use these messages.

#WTP,week,TOW,ECEF-X,ECEF-Y,ECEF-Z,FrqCal&cs

```
#WTP,1282,467123.907,3912409,-78922,5020018,&DA
```

Name	Description
#WTP	Base Station Week, Time, Position data.
week	GPS Week Number (blank if unknown)
TOW	GPS Time of Week (seconds) of transmission of the # character at the start of the message (approx +/-20 msec accuracy)
ECEF-X	Base Station ECEF Position, X coordinate (metres)
ECEF-Y	Base Station ECEF Position, X coordinate (metres)
ECEF-Z	Base Station ECEF Position, X coordinate (metres)
FrqCal	Optional GPS reference clock frequency calibration word. The units are system dependant. Under normal usage this field should be left blank.
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.

16.1 Message Definitions

16.1.1 #EPH, Ephemeris Subframe Message

This message is output approximately once a second, and hence takes up to16 seconds to transmit an Ephemeris for all satellites in view. .

#EPH,SV,W[1], ... ,W[24]&cs

```
#EPH,27,409000,191EA0,D180AF,B1A11B,D70FF6,A17241,0000A0,2E0662,
A1FBD8,349A61,E6DEFE,FBE609,5CBA11,0ADAA1,0DAEAD,724135,00216F,
302D23,FF4726,B8F287,221CA8,A1D0AE,FFA787,A1018D&DE
```

Name	Description
#EPH	**GPS Navigation Message Ephemeris data for a single satellite. See ICD-GPS-200 for full details.**
SV	SV id number for the ephemeris data to follow
W[i] i=1 to 24	24 words of the Ephemeris subframes data from words 3 to 10 of subframes 1, 2 and 3 of the GPS Navigation Message. **Each of the raw 30 bit data words have been logically shifted 6 bits to the right to remove the 6 parity bits leaving the 24 data bits seen in the above example.**
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.

16.1.2 #ALM, Almanac Subframe Message

This message is output approximately twice every seconds, and hence takes up to16 seconds to transmit a complete set of Almanacs.

#ALM,SV,week, W[1], ... ,W[8]&cs

```
#ALM,20,1283,54133D,0F0DC9,FD4100,A10C6F,16E0FE,41DD95,D2B291,
EE002D&92
```

Name	Description
#ALM	**GPS Navigation Message Almanac data for a single satellite.** **See ICD-GPS-200 for full details.**
SV	SV id number for the almanac data to follow
week	Almanac reference GPS week number
W[i] i=1 to 8	8 words of almanac data from words 3 to 10 of the Almanac pages of subframes 4 or 5 of the GPS Navigation Message. Each of the raw 30 bit data words have been logically shifted 6 bits to the right to remove the 6 parity bits leaving the 24 data bits seen in the above example.
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.

16.1.3 #KLB, Klobuchar Ionospheric Parameters Message

This message is output approximately once every 16 seconds.

#KLB,a0,a1,a2,a3,b0,b1,b2,b3&cs

```
#KLB,5,2,-1,-2,38,3,-1,-4&BA
```

Name	Description
#KLB	**GPS Navigation Message Klobuchar ionospheric delay correction model parameters. See ICD-GPS-200 for full details.**
a0	α_0 (x 2^{-30} seconds)
a1	α_1 (x 2^{-27} seconds per semicircle)
a2	α_2 (x 2^{-24} seconds per semicircle^2)
a3	α_3 (x 2^{-24} seconds per semicircle^3)
b0	β_0 (x 2^{11} seconds)
b1	β_1 (x 2^{14} seconds per semicircle)
b2	β_2 (x 2^{16} seconds per semicircle^2)
b3	β_3 (x 2^{16} seconds per semicircle^3)
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.

16.1.4 #UCP, UTC Correction Parameters Message

This message is output approximately once every 16 seconds.

#UCP,A1,A0,Tot,WNt,dtLS,WNLSF,DN,dtLSF&cs

```
#UCP,-20,-8,15,3,13,222,5,13&68
```

Name	Description
#UCP	GPS Navigation Message UTC Correction model Parameters. See ICD-GPS-200 for full details.
A1	A_0 (x 2^{-30} seconds)
A0	A_1 (x 2^{-50} seconds/second)
Tot	t_{ot} (x 2^{12} seconds)
WNt	WN_t (x 1 weeks)
dtLS	Δt_{LS} (x 1 seconds)
WNLSF	WN_{LSF} (x 1 weeks)
DN	DN (x 1 days)
dtLSF	Δt_{LSF} (x 1 seconds)
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.

