AN INTRODUCTION TO DGPS DXING:

Version 2.3   January 2019

Since this guide first appeared around eighteen years ago, then bearing the title of "**DGPS, QRM OR A NEW FORM OF DX?**" it has undergone a number of updates and has been renamed as "**AN INTRODUCTION TO DGPS DXING**". This has appeared in several versions, with a few minor updates to various listings etc. It is now 2019, and the DGPS DXing hobby has become well established and a regular pastime for many DXers, the article has been updated at regular intervals, but the title remains the same, and hopefully the contents are now more appropriate for DGPS DXers (and newcomers to this mode) in the current period.

What is a DGPS Beacon?

Differential **GPS** systems are used to help overcome the limitations in the accuracy of conventional **GPS** systems. By using a fixed reference point as a comparison and comparing this with positions obtained from a conventional **GPS** receiver, a more precise and accurate reading can be obtained by the user. A hand-held GPS receiver may be fine if you are on land, but if you're a mariner trying to navigate your way around a rocky Coast in poor weather conditions, an error of 50 feet or more can be life threatening.

Of course, that is a greatly simplified summary of what is a complex system, and for most beacon enthusiasts, all you will be aware of is hearing a sound that resembles a RTTY/Navtex signal and appears at various points on the LF Bands band between 283.5 and 325 kHz. These signals can be found on the channels listed in the Marine Beacon Bandplan in Section Nine (in Europe the band covers 283.5 to 315 kHz, but in some other parts of the world 315 to 325 kHz are also used), and since many countries closed down their Marine Beacon systems, these are now the dominant signals that appear in this part of the band (with the exception of a small number of aeronautical beacons that are still operating down there). DGPS beacons are heard using **G1D** modulation with Minimum Shift Keying **(MSK).**

In the UK there are several organisations providing the DGPS service and receiving many of these used to require special equipment, since the signals were all encrypted. During 1998, a number of these had the encryption removed, and it became possible for enthusiasts equipped with suitable decoding equipment to receive usable (and therefore 'DXable') idents from them. In the first few years the only readily available decoding program, which was cost effective enough for many DXers to afford, was the 'Radio Raft' program, created by François Guillet F6FLT. A 'limited' version could be downloaded for free, and for a small registration fee this multi-mode decoder could be fully activated to include modes like DGPS. Even today it is still available from various sources (a list of these sources appears later in this document), and once registered could be used for DGPS signal decoding. The downside of this program was that it required the use of a Hamcomm type interface and a computer capable of running DOS programs, which in the early years was no problem, since most PCs running Windows 95/98 were also DOS equipped. You could even run them from a DOS icon on your Windows Desktop if you downloaded a small patch, which was available from the site. In 2007 Windows XP was still the most widely used program for many PC users, and now Windows Vista has been launched – neither of which come equipped for DOS usage. Sadly, for us, this fine old program wont work with these operating systems, though this could well give a whole new lease of life to any old PCs or laptops that you may have lying around, and many of these can be obtained cheaply nowadays. Since many other radio decoder programs will run okay on Windows 98, one of these old PCs one may well be the ideal thing for your radio shack. This may well also have the added benefit of not tying up your main PC and will leave that free for any other functions which you may also want to use it for.

I persisted with my old PC for many years beyond its useful life, but as newer versions of programs like the impressive Skysweeper (more on this later) appeared, it was obvious that my old CPU was now struggling to cope with its demands, and a new PC was eventually built and pressed into shack service in its place. This made quite a difference to my decoding speed and ability, and this is not to decry RadioRaft in any way, since this is still a fine (and inexpensive) program and should still be considered if cost is an issue, its many other modes are still a welcome addition to many a data enthusiast's armoury. If you are experienced with computers you could always set your main PC up as a dual-boot system, with Windows 98 or pure DOS also installed, and boot to this mode when required, but it really all depends on how you use your PC when DXing. I like to log all my catches into an Excel template to speed things up, so my decoder preference these days is for software that will work with Windows. The good news was that as of December 2006 a new contender had entered the ring, and for a very reasonable price too – this was a well-known and established piece of software called "**DSCdecoder**". This will now also decode DGPS signals, and you will find a lot more information about this later in this document. Another new entry in 2008 was the 'Multipsk' program, which now also boasts a DGPS decoding option as well, but only fully working in the registered version. Mac users have not been forgotten either, with a decoding program called 'Amalgamated DGPS' which can handle the entire DGPS Band all at once. One other entry was Spectrum Lab, and some versions of this also decode

this mode as well. More on these programs later, but first we'll look at the hobby of DGPS DXing, and what you can expect to hear, and where you can find it, and a little more about this mode.

DGPS - QRM or a new form of DX?

After several years of cursing the sound of the DGPS signals as irritating QRM, which was spoiling my chances of hearing the few remaining marine and aero beacons in this part of the band, I finally gave in and decided to try and see if this mode was worth decoding. I had been interested in data modes for a long time, and as much as I loved the old Marine Beacons, most of them were going, never to return again, and I was faced with the choice of either getting used to this fact and just going off to listen to the aero beacons instead, or attempting to get to grips with this new system. Well I've always liked a challenge, so I took the latter option, and decided to see if these new signals were worth the effort of decoding.

I have used many different software and hardware decoders, mainly for Ham modes such as SSTV, PSK31 and RTTY, and have also had a long time interest in monitoring the Marine Navtex signals on 518 kHz too, but none of my programs had been capable of decoding the DGPS mode, and so I hadn't taken previously too much notice of it, more so because many of the DGPS Beacons were encrypted anyway and there wouldn't have been much point even trying. Thankfully the encryption had been removed from many of these signals, and after seeing various logs posted on the late and lamented WUN reflector (now UDXF), and then reading all of the interesting articles about this subject on Klaus Betke's excellent website (see 'Datasources' later in this publication), I thought that it was perhaps time to try out the RadioRaft program, which was then available at a reasonable price, and see for myself what it was all about. Klaus did give some very good information about how to build a hardware decoder on his website, but for various reasons I decided to go for the software option instead and promptly registered my trial copy of RadioRaft.

Enter the RadioRaft Decoder:

Free 'trial' versions of this program could be downloaded from various websites (see 'Datasources' and check the list of URLs later in this publication), and one was duly installed. In its unregistered form it wouldn't work with the DGPS mode, and being a DOS based program, it required a Hamcomm type interface to connect it to the PC's Serial Port. You could either boot up your PC in the DOS mode or try running it via a DOS prompt in a Windows environment, though with the downloading of a small additional .pif file from the RadioRaft website this could be more easily run from an icon on your Windows desktop (Windows 95/98 only). I purchased a registered copy from Pervisell, a UK company, via their website (they offered a good service worldwide and will accept most cards online) and duly installed it as per instructions. It took a little while to get used to it, but after printing out the 30+ pages from the help file I had a reasonably good instruction manual to work with, and soon got familiarised with its controls. Keen to see what a DGPS signal looked like, I quickly tuned to the frequency of one of the strong 'locals, and then left the program in its 'auto search' mode. After a few seconds up popped the following message in the format shown below:

```
------------------------- Msg:9 ------------------------
Ref.Id:682  Z:46:43.8  Seq:2  Length:5  Health:0
Data: 7DFD85 F6841C {Err}
------------------------- Msg:9 ------------------------
Ref.Id:682  Z:46:48.0  Seq:4  Length:5  Health:0
Data: 14FB9E 020702 FE2F00 {Err}
------------------------- Msg:9 ------------------------
```

At first glance this might look like gibberish, but for the DXer the important bit here is the Ref.Id number, which in the above example is '682'. A look at the chart below shows that this belongs to Point Lynas in Anglesey, North Wales, which is the closest beacon to my home location. Working out the IDs from the available lists can be a bit challenging at first, mainly because some show several different numbers, and it's not always apparent which is the correct one. To overcome this, a good list and a little common sense are required and matching the frequencies with the Ref.Id should come up with the right answer very quickly, especially if you visit the Datamodes section of the NDB List website and download a copy of the **World DGPS Database** that I created just for this purpose.

Having got the thing to work my next thought was "are these really DXable, or am I only going to hear the same ones every time I tune in? Well after eighteen months of use I was more than sure that they were DXable, and I'd noticed that they seemed to suffer the same nightly changes and variations in propagation as any other type of radiobeacon and brought up many of the same surprise catches. As an example, on some nights I was hearing mainly Spanish and French idents, but on others very few of these were audible, and many of the Scandinavian DGPS idents were dominant instead. Sill being very much a novice at this

mode, but with the winter DX season getting into full swing and static levels dropping, I was very keen to see if reception of any of the Trans Atlantic DGPS beacons was possible. Early on the morning of the 5th of January 2002 the k Index was low, and conditions towards North America were excellent, and over 20 Canadian NDBs were audible on the band. This seemed like the perfect time to put any theories to the test, and I'm pleased to say that I wasn't disappointed that night. Sure enough, the most easterly of the Canadian DGPS beacons at Cape Ray on 288.0 kHz was successfully decoded here in northwest England:

Date: Saturday 5th of January 2002:   Time: 0453 utc   KHz: 288.0
Beacon: Cape Ray, Newfoundland, Canada.   Ref ID: 340/942

```
---------------------------- Msg:9 ----------------------------
   Ref.Id:340  Z:7:15.0  Seq:1  Length:5  Health:1
   Data: 1BFFC5 02100F {Err}
---------------------------- Msg:7 ----------------------------
   Ref.Id:340  Z:7:16.2  Seq:2  Length:9  Health:0
   Lat:17340  Long:54752  375 Km  290.0 Khz  R/beacon operation normal
   Tx.Id:942  200 Bauds MSK asynchronous  No added coding {Err}
---------------------------- Msg:9 ----------------------------
   Ref.Id:340  Z:7:18.0  Seq:3  Length:5  Health:3
   Data: 1A010B {Err}
---------------------------- Msg:9 ----------------------------
```

On first look the above data was a little puzzling, as it showed the frequency as 290.0 kHz. On further checking it was noted that this beacon had been on 290 kHz until recently, and it appears that the operators hadn't yet got around to updating the information. The message also contained two different types of messages too, the more typical "Type 9", and a "Type 7", which I later discovered was the "Radiobeacon Almanac" message, which some beacons broadcast at regular intervals.