16.1.5 #TIM, Time Input Message

This message is output every seconds to provide an approximate starting GPS Time.

This message has not currently been implemented.

#TIM,week,TOW,TOW_rms,FS_TOW,FS_rms&cs

Without a Frame Synch pulse input

```
#TIM,1282,467123.907,10,,&hh
```

With a 1PPS with 100 nsec RMS accuracy used as a Frame Synch pulse input

```
#TIM,1282,467123.907,10,467123.000000000,100,&hh
```

Name	Description
#TIM	Time input data.
week	GPS Week Number (blank if unknown)
TOW	GPS Time of Week (seconds) of transmission of the # character at the start of the message
TOW_rms	RMS accuracy (integer milliseconds) of the above TOW relative to when the # character was transmitted.
FS_TOW	GPS Time of Week (seconds) of the last Frame Synch pulse inserted. Leave blank if it is unknown, or no pulse was sent.
FS_rms	RMS accuracy
FrqCal	Optional GPS reference clock frequency calibration word. The units are system dependant. Under normal usage this field should be left blank.
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.

16.1.6 #LOC, Location Message

This message is output every seconds and provides an estimate of the user's location along with an uncertainty for this estimate.

This message has not currently been implemented.

In many Network Assistance applications the location provided will be the position of the Base Station itself, and the uncertainty will be sufficiently large to cover all possible positions that a user able to communicate with that Base Station could be located at. In this case the RMS uncertainty should be set to the maximum cell size / 3, for a 3-sigma limit.

#LOC,Lat,Long,Alt,Unc_SMaj,Unc_SMin,Unc_Brg,Unc_Vert&cs

For an input location of 52 14.971 N 1 09.354W 203m altitude, with an circular horizontal uncertainty of 3 km RMS and a vertical uncertainty of 200m RMS.

```
#LOC,5214971,-109354,203,3000,3000,0,200&hh
```

Name	Description
#LOC	Location input data
Lat	WGS84 geodetic latitude formatted as : (Latitude_degrees * 100000 + Latitude_minutes * 1000) +ive North.
Lon	WGS84 geodetic longitude formatted as : (Longitude_degrees * 100000 + Longitude_minutes * 1000) +ive East.
Alt	WGS84 ellipsoidal altitude (metres) +ive Up.
Unc_SMaj	Horizontal RMS uncertainty semi-major axis (metres)
Unc_SMin	Horizontal RMS uncertainty semi-minor axis (metres)
Unc_Brg	Horizontal RMS uncertainty bearing of semi-major axis (degrees)
Unc_Vert	Vertical RMS uncertainty bearing of semi-major axis (metres)
cs	8-bit accumulative checksum of all bytes in-between the # and & characters in hexadecimal.

16.1.7 Example Sequence Of Messages

This is an example of a sequence of message for a Demonstrator system (ie #WTP messages are used rather than the new and still to be implemented #TIM and #LOC messages). The blank line does not exist in reality, and has only been inserted to show where a gaps exist in the transmission bursts.

```
#WTP,1282,467130.051,3912410,-78920,5020020,&BD
#EPH,01,409101,111EA0,D180AF,B1A11B,D70FF9,977242,00000F,2ECB20,9701FE,2B44A2,48C011,018D02,B391A6,1
10EA1,051E1D,72427D,002747,E62DBD,FFE127,EDA07F,1D67BC,612361,FFAB6F,97057C&66
#ALM,31,1283,5F6302,0FFBE7,FD4500,A10D3C,BFB770,283629,171561,25006B&4D
#ALM,01,1283,412B43,0F1879,FD5F00,A104C7,42EDF7,BC5419,3D242B,2E001E&67

#WTP,1282,467131.075,3912410,-78919,5020021,&CD
#EPH,04,409000,191EA0,D180AF,B1A11B,D70FF3,DA7242,00FF7E,E0784B,DA00CE,36AD6B,133310,00EC03,65D59D,0
98BA1,0D9E63,72424C,FF97F2,66D059,002327,10BCB9,2490FD,AD84C2,FFA4B2,DAFBFE&04
#ALM,03,1283,432F7E,0FF64D,FD3B00,A10D11,BEB470,15D9EF,7CA673,040031&84
#ALM,04,1283,443663,0F0AA4,FD4500,A10D41,ED6DD4,FDA9F2,052B62,E0FF85&9E

#WTP,1282,467132.099,3912410,-78919,5020022,&D5
#EPH,05,409103,1DDDE3,D180AF,B1A11B,D70FF7,387080,00000F,059C84,38FB53,375532,23061B,FBAC02,CBD5FA,1
3B4A1,0DCF97,70807C,FFDC99,1E10E7,000626,261485,16E322,EB337C,FFA480,38F9C1&93
#ALM,05,1283,452CD1,0FFBF7,FD3C00,A10D46,94244E,22EAF7,F70045,050016&68
#ALM,06,1283,463678,0FFB30,FD4300,A10D92,C0E3E9,AF2AD0,280C02,2D014F&72

#WTP,1282,467133.123,3912410,-78918,5020022,&C9
#EPH,06,409001,191EA0,D180AF,B1A11B,D70FF5,4B7242,000145,2C7A40,4B084E,38258E,0A93F7,068403,6813BB,1
294A1,0E1379,72427F,0059C5,DCF2CA,FFE026,199E24,1831AF,1F3454,FFA567,4B0CA5&41
#ALM,07,1283,476B8C,0FFC42,FD4500,A10C34,BFC27E,B5493D,7DE84A,36FF7D&DA
#ALM,08,1283,484AA1,0F0F3E,FD5700,A10C85,6DEFF7,630BEA,2ECA8F,FF0004&D3

#WTP,1282,467134.147,3912410,-78918,5020023,&D1
#EPH,07,409000,191EA0,D180AF,B1A11B,D70FFC,827241,00FF54,376860,8209B4,38FCE3,AAEB14,08BC06,B924E7,1
29CA1,0CAD61,72412A,FFC2C4,BB803E,006626,2AC533,1954B5,42FB87,FFA246,820D5F&9D
#ALM,09,1283,49831A,0F06BA,FD4D00,A10D21,6B1798,2BACC4,1CCC36,F8FFED&D3
#ALM,10,1283,4A3140,0F186D,FD5000,A10DC1,17BA55,0CF794,AB51B6,06000F&4F

#WTP,1282,467135.171,3912410,-78917,5020024,&CF
#EPH,10,409201,091EA0,D180AF,B1A11B,D70FFB,E97242,000006,06598F,E9FAD2,2D0F11,45B59C,FBAD03,147CC7,1
1F7A1,0E1E37,72427C,00231C,B2DB46,001A27,ED6AE7,1B720C,FA5223,FFA8BA,E9F011&B5
#ALM,11,1282,4B18FE,90E825,FD1400,A10CF2,ED07E2,02BFAA,7EA606,12002A&86
#ALM,13,1283,4D1370,0F1B34,FD6400,A10CA5,423D1E,25448B,AD34F8,FC001B&68

#WTP,1282,467136.195,3912411,-78917,5020024,&D7
#EPH,11,409101,1DDDE3,D180AF,B1A11B,D70FE7,207080,00001B,12253A,200267,43937F,DD1C4E,022C01,8F160C,0
7CEA1,0D7145,70807E,FFE2ED,13C163,FFE024,E8BFB7,22D002,C42A93,FF9E52,20FC47&7A#ALM,14,1283,4E0AB1,0F
1791,FD5D00,A10CB3,41D87B,BB15FC,79C4E8,FC0019&AB
#ALM,15,1283,4F4826,0F0F3F,FD4C00,A10CDC,EF95B3,5D7FC0,24AD4C,27003F&C1

#WTP,1282,467137.219,3912411,-78916,5020025,&D5
#KLB,5,2,-1,-2,38,3,-1,-4&BA
#UCP,-20,-8,15,3,13,222,5,13&68
```

#ALM,16,1283,5014B5,0F0C4C,FD5500,A10C39,97277F,C8792E,FAD2CF,010002&6E

#ALM,17,1282,518D10,90108E,FD4900,A10CD1,F63811,8FCC07,7F941E,F0FFB0&8A

#WTP,1282,467138.243,3912412,-78916,5020026,&D5

#EPH,13,409000,191EA0,D180AF,B1A11B,D70FE8,B17242,000006,FCC7B1,B10249,2AFD13,2B281F,01F801,37728C,1117A1,0CFC41,72427F,FFC547,35343B,003528,195810,1D4B25,2CC22A,FFAA94,B10849&11