On newer versions of RadioRaft (3.21), the creator had made some improvements to the way it decoded the messages, and whilst I won't go into the ins and outs of how you do the upgrade here, a visit to the RadioRaft website, where this is comprehensively covers, will explain all. I will show some examples of what the results obtained with this latest version looked like below though:

```
---------------------------- Msg:9 ----------------------------
   Ref.Id:682  Z:46:43.8  Seq:2  Length:5  Health:0
   Data: 7DFD85 F6841C {Err}
---------------------------- Msg:9 ----------------------------
```

In version **3.20** as can seen above, the more common 'message 9' items were displayed as shown, with each line separated by a hyphenated line. In version **3.21** the messages now appear like this:

```
MSG 9   Beacon 682   Z-Time 44:19.2  Sequence:1  Length:5  Health:0
Data: 05F88F EB401A FDBBE7 DF07FB DEE9DE
```

The difference may seem minimal, but the program does seem to decode the actual time each message was received more efficiently, e.g. Z-Time 44:19.2 shows that this message was received at 44 minutes 19 seconds past the hour. Some other beacons also showed a little more information such as frequency etc. at certain intervals, but again this seems to vary from country to country, and some administrations seem to broadcast the almanacs more than others.

Some other beacons also carried the 'Message 3' and older 'Message 1' type decodes as well, and below are a few more examples of these:

```
MSG 3   Beacon 670   Z-Time 25:12.6  Sequence:7  Length:4  Health:0
Beacon coordinates (mtrs):  X= 3604060.89  Y= -522522.52  Z= 5218824.54
```

```
MSG 1   Beacon 460   Z-Time 42:24.0  Sequence:1  Length:14  Health:0
Data: 01FB8B F91A05 FC55F6 0C06FE E1F939 11FBCB F82616 FBBBFA
Data: BB18FD 00F804 19FE23 FA5A1E FE5AF9 25AAAA
```

Probably the most interesting message was this 'Message 7' 'Beacon Almanac' sent by Beacon No. 693, a new beacon located near Stirling in Scotland, which had come on air in 2001:

```
MSG 7   Beacon 693   Z-Time 30:43.2  Sequence:4  Length:12  Health:0

Position: 56ø04'38.1" North   04ø03'13.8" West
Range: 370 Km  Frequency: 285.5 Khz  R/beacon operation normal
Tx.Id: 443  100 Bauds  MSK asynchronous  No added coding

Position: 57ø08'45.0" North   02ø02'36.2" West
Range: 277 Km  Frequency: 297.0 Khz  R/beacon operation normal
Tx.Id: 446  100 Bauds  MSK asynchronous  No added coding

Position: 55ø16'50.2" North   08ø14'41.9" West
Range: 370 Km  Frequency: 288.5 Khz  R/beacon operation normal
Tx.Id: 435  100 Bauds  MSK asynchronous  No added coding

Position: 53ø25'25.1" North   04ø17'04.3" West
Range: 277 Km  Frequency: 297.5 Khz  R/beacon operation normal
Tx.Id: 442  100 Bauds  MSK asynchronous  No added coding
```

The four TX Ids shown in the list of Message Type 7 decodes above are from the following beacons:

443	Stirling	Scotland
446	Girdle Ness	Scotland
435	Tory Island	Ireland
442	Point Lynas	Wales

At first look I thought this was a list of DGPS beacons operating in the northern part of the UK and the Irish Republic, but there are other beacons in the Scottish Islands, which weren't included here. I will need to monitor for much longer periods and see how often and how regularly "message 7s" appear. Below are some more of the messages received with this later version, and if you are still using the older version of RadioRaft you might well like to consider upgrading to the later version 3.21.

Note that RadioRaft shows the TX ID in its Message 7 type decodes, whereas the Message 9 Types usually show the BC Ref IDs instead (each DGPS beacon has both types allocated).

```
MSG 1   Beacon 460   Z-Time 52:46.8  Sequence:3  Length:17  Health:0
Data: 07F88B 15DD08 FAD917 CF09FB D315D2 0AFAB9 17E70F FA9E16
Data: 1C12FC 5E17EA 17FD97 16621A FE0A16 E41CFD B3162A 1DFDEE
Data: 18D4AA

MSG 3   Beacon 460   Z-Time 53:00.0  Sequence:6  Length:4  Health:0
Beacon coordinates (mtrs):  X= 4141610.79  Y= -128560.95  Z= 4832821.76

MSG 9   Beacon 425   Z-Time 30:25.2  Sequence:4  Length:5  Health:0
Data: 17FF5A 006332 FFEEFF EB29FF 6400D3

MSG 9   Beacon 670   Z-Time 22:36.0  Sequence:1  Length:5  Health:0
Data: 06FED0 023905 FCA502 0C0EF9 58002B

MSG 9   Beacon 665   Z-Time 37:18.0  Sequence:7  Length:5  Health:0
Data: 05FBDC F30C1E FE8AF1 2501FC 2CEF1A

MSG 9   Beacon 428   Z-Time 38:37.2  Sequence:7  Length:4  Health:0
Data: 11FD3C 022621 FD4A00 1AAAAA

MSG 9   Beacon 684   Z-Time 39:36.0  Sequence:5  Length:5  Health:0
Data: 16FC97 08BB1E FEA005 2511FA B70626

MSG 1   Beacon 813   Z-Time 43:46.8  Sequence:0  Length:14  Health:0
Data: 21FE90 E41A38 00470B 043E00 C4F925 060130 093939 005FFB
Data: 5A2AFD F9119A 25FEF1 FE0C36 FE4508 BBAAAA

MSG 9   Beacon 425   Z-Time 47:25.2  Sequence:2  Length:5  Health:0
Data: 18FEFE 010425 FE2F00 0C31FD CA0226
```
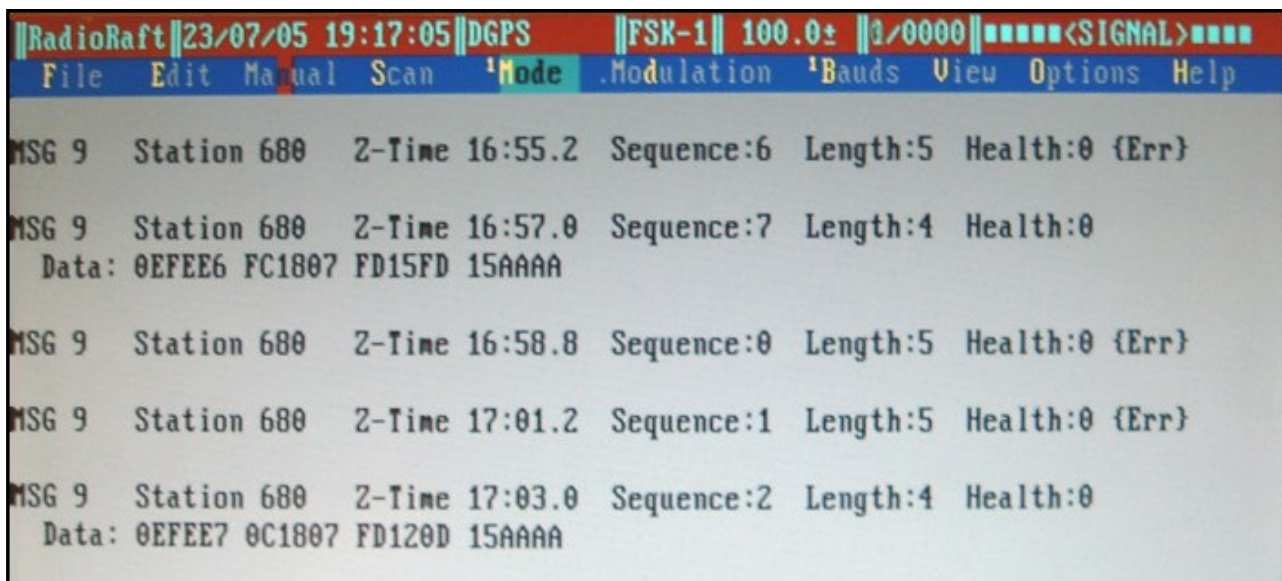
Below you will see a screen shot of the RadioRaft screen. It's less elegant than the Skysweeper program, but still very effective (and a lot cheaper!), and here can be seen decoding a "Message 9" type signal from Beacon 680 (St Catherine's Point, England):


```
RadioRaft 23/07/05 19:17:05 DGPS        FSK-1  100.0±  1/0000 ■■■■■<SIGNAL>■■■■
   File   Edit  Manual   Scan    ¹Mode  .Modulation  ¹Bauds  View  Options  Help

MSG 9   Station 680   Z-Time 16:55.2  Sequence:6  Length:5  Health:0 {Err}

MSG 9   Station 680   Z-Time 16:57.0  Sequence:7  Length:4  Health:0
 Data: 0EFEE6 FC1807 FD15FD 15AAAA

MSG 9   Station 680   Z-Time 16:58.8  Sequence:0  Length:5  Health:0 {Err}

MSG 9   Station 680   Z-Time 17:01.2  Sequence:1  Length:5  Health:0 {Err}

MSG 9   Station 680   Z-Time 17:03.0  Sequence:2  Length:4  Health:0
 Data: 0EFEE7 0C1807 FD120D 15AAAA
```

Some of the problems encountered with this decoder:

So far, and with the aid of the nightly variations in propagation and the assistance of a good bi-directional Loop aerial, I'd been able to log a good many of the DGPS reference IDs. One of the problems I had noticed though was that the high summer static levels could make life very frustrating, and sometimes I needed to sit on a channel for a long time before I was able to get a decent decode. The other problem, and perhaps a more troubling one, was that unlike good old morse code, where the ears can be trained to hear very weak signals and can separate several beacons operating on the same channel, DGPS required a reasonable level of signal to make the decoder even start to work in the first place. The operator finds himself pretty much in the hands of the software and unable to do very much about this. This may well be less of a problem with some of the commercial 'hardware' decoding systems, but not having had a chance to try out any of these I couldn't confirm if that was true or not, and if this could be a limiting factor when it comes to chasing DX using any sort of decoder. Patience seems to be the only real answer to this problem.

The other problem was of course the need for a PC and a hardware decoder interface, and this immediately ruled this mode out for non-PC users, since unless they have a dedicated hardware decoder available, they will not be able to decode the signals. On the plus side though, and as I said previously in this article, a fairly cheap 'older' PC or laptop could be used for this mode and software, and these can be picked up for next to nothing these days from many sources such as eBay, and probably for less than the cost of a Hamcomm interface (unless you build your own that is!). The down side again is the need to be sure that you don't end up creating a new QRM source in your shack, and one that will be so bad it might prevent you from hearing any signals on the LF Bands in the first place.

Other 'negative' points found with prolonged use of this program was the lack of sensitivity (it did seem to require a high level of signal to get a lock with some beacons, though this may well have been due to inadequacies in the PC itself), and the fact that I just couldn't get it to work when using a very narrow IF Filter (125 Hz) – that had really put me at a disadvantage when trying to decode very weak signals, this was something that wasn't a problem with most conventional NDBs.

overall though, I did like RadioRaft, though it wasn't perhaps the most user friendly of programs for the inexperienced DXer to operate, and it's just a shame that no Windows version of this program was ever produced to replace/complement it. I often felt that I would like something a little better for this mode, and in 2003 my prayers were to be answered with the introduction of a DGPS decoder function to the already very sophisticated and established Skysweeper suite of software decoding programs.