#ALM,18,1282,522AA4,900DCE,FD4700,A10D0E,1DF18C,88F19F,28FEAD,F7FFF8&FA

#ALM,19,1283,531D34,0F0B61,FD5700,A10C3B,C40980,B01E11,C94607,FE0028&41

#WTP,1282,467139.267,3912412,-78916,5020026,&DC

#EPH,14,409001,15DDE3,D180AF,B1A11B,D70FEA,987080,00FFFA,FCC5C4,980134,2BC2B4,9B6179,00CD00,AA3442,10B8A1,0D0B72,70807E,002E46,D14B00,FFFD27,DF19FD,1DEDBB,5500DE,FFA9E7,980618&07

#ALM,20,1283,54133D,0F0DC9,FD4100,A10C6F,16E0FE,41DD95,D2B291,EE002D&92

#ALM,21,1283,554A57,0F067A,FD4100,A10D07,EE6B06,7C6B50,24326A,0A000B&42

#WTP,1282,467140.291,3912413,-78916,5020026,&D2

#EPH,16,409000,191EA0,D180AF,B1A11B,D70FEB,B07242,00FFFB,01056B,B0FC55,2F6C60,CEB392,FCE001,4ACF8D,1445A1,0CAE29,72427F,00039C,200047,000627,2B6F6E,1819C8,529753,FFA9D7,B0FCD3&A8

#ALM,22,1283,5627B5,0F0C16,FD4000,A10D03,1967D9,C39FBE,9F16BE,020007&5C

#ALM,23,1283,571E8D,0F0BE4,FD5000,A10DB5,41C23B,552133,97BE38,120074&42

#WTP,1282,467141.315,3912413,-78916,5020026,&D0

#EPH,17,409000,191EA0,D180AF,B1A11B,D70FFD,B47241,00FF92,F0B418,B4FF4C,342DAB,86653B,FF3C08,CFB404,09ADA1,0D2FCE,724117,0054F6,4270E1,FF6A27,6F480E,24AD8F,C5200D,FFA5C4,B400CF&14

#ALM,24,1283,584D70,0F115B,FD4F00,A10D20,EE8BD9,C729AF,2413DD,060029&7D

#ALM,25,1283,595C90,0F023B,FD4700,A10D99,690B93,C0709E,3C3E96,090010&3C

#WTP,1282,467142.339,3912413,-78916,5020027,&D8

#EPH,20,409001,191EA0,D180AF,B1A11B,D70FF1,8D7242,000020,EE3A42,8DFC4E,302338,979E6A,FC5901,34559B,118BA1,0CDA02,72427D,FFE51B,D9E55F,FFEF27,4328C4,1B5441,D2650C,FFA85E,8DF4D2&DE

#ALM,26,1283,5A7FAC,0F1A1E,FD6300,A10D2F,425700,196253,685883,18008E&46

#ALM,27,1283,5B95C2,0F0530,FD4900,A10D44,6A373F,A8A532,FC1029,2E00B3&55

#WTP,1282,467143.363,3912414,-78915,5020027,&D6

#EPH,23,409000,191EA0,D180AF,B1A11B,D70FED,077242,000060,124D1E,070277,308AFD,DDAE47,01FB01,E8E9D6,10CBA1,0E2EB4,724279,FFCE46,BAE11B,FFBA27,2454FE,1C8554,F6CD2E,FFA7BD,070592&FE

#ALM,28,1283,5C4A82,0F0AF8,FD5400,A10D25,97951C,9F616D,C354BE,050005&68

#ALM,29,1283,5D42FB,0F181D,FD5E00,A10D8B,41015B,C9DFD2,C03EB0,30FFD9&CC

#WTP,1282,467144.387,3912414,-78915,5020027,&DD

#EPH,24,409000,191EA0,D180AF,B1A11B,D70FFD,797241,00001A,0639AF,7900CE,33F689,E735BA,010304,D62923,092DA1,0D77A1,724120,0041F3,849D01,005127,7C25BE,2539C7,26812C,FFA692,79FC34&E6