More about this in the next section………

Introducing Skysweeper:

In late 2003 a very interesting development had come to my attention – the well-known and very versatile "Skysweeper" decoding software produced by Skysweep Technologies in Finland, had brought out a new version of their program, and this one now included the facility for decoding DGPS signals – a very welcome development indeed, and one that I was only too eager to check out.

This program, whilst not the cheapest of options, had arrived like the proverbial "answer to a maiden's prayer", and was now allowing many more DXers to sample DGPS and a great many other modes as well.

"So, what were the advantages of this program over RadioRaft you might well ask"? Well apart from running purely in a Windows environment and not requiring your PC to be DOS capable (which was good news for the growing numbers of Windows 2000/NT/XP/Vista users), it also proved to be far more user friendly, and from my own observations, a lot more sensitive too - very important when trying to get a decode on a very weak and distant signal. Not only that, but it also decoded a whole variety of other modes too, and those of us with Amateur Licences could even use it to transmit SSTV, PSK31 and RTTY signals if we so wished. As I said previously, it's not the cheapest of options (around £60 GBP, $125 US or 99 Euros for the 'Standard' version), but for the vast number of data modes it will decode (a full list is given below), it is a very good addition to any Radio Shack if you happen to have an interest in many of the systems it covers.

One of the things I liked about this software is that the creators were very open to suggestions and ideas for newer versions, and information and questions could be asked and answered on their e-mail reflector at Yahoogroups. New versions were released on a regular basis, and if you'd already registered your copy you could receive these without any additional payments being required. Sadly, as of 2009, Skysweep decided to stop producing this program, so unless you already have a copy, this is no longer and option for decoding this mode. RIP Skysweeper, you weren't cheap, but we'll miss you all the same.

SKYSWEEPER CAPABILITIES: (Standard version, 'Professional' contains many more)

Applications:	Decoders:	Filters:	Generic Decoders:	Transmitters:
Bit Analyser	ACARS	Audio Expander	GFSK	CW
Chat	AX25	Equaliser	GMSK	HELL
CTCSS	COCUELET	FIR Filter	GMPSK	MFSK16
DLL	CW	Frequency Shift	GMSK	QPSK
Signal Properties	DGPS	HUM Remove	GQPSK	PSK
Recorder	DTMF	Median Filter	GPAM	RTTY
Squelch	GMDSS	Mixer	GPSK	SIGGEN
Recorder	HELL	Median Filter		SKYB
Squelch	HFDL	Mixer		SSTV
	HF FAX	Noise Reducer		STANAG4285
	MFSK16	Notch Bank	**Analyzer Types:**	STANAG4539
Visualization:	MFSK36	Pitch	IQ Constellation	
3D FFT	MIL-ALE	3D FFT	Auto Correlation	
EYE Diagra	QPSK		Bit Table	
IQ Constellation	PACTOR		FFT / Power Spectrum	
Signal Statistics	RTTY		FSK Bit Analyzer	
PSK	SELCAL		FSK Speed Analyzer	
SPECTROGRAM	SITOR		High Resolution FFT	
	SKYB		PAM Bit Analyzer	
	SSTV		Phase Analyzer	
	STANAG4285		Signal Statistics	
	STANAG4539		EYE Diagram	
	WEFAX		Histogram	

As can be seen from the above list, this was a very comprehensive program, and if you thought it was an expensive way just to decode DGPS beacons, well, I think the list of other decoders included gives you the answer to that. Since purchasing my copy I've had lots of fun decoding SELCAL, GMDSS (DSC) and ACARS from the aircraft, and experimenting with a few of the other modes, many of which were unfamiliar to me before I bought my copy.

Whilst it was available users were able to download a 'free' demo version (the DGPS mode would work but only on short pre-recorded items in the demo mode, it would only decode in 'real time' once registered!), and that was useful in giving you a better idea of whether this was something you might like to pay for. For the lottery winners out there, Skysweeper also produced a 'Pro' version, but this was around six times the cost of

the standard version and I never had a chance to try it out, so I can't say whether the extra features it offered were worth the additional costs involved. If you only wanted it for DGPS decoding then I would probably advised you to have gone for the cheaper 'Standard' version, or for the better DSCdecoder program instead.

The trial version is no longer available from the Skysweep website, but UK supplier Pervisell (where I bought my copy from), still have the program downloads available for registered users and will continue to support re-activations for the foreseeable future.

Pervisell: http://www.pervisell.com/ham/index.html

One final comment, before trying out this software do be sure that your computer has enough resources to handle it. Below is the minimum recommended list of operating requirements from the Skysweeper Help File in the current version of Standard 3.13:

-Pentium 800 MHz
-Sound Card
-30 MB of Hard Disk space
-256 MB RAM
-Windows 95;Windows 98, Windows NT, Windows NT, Windows 2000 or Windows XP operating system

Skysweep Technologies are a High-Tech company based in Espoo, Finland.

Right, that's the commercial over with, let us now look at how the program looks and operates:
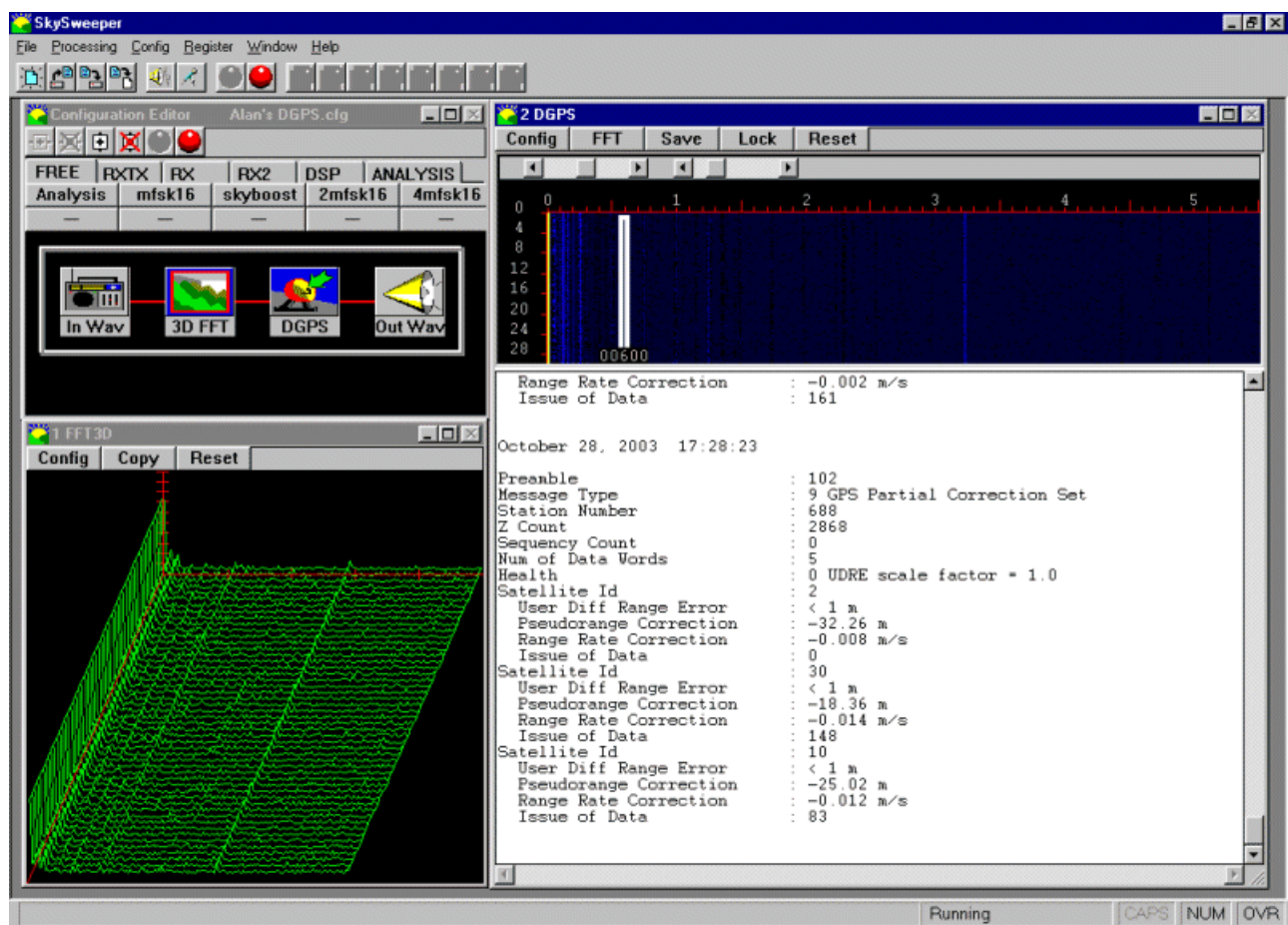

Above - This is a shot of the main Interface set in DGPS mode:

The image above shows how the program looks when it is opened and set to decode DGPS beacons (you click on FILE, OPEN and then select DGPS from the list, or use one of the tabs at the top left of the Window to select this). The window at the top right shows the 'config' panel, this is very important when first setting up the software, since it needs to be matched up with the pitch of the receiver's audio/BFO for best results. The default setting for this is 1000 Hz, but this can be easily altered by clicking on the 'config' button, and then re-setting the pitch as appropriate. In my case, I like the pitch of my CW at a slightly lower than normal 500 Hz (the common default for many radios is around 800 Hz), and below I have included an image showing the settings panel.

When you open your config box for the first time it will show 1000 Hz, but a little experimenting will soon have your signal traces lined up like the next image does. My AOR-7030 has its BFO pitch set to 500 Hz, so if your pitch is set to something else you will probably find that they don't line up properly. You can correct this by using your mouse, but it's a good idea to 'save' your settings once you've done this, or you might find yourself having to reset the program every time you open it up for a new monitoring session.