#ALM,30,1283,5E3DD5,0F006D,FD4300,A10C7A,95D8A6,3389C4,D0357A,480018&63

#ALM,31,1283,5F6302,0FFBE7,FD4500,A10D3C,BFB770,283629,171561,25006B&4D

#WTP,1282,467145.411,3912415,-78915,5020028,&D4

#EPH,25,409201,091EA0,D180AF,B1A11B,D70FF0,9D7242,000007,098A6F,9DFD25,35BEA2,3A5296,FDB305,CA1705,0ADBA1,0E03CB,72427D,00656E,04A569,001426,89A0F5,21F3C0,67A21D,FFA678,9D02CC&77

#ALM,01,1283,412B43,0F1879,FD5F00,A104C7,42EDF7,BC5419,3D242B,2E001E&67

#ALM,03,1283,432F7E,0FF64D,FD3B00,A10D11,BEB470,15D9EF,7CA673,040031&84

#WTP,1282,467146.435,3912415,-78915,5020028,&DB

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```
#ALM,04,1283,443663,0F0AA4,FD4500,A10D41,ED6DD4,FDA9F2,052B62,E0FF85&9E

#ALM,05,1283,452CD1,0FFBF7,FD3C00,A10D46,94244E,22EAF7,F70045,050016&68


#WTP,1282,467147.459,3912415,-78915,5020028,&E2

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#ALM,06,1283,463678,0FFB30,FD4300,A10D92,C0E3E9,AF2AD0,280C02,2D014F&72

#ALM,07,1283,476B8C,0FFC42,FD4500,A10C34,BFC27E,B5493D,7DE84A,36FF7D&DA


#WTP,1282,467148.483,3912416,-78915,5020029,&E2

#EPH,31,409000,191EA0,D180AF,B1A11B,D70FF3,CA7242,00006A,24E7EF,CA0977,373D7D,0A92EB,07AF06,2F3ECA,1
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#ALM,08,1283,484AA1,0F0F3E,FD5700,A10C85,6DEFF7,630BEA,2ECA8F,FF0004&D3

#ALM,09,1283,49831A,0F06BA,FD4D00,A10D21,6B1798,2BACC4,1CCC36,F8FFED&D3


#WTP,1282,467149.507,3912417,-78915,5020029,&E1

#EPH,01,409101,111EA0,D180AF,B1A11B,D70FF9,977242,00000F,2ECB20,9701FE,2B44A2,48C011,018D02,B391A6,1
10EA1,051E1D,72427D,002747,E62DBD,FFE127,EDA07F,1D67BC,612361,FFAB6F,97057C&66

#ALM,10,1283,4A3140,0F186D,FD5000,A10DC1,17BA55,0CF794,AB51B6,06000F&4F

#ALM,11,1282,4B18FE,90E825,FD1400,A10CF2,ED07E2,02BFAA,7EA606,12002A&86


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98BA1,0D9E63,72424C,FF97F2,66D059,002327,10BCB9,2490FD,AD84C2,FFA4B2,DAFBFE&04

#ALM,13,1283,4D1370,0F1B34,FD6400,A10CA5,423D1E,25448B,AD34F8,FC001B&68

#ALM,14,1283,4E0AB1,0F1791,FD5D00,A10CB3,41D87B,BB15FC,79C4E8,FC0019&AB


#WTP,1282,467151.555,3912418,-78914,5020030,&D5

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#ALM,15,1283,4F4826,0F0F3F,FD4C00,A10CDC,EF95B3,5D7FC0,24AD4C,27003F&C1

#ALM,16,1283,5014B5,0F0C4C,FD5500,A10C39,97277F,C8792E,FAD2CF,010002&6E


#WTP,1282,467152.579,3912418,-78914,5020031,&DD

#KLB,5,2,-1,-2,38,3,-1,-4&BA

#UCP,-20,-8,15,3,13,222,5,13&68

#ALM,17,1282,518D10,90108E,FD4900,A10CD1,F63811,8FCC07,7F941E,F0FFB0&8A

#ALM,18,1282,522AA4,900DCE,FD4700,A10D0E,1DF18C,88F19F,28FEAD,F7FFF8&FA


#WTP,1282,467153.603,3912419,-78914,5020031,&D3

#EPH,06,409001,191EA0,D180AF,B1A11B,D70FF5,4B7242,000145,2C7A40,4B084E,38258E,0A93F7,068403,6813BB,1
294A1,0E1379,72427F,0059C5,DCF2CA,FFE026,199E24,1831AF,1F3454,FFA567,4B0CA5&41