Skysweep made some changes in recent versions of the program, and the 'Save' menu now offers an option to display your decodes in Table format, which can save you a lot of windows filled with extra unwanted data, or you can also set the program to show any 'Raw' data as well. It's worth experimenting with these settings so you can see how they all work.
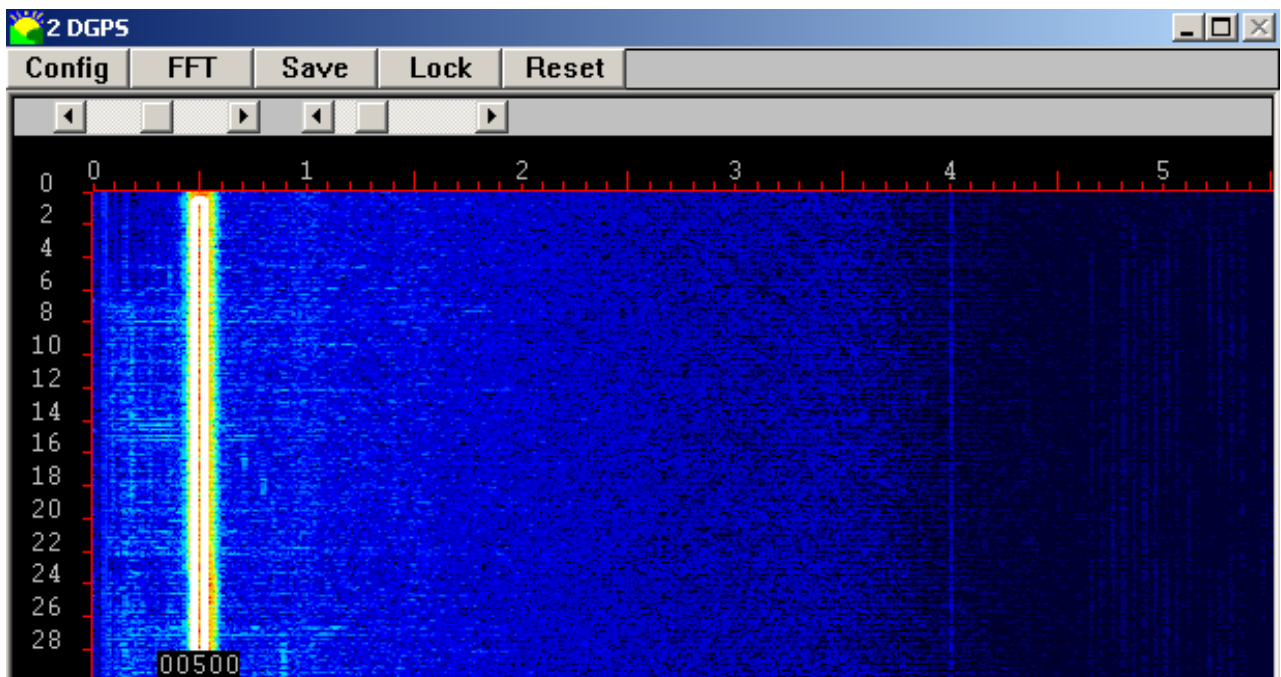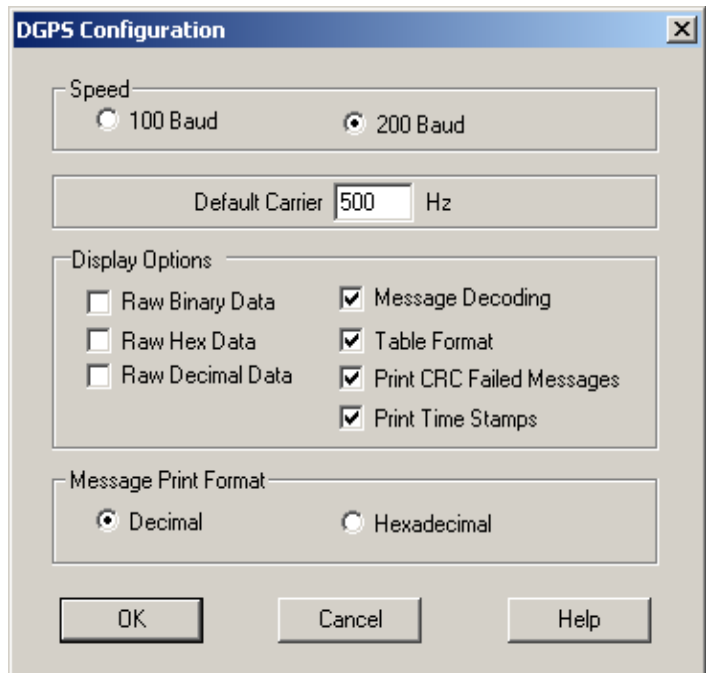

If your trace shows the incoming signal markers to the left or right of the lines marked with your pitch (in my case 500 Hz), you will need to access the Config panel and make some slight adjustments (either higher or lower in frequency). I should also mention that the config panel is also used to set the baud rate to match the incoming beacon, which in many cases this will be 100bps, though there are still quite a lot of 200bps beacons in some parts of the world (especially North America). If you're not having much luck in getting a decode then try changing this setting, it may well make all the difference. A lot will depend on which part of the world you are living in, but trial and error, or a database (such as the ones to be found in the NDB List Datamodes section) will soon give you an idea of which setting is most likely to work. You can of course open two windows, one set to 100bps and one to 200bps, and this allows easy reception of either baud rate without the need to change any settings and is my preferred method of using it. The other advantage of this is that you can 'get rid' of unnecessary blocks, such as the Config Editor and FFT 3D boxes, these just use up your resources and aren't necessary for DGPS decoding.

Once things are set to your satisfaction you can save your settings and give it a 'friendly' name. I just call mine "doubledgps", and when I open the program now I just click on "File" + "Open", then select the "doubledgps.cfg" icon from the list, then everything is already setup and ready to go, and without all of the messing around required to get your pitch and BFO set to the right frequencies every time. If you use more

than one receiver you can easily create a setting for each of them, and name them accordingly, this will also speed up your set ups at the start of a listening session.

Another useful thing well worth mentioning here is the "Save" function panel. This box is self-explanatory, but it's worth setting this to make a copy of your results for later analysis, or for posting along with your logs. In my setup, I create a new log with the day's date and the bps rate e.g. 25th July 200bps for the window set to decode 200bps signals, and another one for the window set for 100bps, this allows me to save a hard copy of all my incoming decodes during the session.

In the next paragraph we will look at the 'save text' window, this is a very useful and important function, which will allow you to save all your incoming decodes and time stamp them for later checking:
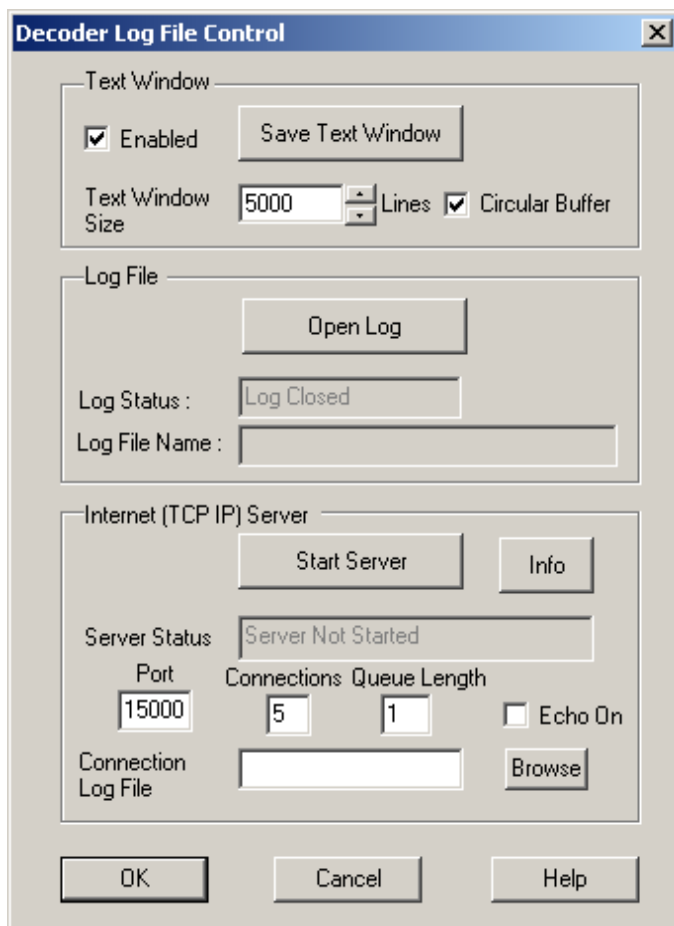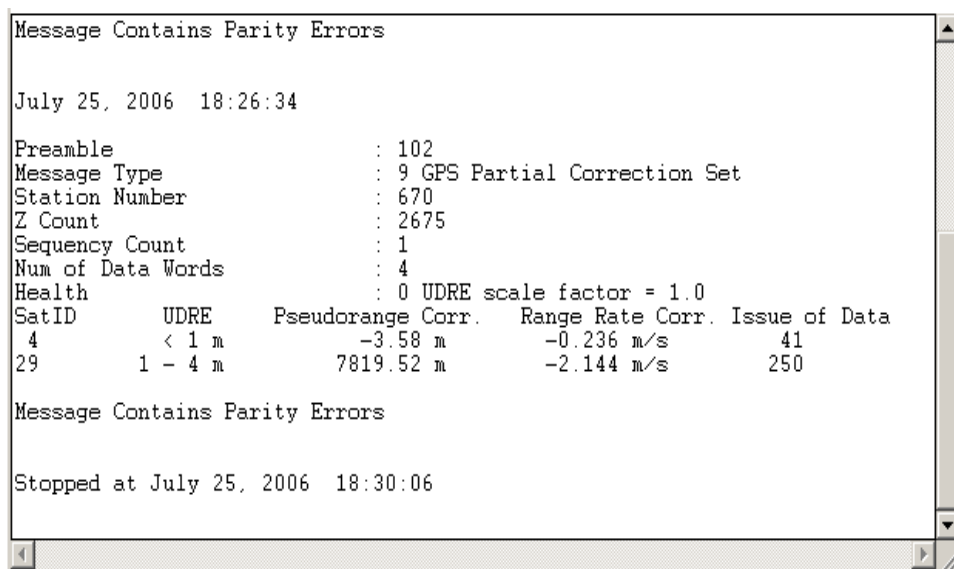

Left: This window allows you to save the text currently displayed in the screen, and open a logging file, which will save all the incoming decoded text into a log (.log) file on your hard drive.

There is also a facility for uploading the data to a server, but I haven't made any use of this function and can't really say too much about how it works.

My normal procedure is to click on the "Open Log" button at the start of my listening session and leave this logging the data. Normally I would give this a file name of the current day's date – very useful when trying to find the file again some days or weeks later.

Below: This is what you will see in the main window during a decoding session, or in the text file, which you have saved and are viewing at the end of a session. There are several different message types, but the ones most commonly seen are of the Type 9, or Type 7 variety, and here you can see the results of a Type 9 decode I made recently. The data we are most interested in here is the '**Message Type'**, this figure of **682** shows that the beacon being decoded is my most local beacon at Point Lynas in North Wales, and it transmits on 297.5 kHz at 100bps.

```
Message Contains Parity Errors


July 25, 2006  18:26:34

Preamble                     : 102
Message Type                 : 9 GPS Partial Correction Set
Station Number               : 670
Z Count                      : 2675
Sequency Count               : 1
Num of Data Words            : 4
Health                       : 0 UDRE scale factor = 1.0
SatID     UDRE     Pseudorange Corr.    Range Rate Corr.  Issue of Data
 4        < 1 m           -3.58 m          -0.236 m/s          41
29        1 - 4 m       7819.52 m          -2.144 m/s         250

Message Contains Parity Errors


Stopped at July 25, 2006  18:30:06
```

Left: Much of the data displayed in the message window will be of little interest to the DXer, the main bit that we are interested in is the beacon number in the 'Message Type' which will appear like this in the program's message window, when set for 'Table' format.

More information about the various message types used by DGPS beacons can be found later in this publication.

The Double DGPS Window:

Below is an example of how you can set up your Skysweeper program to decode either 100 or 200bps signals without having to constantly change your settings, my thanks to Martin Francis (www.classaxe.com) for coming up with this great and simple idea for decoding both speeds:
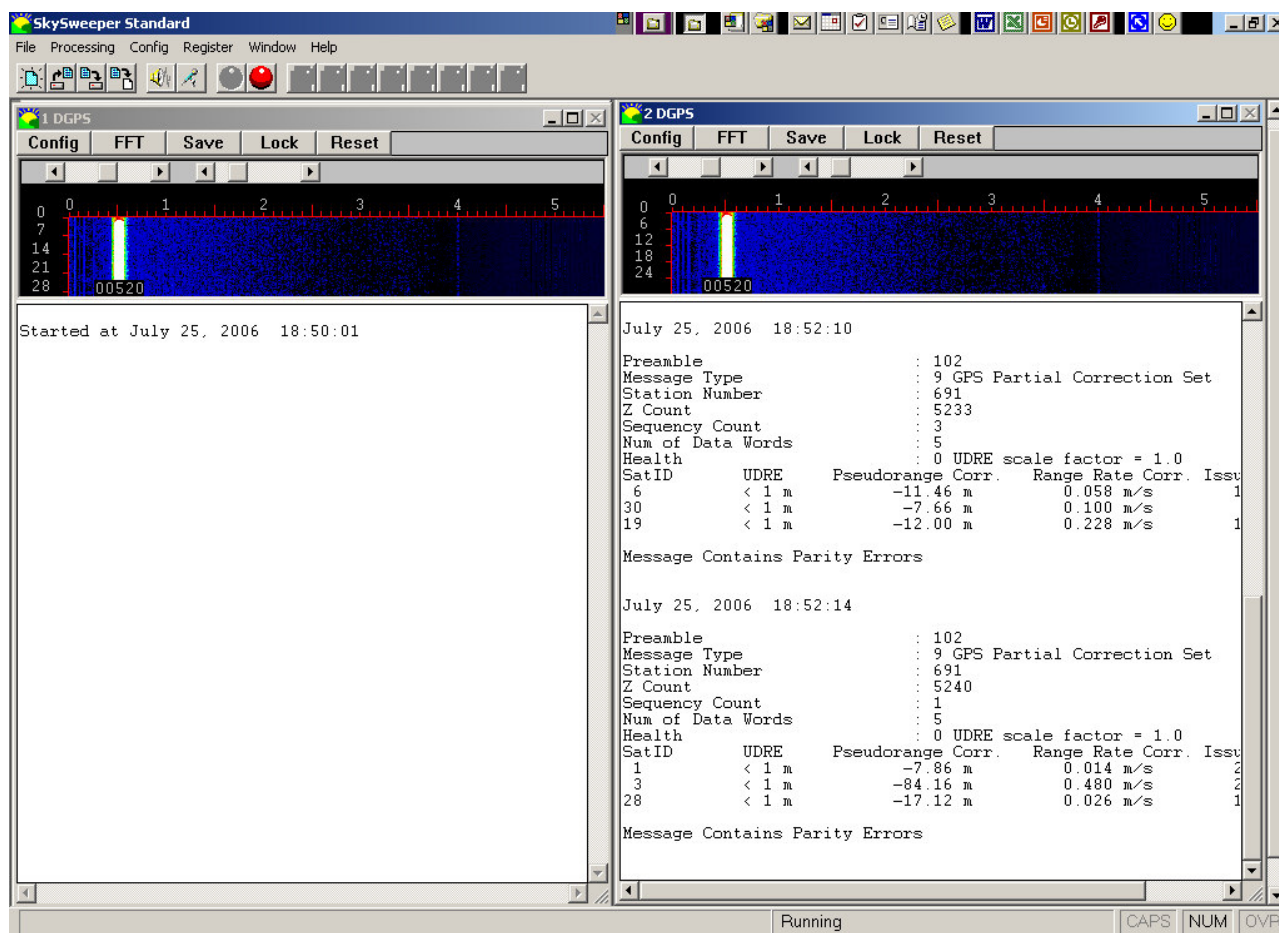
Above: The left-hand window is set to decode 200bps signals, the right hand one is set for 100bps. In this example the Wormleighton beacon in the UK on 291.0 kHz has its 100bps signal decoded in the right-hand window, whereas if a 200bps signal was tuned in the left-hand window would start decoding instead. Note how the 3D config box and the Configuration Editor boxes have been turned off in this set up, and this gives a much cleaner working area for the user.

Negative points of Skysweeper:

There aren't many, but there are the odd niggles. The later versions of the program are a lot resource heavier than the older versions, so if your PC is getting on a bit you might find it very slow at getting to grips with some of the decodes. Unlike RadioRaft, you really need a decent PC to get the best out of this program. My main niggle (and one that I have suggested to Skysweep, and hopefully will be fixed in later versions) is the lack of any means of changing the displayed time to UTC, rather than your PC's own clock. This is important if you like to view your saved logs later, and a setting like the one that does exactly this in the excellent "SeaTTY" Navtex decoding program, would be just the ticket here. In the UK this is not too big a problem since apart from the summer months when local time is UTC + 1 hour we get the correct time anyway, but for users in more distant parts of the world this must be very annoying I would think.

Skysweeper also has a bad habit of generating 'false' signals too, and whilst an experienced user will soon learn to spot these and separate them from the genuine ones, they can cause all kinds of confusion for the newer users of this mode. Most Message Types used by DGPS beacons fall into a limited category, so anything outside of these should be treated with caution, especially if only one decode 'frame' is received, and not multiple identical decodes. I have covered this important topic more fully in the later section covering DGPS Message Types and given several examples of 'false' decodes. The reasons for these being created are more complex, but sometimes not being tuned in properly, or even loud static bursts can start the decoder going and 'invert' signals, and this can be a problem when unattended monitoring is being attempted, and the user can't see what is causing it.

As I've previously stated, Skysweeper is not an inexpensive program, but "You gets what you pays for", as the old saying goes, and you certainly get a lot in this program. I have found that some of the other 'dedicated' programs such as SeaTTY, or MixW are better and more user friendly for many of the popular Ham modes such as SSTV, but all in all it was well worth the cost, and of course was a good program for the DGPS mode. Skysweep suggest an external SB Live! 24-bit SoundBlaster sound card for best results. I would love to be able to run this against a hardware decoder and see just how they compare, but that is a pleasure that will have to wait for another day, unless of course someone out there has already done this, and would like to let me know about their conclusions. I await such information with bated breath! ☺

# Introducing "DSCdecoder"– The DGPS enthusiast's best friend?

In December 2006 I was very pleased to hear from the creator of the COAA suite of decoding programs that their well established "DSCdecoder", which was originally designed to decode the DSC and NAVTEX signals on MF/HF and VHF, was now able to decode DGPS signals as of version 3.8, and at the price this was being offered for, looked like the 'missing link' that the DGPS DXing community had long been waiting for. Naturally I was only too keen to try this out and see what it had to offer, and how it compared with the other two decoders on the market, and the following section takes a good look at how this program operates, and what it has to offer for the already active, or budding DGPS DXer:

## So, what is different about this decoder then?

One thing that is immediately noticeable is that the user can download a fully-working evaluation copy for a period of 21 days, which is excellent news for anyone who is thinking of trying this mode for the first time but doesn't want to spend a lot of money on a mode which they might not like. This has always been one of the drawbacks with Skysweeper, which in demo mode will only decode pre-recorded .wav files and can't decode signals in real-time unless registered. A number of enthusiasts have told me this did put them off a bit, since you can't really get a feel for how sensitive a decoder is until you have used it under 'battlefield conditions' on a weak signal. With the high cost of the Skysweeper you must be keen and be prepared to take a gamble that you will like the DGPS mode, or one of its other modes before you shell out on a full copy.

DSCdecoder's evaluation period will allow you to get a good idea of just how well it will work for you, and you can also try out its other modes too, which is good news for those who also like to monitor the DSC and NAVTEX channels. I will take a closer look at the program's NAVTEX decoding abilities in the 'navguide' publication in the NAVTEX section of the NDB List website at some future date, but for the moment I just want to concentrate on its DGPS decoding abilities in this document.