#ALM,19,1283,531D34,0F0B61,FD5700,A10C3B,C40980,B01E11,C94607,FE0028&41

#ALM,20,1283,54133D,0F0DC9,FD4100,A10C6F,16E0FE,41DD95,D2B291,EE002D&92
```

17. NMEA Configurability Details

This section describes how the NMEA output can be configured for different Refresh Rates, Content and Baud Rates.

- UART Configuration (i.e. baud rate) Query:

```
$PRTHQ,U1CM
$PRTHQ,U2CM
$PRTHQ,U3CM
```

- UART Configuration (i.e. baud rate) Set:

```
$PRTHS,U1CM
$PRTHS,U2CM
$PRTHS,U3CM
```

- NMEA Output Configuration (i.e. output frequency) Query:

```
$PRTHQ,U1OP
$PRTHQ,U2OP
$PRTHQ,U3OP
```

- NMEA Output Configuration (i.e. output frequency) Set:

```
$PRTHS,U1OP
$PRTHS,U2OP
$PRTHS,U3OP
```

17.1 NMEA Configuration Query ($PRTHQ,UxOP):

The command takes the form "`$PRTHQ,UxOP`" where x is a port number. On the CW25 platform, the port number is always between 1 and 3 inclusive.

The response string 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 remainder of the string is dependent on the NMEA sentences supported by the system, but lists each supported sentence along with the output interval in seconds of that sentence. A NMEA checksum of the form "`*4D`" is appended to the output string.

The list of currently supported NMEA sentences are shown below, together with the abbreviated name used in the response string.

Abbrev.	NMEA Sentence
GLL	GPGLL - Geographic Position - Latitude longitude
RMC	GPRMC - Recommended Minimum Specific GNSS Sentence
VTG	GPVTG - Course Over Ground and Ground Speed
GGA	GPGGA - GPS Fix Data
GSA	GPGSA - GNSS DOPS and Active Satellites
GSV	GPGSV - GNSS Satellites in View
GRS	GPGRS - GNSS Range Residuals
GST	GPGST - GNSS Pseudorange Errors Statistics
PLT	POLYT - Time
PLP	POLYP - Position (Lat, Long)
PLU	POLYU - UTM position
PLG	POLYG - Local Grid position
PLS	POLYS - Satellite data
PLH	POLYH - HDS Time Information
PLI	POLYI - Additional Information

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
```

17.2 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 CW25 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 is 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
```

17.3 UART Configuration Query ($PRTHQ,UxCM):

The command takes the form "`$PRTHQ,UxCM`" where x is a port number. On the CW25 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 CW25 platform. Consequently, the Rx and Tx baud rates returned will always be identical.

17.4 UART Configuration Set ($PRTHQ,UxCM):

The command takes the form "`$PRTHS,UxCM,57600,57600,N,1`" where x is a port number. On the CW25 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 CW25 platform. Consequently, the Rx and Tx baud rates must always be specified to be the same value. In addition, the CW25 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.

18. MISCELLANEOUS

18.1 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	American Department of Defence.
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 Centred 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
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 metres; 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
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	Co-ordinated 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)

18.2 Contact Details

For further details and hot-line support please contact:

International Customer Support

Navsync Ltd.
BAY 143,
Shannon Industrial Estate,
Shannon,
Co. Clare,
Ireland.

Telephone: +353 61 472221
Facsimile: +353 61 472226

18.3 World Wide Web Information

There are several GPS related sites on the World Wide Web (www) that are excellent sources to obtain further information about GPS and the current status of the satellites.

U.S. Coast Guard Navigation Center

Civilian GPS service notices, general system information, and GPS outage reporting:

www.navcen.uscg.mil/gps

U.S. Naval Observatory

General USNO information and links to USNO timing and other useful sites:

www.usno.navy.mil

NAVSYNC GPS Homepage

General GPS information and links to other useful GPS sites:

www.laafb.af.mil/SMC/CZ/homepage

National Marine Electronics Association (NMEA)

For information on the NMEA protocol specification:

www.nmea.org

Radio Technical Commission for Marine (RTCM)

For information on the RTCM specification for DGPS corrections:

www.navcen.uscg.mil/dgps/dgeninfo

General GPS Information

Glossary of GPS terms:

www.gpsworld.com/resources/glossary.htm