One of the first thing that is noticed on opening the DSCdecoder interface is just how different it looks to the other two DGPS decoders, and I had to spend a little time familiarising myself with its controls and settings and trying out all the different options. One thing that quickly caught my eye was the 'chart' option, which will take the information from certain types of decodes and translate them into a position on a map of the world, which comes as standard with the program, this was quite a novel idea, and probably originally designed to show the positions of transmitting vessels using the DSC mode, but it was nice to see just where a DGPS beacon was located, rather than having to dig out an atlas (or Google Earth) and look it up on there every time. I assume that this function was mainly intended for the DSC and NAVTEX modes, but it was an interesting option to experiment with.
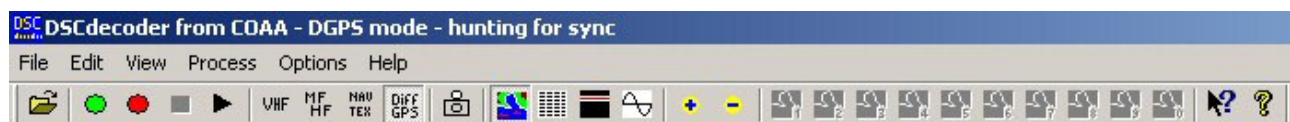
In the image seen above we can see the DSCdecoder toolbar, and as you can see, the modes can quickly be selected by clicking on one of the toolbar buttons, or alternatively by clicking 'options' and selecting it from the drop-down menu that appears, which will also offer the user a number of other options too. On clicking the DGPS button initially, you will see a box appear as in the example on the right, where you will be able to select the required baud rate (or auto to auto-select it), and match the audio to your receiver's BFO output or pitch (*NOTE#* the default setting is 1700 Hz, mine shows 500 Hz, since this is the pitch that I normally have my receiver's BFO set to, you will need to set it to whatever your own receiver is using!).
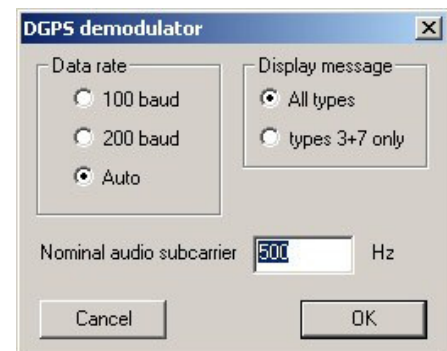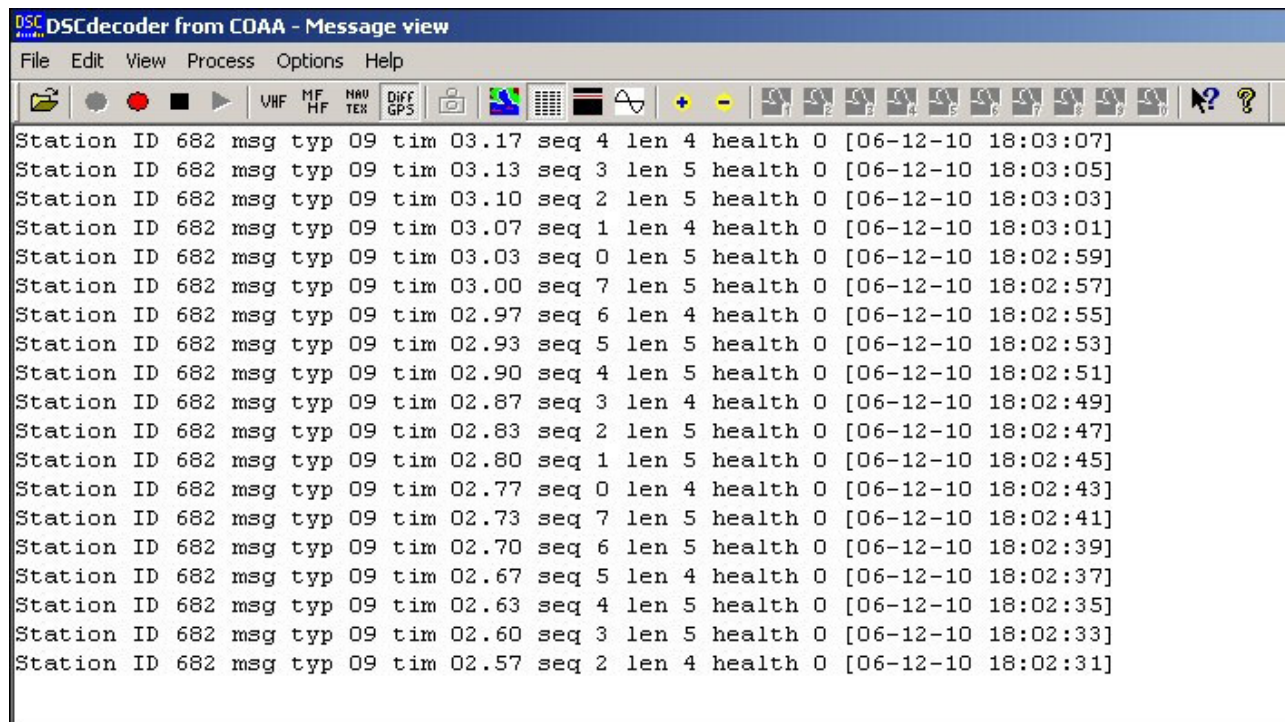
Once you have chosen your desired settings, be sure to 'save' your configuration by clicking on 'file' and then 'save configuration', this will gives you five choices A,B,C,D or E, you can choose one of these and then easily bring up all of your own personal favourite settings from here the next time you open the program if you need to. One change I should mention occurred in version 4.3, when a new 'toolbar' was added, which allows the user to select the bps rate without having to click on the menu every time, now whenever you press the green button to start your decodes this 'floating' toolbar appears (you can position anywhere on your screen that suits you), and this makes switching modes very simple and easy to do with just a single click of your mouse.

On the left-hand side of the toolbar you will see a green button and clicking on this will start the processing of the audio signals. To the right of this is a red button, clicking on this will allow you to easily record .wav files, and you will notice when you click on this that the button to the left of it shows a small black square, this is the button that you use to stop your recording. The button to the right of this displaying a small black triangle is your playback button. Next, we see four buttons showing the legends 'VHF', 'MF/HF', NAVTEX' and 'Diff GPS", these are the shortcuts to the mode selection, so the latter one is the one we require to decode our DGPS signals. To the right of the 'Diff GPS' button is a small icon showing a camera, this allows you to take a screen dump of the displayed text, again a very useful function, since I normally must open Paint Shop Pro and use the 'Screen Capture' facility to do this in Skysweeper. The next four buttons are 'Chart', 'Messages, 'Spectrum' and 'Signal', and selecting either of these will choose what you see on your screen, e.g. 'Chart' will show a map of the globe, which will indicate the location of the beacon or beacon if the necessary text is decoded, and 'Messages' will display the actual decodes. 'Spectrum' and 'Chart' display information about the incoming signal, so for DGPS you will generally want the 'Messages' button selected for your DGPS decoding. To the right of these are some + & - buttons, these are used for zooming in and out on the chart, and finally, there are a row of 10 'Quick Chart' buttons, which enable you to open a predefined chart with a single click. The program also comes with a very useful 'Help' file too, which will answer most questions.

Starting your decode:

We have now opened the program, selected 'Diff GPS' from the button on the toolbar, and chosen our required baud rate of either 100 or 200 baud (or auto-select to do this automatically), and selected the 'Messages' window, and if your soundcard settings are correct (you can check this by clicking 'Options', 'Audio' and 'Soundcard' from the drop down menu), we should now be ready to go, and we can now set our receiver to one of the DGPS channels between 283.5 kHz and 325 kHz and see what appears.

It's always a good idea to do your initial set-ups on one of your stronger local beacons, so in my case this is Point Lynas in North Wales, which broadcasts the Ref Id. of **682** on 297.5 kHz. With my receiver tuned to this channel we can see the resulting decode in the screen shot below:


```
DSC DSCdecoder from COAA - Message view

File  Edit  View  Process  Options  Help

Station ID 682 msg typ 09 tim 03.17 seq 4 len 4 health 0 [06-12-10 18:03:07]
Station ID 682 msg typ 09 tim 03.13 seq 3 len 5 health 0 [06-12-10 18:03:05]
Station ID 682 msg typ 09 tim 03.10 seq 2 len 5 health 0 [06-12-10 18:03:03]
Station ID 682 msg typ 09 tim 03.07 seq 1 len 4 health 0 [06-12-10 18:03:01]
Station ID 682 msg typ 09 tim 03.03 seq 0 len 5 health 0 [06-12-10 18:02:59]
Station ID 682 msg typ 09 tim 03.00 seq 7 len 5 health 0 [06-12-10 18:02:57]
Station ID 682 msg typ 09 tim 02.97 seq 6 len 4 health 0 [06-12-10 18:02:55]
Station ID 682 msg typ 09 tim 02.93 seq 5 len 5 health 0 [06-12-10 18:02:53]
Station ID 682 msg typ 09 tim 02.90 seq 4 len 5 health 0 [06-12-10 18:02:51]
Station ID 682 msg typ 09 tim 02.87 seq 3 len 4 health 0 [06-12-10 18:02:49]
Station ID 682 msg typ 09 tim 02.83 seq 2 len 5 health 0 [06-12-10 18:02:47]
Station ID 682 msg typ 09 tim 02.80 seq 1 len 5 health 0 [06-12-10 18:02:45]
Station ID 682 msg typ 09 tim 02.77 seq 0 len 4 health 0 [06-12-10 18:02:43]
Station ID 682 msg typ 09 tim 02.73 seq 7 len 5 health 0 [06-12-10 18:02:41]
Station ID 682 msg typ 09 tim 02.70 seq 6 len 5 health 0 [06-12-10 18:02:39]
Station ID 682 msg typ 09 tim 02.67 seq 5 len 4 health 0 [06-12-10 18:02:37]
Station ID 682 msg typ 09 tim 02.63 seq 4 len 5 health 0 [06-12-10 18:02:35]
Station ID 682 msg typ 09 tim 02.60 seq 3 len 5 health 0 [06-12-10 18:02:33]
Station ID 682 msg typ 09 tim 02.57 seq 2 len 4 health 0 [06-12-10 18:02:31]
```

As you can see in the data above, the message window displays the Beacon ID, followed by the Message Type, which are the main items that DGPS DXers are interested in, and at the right-hand side of the screen we can see the date and time that the message was received (in this case this is in yy/mm/dd format, or the

10th of December 2006 in this case!). I should also point out here that the time which is displayed (in my case 18:02 utc) is the time displayed in my computer's clock setting, which also happens to be utc, but users living in other time zones should make allowances for any time differences if they log in utc.

Once you are happy that all is working okay and that your message types look okay (the more common types are the Type 1, Type 3, Type 7 and Type 9 messages), then you are ready to try it out on the weaker signals (please note that 'phantom' decodes are possible from time to time with most decoders, so any message types other than the ones listed above should be treated with caution. There is some information about this subject later in this document, but I would also recommend that readers should refer to the article called "DGPS Formats" by Brian Keyte if you can get hold of it, this provides a lot more information about the various message types and how to spot any 'phantom' decodes.

Some DGPS beacons will also broadcast a "Type 7" Beacon Almanac message at regular intervals (often 15 or 30 minutes) as well as the more usual 'Type I' and 'Type 9' formats, and, according to the information in the Help File, when this happens the DSCdecoder displays this information in the 'View - Messages' screen and also plots the position of each beacon with a conventional radio beacon symbol on the View - Chart screen. The label gives the numeric ID of the beacon in square brackets. Below you can see an example of the how the message is displayed on the chart when a 'Type 7' message is received and decoded, this is the standard chart that comes with the program, but you could probably use any suitable chart in its place:
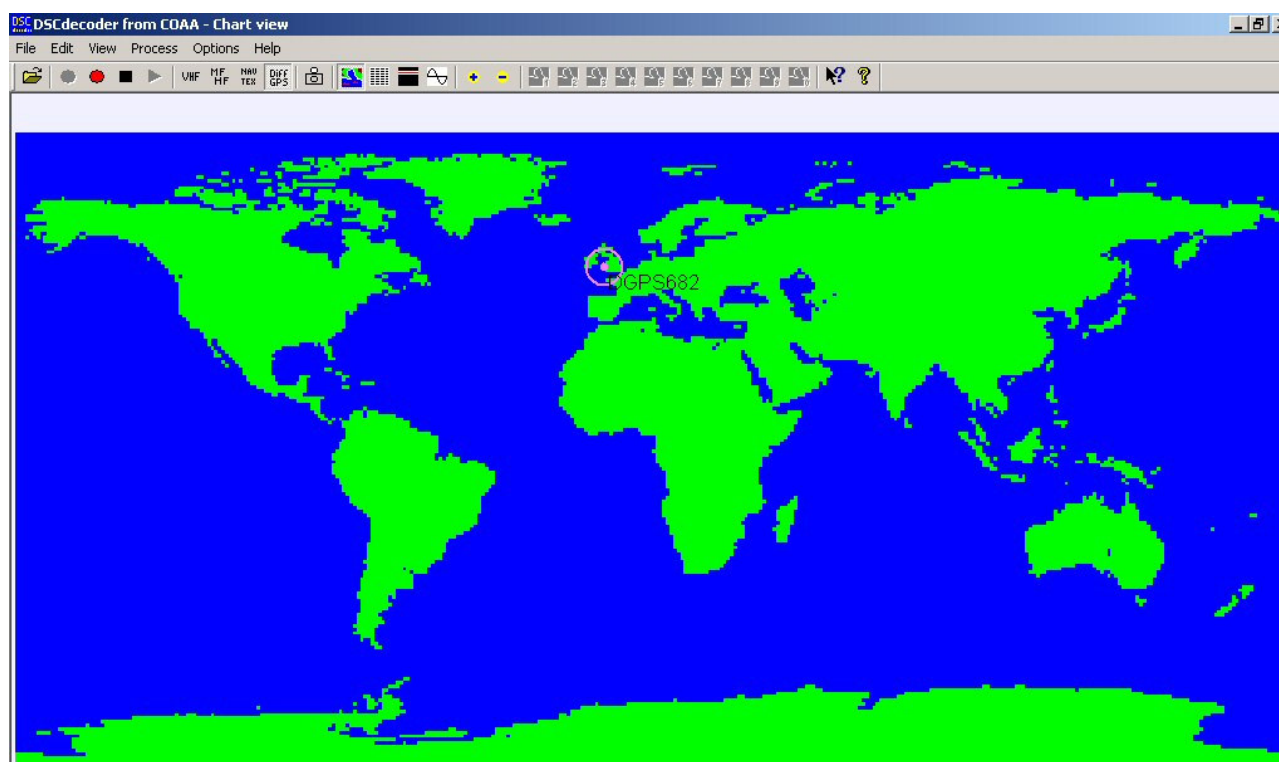
Notable updates as of 2010:

Since the last edition of this publication DSCdecoder has undergone several slight changes and improvements, but rather than re-write the entire section I have detailed the changes below – all changes for the better I might add, and this program is now even better than before. One new feature from version 4.3 is the addition of a 'floating toolbar', which allows the user to easily switch between 100bps and 200bps signals, something which has proved to be very useful. This toolbar appears whenever you click on the green 'start' button, and you can easily move it wherever you prefer it on your decoder's screen.
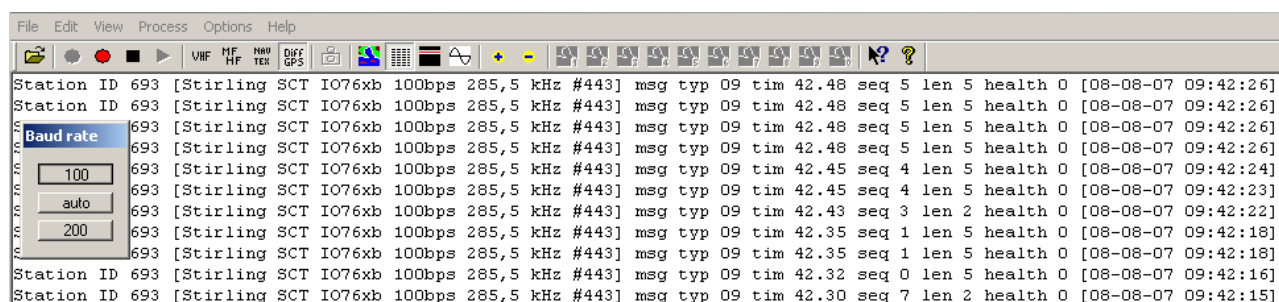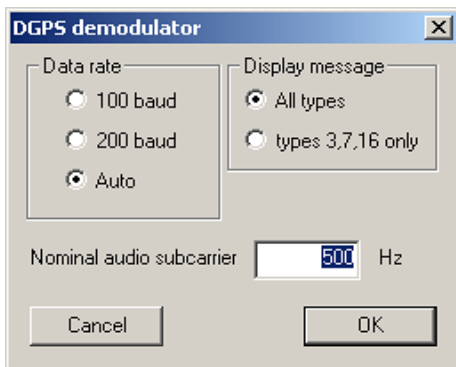
One other notable development as of September 2009, was the discovery that a new beacon which was testing from the Czech Republic town of Obristvi was transmitting a 'Type 16' message, which DSCdecoder was unable to decipher. Again, creator Bev came to the rescue and as of version 4.5.5.2 the ability to decode type 16 messages was also added, and this now appears in the options menu as you can see on the image to the left.

Bev also commented that "The type 16 messages ("msg typ 16") give expansion lines beginning 'Special:'. Not all stations use this message type and those that do, may only do so for special events, problems, warnings, etc".

He also commented that "It may be worth mentioning that you may sometimes see "msg typ 16" with no expansion of the message in the following line. DSCdecoder publishes the report header (2 words) if the checksums are correct. It only publishes the expansion if the checksums on the succeeding words in the message (maybe a dozen or more) are all good. Clearly, under marginal conditions, there is much more chance of just two words (the header) having good checksums than of a dozen or more words (the whole message) having a good checksum. Accordingly, do not be surprised to see some type 16 messages reported but not expanded".

Conclusions:

One thing that has always impressed me about this program is just how simple it is to use once the user has got used to the interface and set it up to their satisfaction, and, also just how well and how quickly it locks onto a signal, which isn't always the case with the more expensive Skysweeper program. Registration of the program after the 21 day trial period ends is a very reasonable 25 Euros (about $33 US, or £17 GBP), and, with the additional bonus of also being able to decode DSC and NAVTEX signals as well, is a real bargain in my opinion, and really fills the need for a reasonably priced and effective program for those who can't afford the more expensive Skysweeper software or are only interested in the modes covered by this decoder. Coupled with a creator who is very responsive to requests for additional features, this program is a great asset to DGPS enthusiasts.

I certainly like the program, and the more I use it, the more impressed I am with it, and I would recommend that anyone reading this guide and wondering if DGPS DXing is for them gives it a good try out first. I am sure that many DXers who have often thought about this mode but have been put off by the need to 'pay upfront' for software that will handle it will now have no excuse for not giving it a try. DSCdecoder is a welcome addition to the DGPS hobby, and a great asset for all DGPS enthusiasts, it's a definite keeper, and the best of all the available programs in my humble opinion. To date I have logged 135 DGPS beacons from 35 countries, including 12 from Canada and 15 from the USA – all but five of these transatlantic catches only being made since the DSCdecoder's arrival on the scene. Definitely an excellent program that's for sure!

System requirements & download details:

You will require at last a Pentium level PC running Win95/98/Me/2k/XP, and also a compatible sound card, and the program can be downloaded from the following site: http://www.coaa.co.uk/dscdecoder.htm
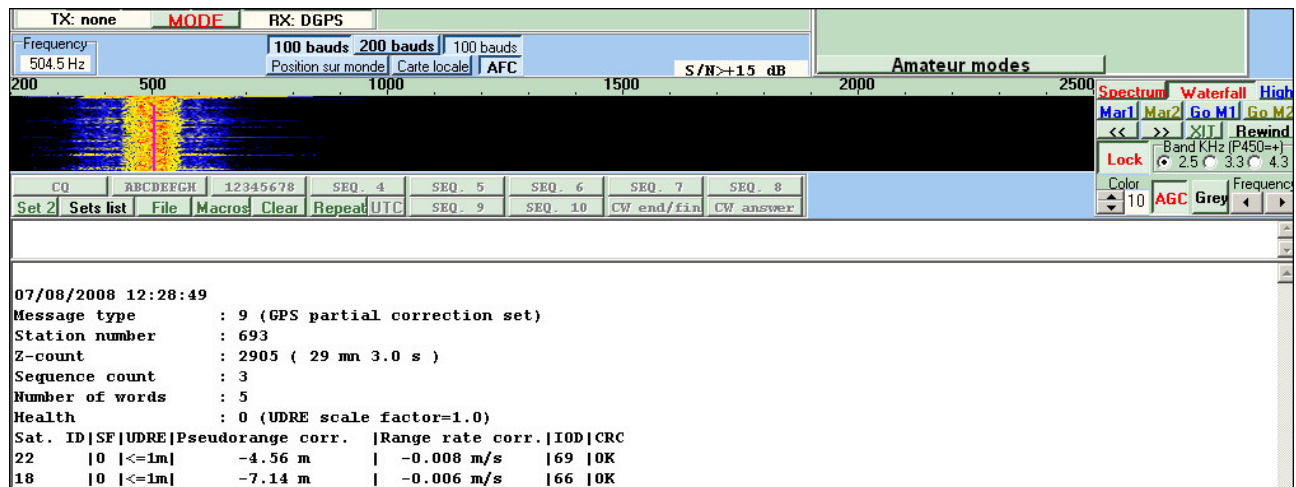
Registration can be securely on-line from the above page, and costs only Euro €25 (plus VAT for EU residents) for personal use. A higher fee applies for professional or commercial use of DSCdecoder.

Introducing MultiPSK- an old decoder with a new mode now added:

One decoding program that has been around for a long time is the 'Multimode' decoder, created by Patrick Lindecker, F6CTE. This program will decode many modes and has been popular with many hams and SWLs for a very long time now. In many of the more common modes the decoder will work as 'freeware' – e.g. SSTV, RTTY, NAVTEX, psk etc., but as of version 4.16, this now also offers a 'professional' option, which for a small registration fee, will unlock additional modes, one of these being a DGPS decoder. Users who already have registered copies should be able to upgrade for free, but for first time users, it can be tried out as a fully working option, though it should be noted the user is limited to just 5 minutes periods at a time when the program is in its unregistered mode.

I have tried this out, and it worked about as well as Skysweeper on reasonable DGPS signals, but I didn't find that it locked anything like as quickly as DSCdecoder did on weaker ones. Several other enthusiasts

though have found it to be very sensitive, so it may well be that I haven't yet got mine set up quite right, or that it isn't quite as effective when in trial mode. Still, with the vast number of modes that this program will decode it does offer excellent value for the registration price, especially if you want to be able to decode numerous other modes. For first time users the five minutes of 'live' decoding will make it a far more attractive option than the very expensive Skysweeper, which will only decode pre-recorded files in its demonstration mode.


```
TX: none    MODE   RX: DGPS
Frequency
504.5 Hz        100 bauds  200 bauds  100 bauds                           Amateur modes
                Position sur monde  Carte locale  AFC      S/N>+15 dB
200        500              1000              1500              2000              2500  Spectrum  Waterfall  High
                                                                                       Mar1 Mar2 Go M1 Go M2
                                                                                       <<  >>  XIT  Rewind
                                                                                       Band KHz (P450=+)
                                                                                       Lock  ⦿ 2.5 ○ 3.3 ○ 4.3
     CQ      ABCDEFGH   12345678   SEQ. 4   SEQ. 5   SEQ. 6   SEQ. 7   SEQ. 8          Color       Frequency
Set 2  Sets list  File  Macros  Clear  Repeat UTC   SEQ. 9   SEQ. 10  CW end/fin  CW answer       ▲10  AGC  Grey  ◄  ►

07/08/2008 12:28:49
Message type         : 9 (GPS partial correction set)
Station number       : 693
Z-count              : 2905 ( 29 mn 3.0 s )
Sequence count       : 3
Number of words      : 5
Health               : 0 (UDRE scale factor=1.0)
Sat. ID|SF|UDRE|Pseudorange corr.  |Range rate corr.|IOD|CRC
22     |0 |<=1m|      -4.56 m      |  -0.008 m/s    |69 |OK
18     |0 |<=1m|      -7.14 m      |  -0.006 m/s    |66 |OK
```

I do like Multipsk as a general decoding program and use it for many of the other ham modes, though now DSCdecoder would still be my first preference for the DGPS mode every time. It does have much to commend it though, and I'm very pleased to see this mode now included, and particularly like the way it brings up a nice little toolbar for adjusting the bps rates, and its waterfall display for tuning the signals in. Well worth a try out though, since you may well find it preferable.

Introducing Multimode:

One decoding program that I haven't been able to try out yet is the 'Multimode' program created by Black Cat Systems. Not that I have any objections to this software, it's just that this is a dedicated program for Mac users, and I just don't happen to have a Mac! As far as I know this is just about the only decoding program that will run on Mac computers, along with DGPS it will also handle a wide range of other common and not so common modes as well. A trial version can be downloaded from the Black Cat website, and according to the site a fully registered version costs $89 US, though there is a 'lite' version also available as well for $29. That's as much as I can tell you about this program, and if you are a Mac-user I would suggest that you download the trial version and test it for yourself. I would be interested in hearing from anyone who has used this successfully with DGPS signals though and would love to hear your opinions about its performance.

Spectrum Lab – An old favourite that now decodes DGPS:

Another program appeared in 2009 which could also decode the DGPS mode, but this one had already been around for several years and was already widely used to decode a wide number of slow speed CW modes, and various other systems. Best of all though, this program is completely free of charge and fully working. This program, which is known as 'Spectrum Lab' was created by Wolf - DL4YHF and is available for download from the link below. I would recommend visiting Wolf's site and reading the additional information about this mode before trying it out though:

Information: http://freenet-homepage.de/dl4yhf/speclab/dgps_dec.htm
Download: http://dl4yhf.SSL7.com/speclab/install_speclab.zip   (V2.75 b08)

The screen dump below shows the Spectrum Lab interface and setting it up can be a bit daunting at first if you've never used it before, though once you get things working correctly it works very well and is very sensitive with weak signals. Be sure to 'save your settings' before closing the program though (click on FILE, then SAVE SETTING in the main window, and give it a memorable name, you can then 'open' this next time and it will save you from having to work out the settings again). As can be seen from the above image I had the display window set to show the audio spectrum from 300 Hz to 1000 kHz, and the centre frequency set at 500 Hz, which is the pitch I use with my receiver when decoding CW and DGPS signals.
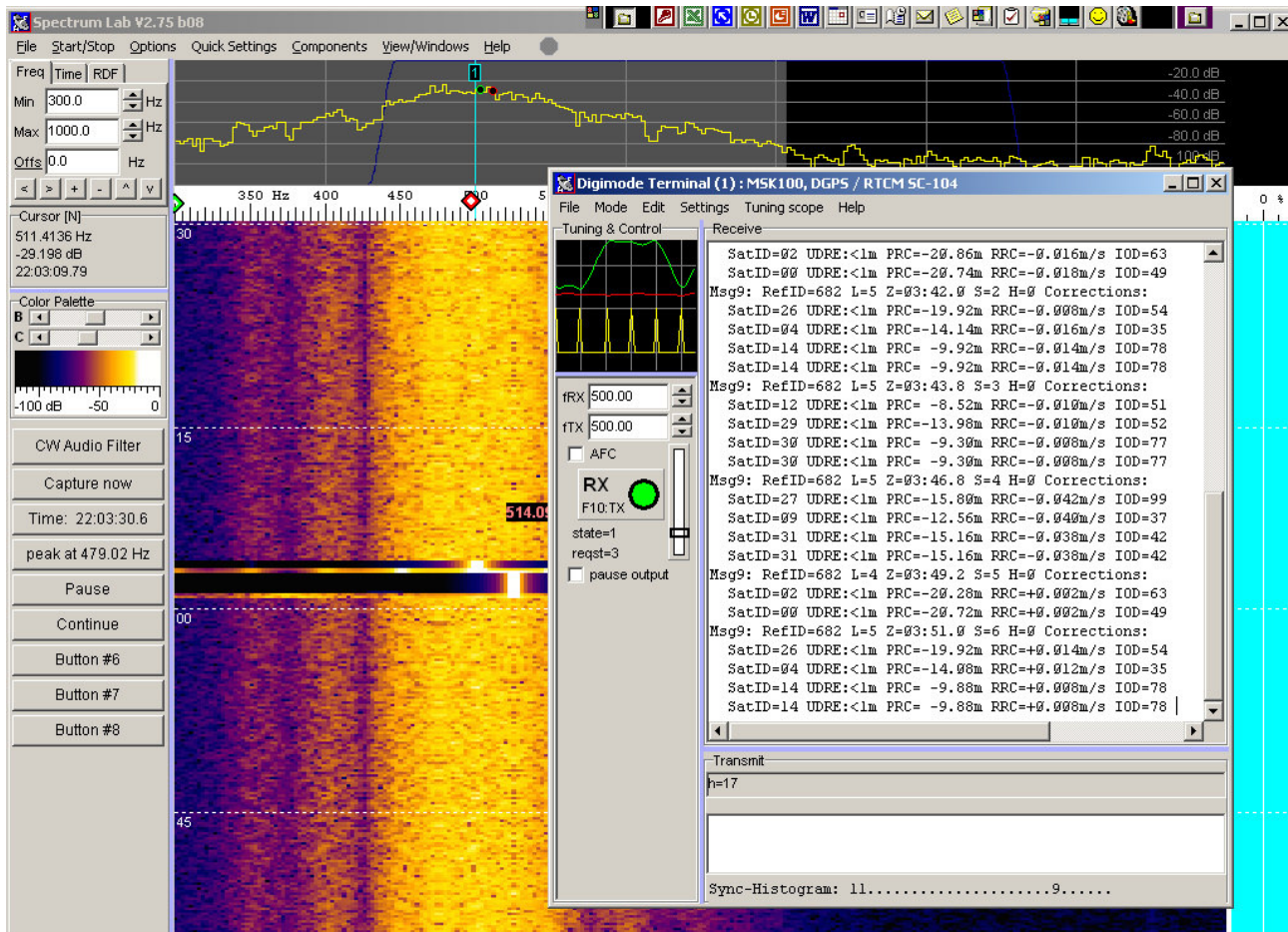
For the benefit of anyone trying this for the first time, and to save you a lot of fiddling around and stress, the instructions below should help you to get started with it. Please note though that your audio pitch may be different to mine, so you may need to make allowances for this when setting it up.

1. On opening the program you will notice the toolbar pictured below left at the top of your screen:
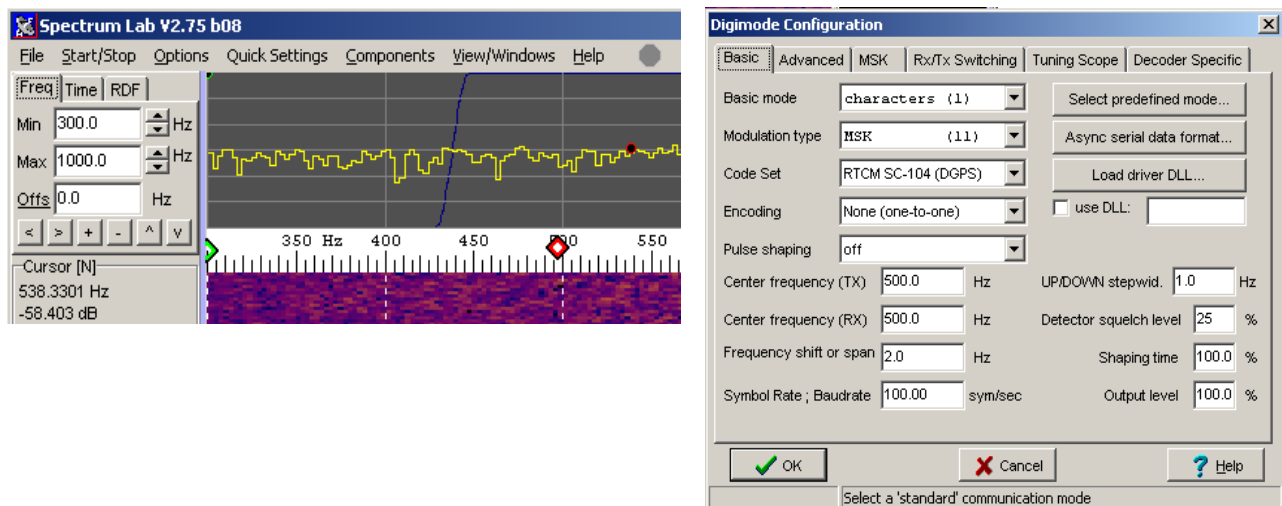
2. Click on 'Quick Settings' and from the dropdown menu select 'Predefined Digimodes', and two windows should appear, the 'Digimodes Terminal' and 'Digimode Configuration'. From the images below you can see how mine is set up, and the audio settings reflect that fact that the audio pitch of my AOR AR-7030+ is generally set to 500 Hz, if yours is different you will need to set this accordingly, and may need to play around with it a little until you get it right. Once chosen click the 'OK' button and the box should vanish from your screen.

3. Now you should see your 'Digimode Terminal' window, and if you have set this right it should be displaying information such as **MSK100, DGPS / RTCM SC-104** this denotes that your decoder is set to decode the 100bps signals (you will need to change this to 200bps for beacons that use that rate instead). Now we are almost ready to start decoding, so now you can set your radio receiver on one of the stronger local signals

16

and after ensuring that the audio is arriving at your PC's soundcard okay, you can go to the next stage and start the Digimode Terminal, which we can see in the image below left:
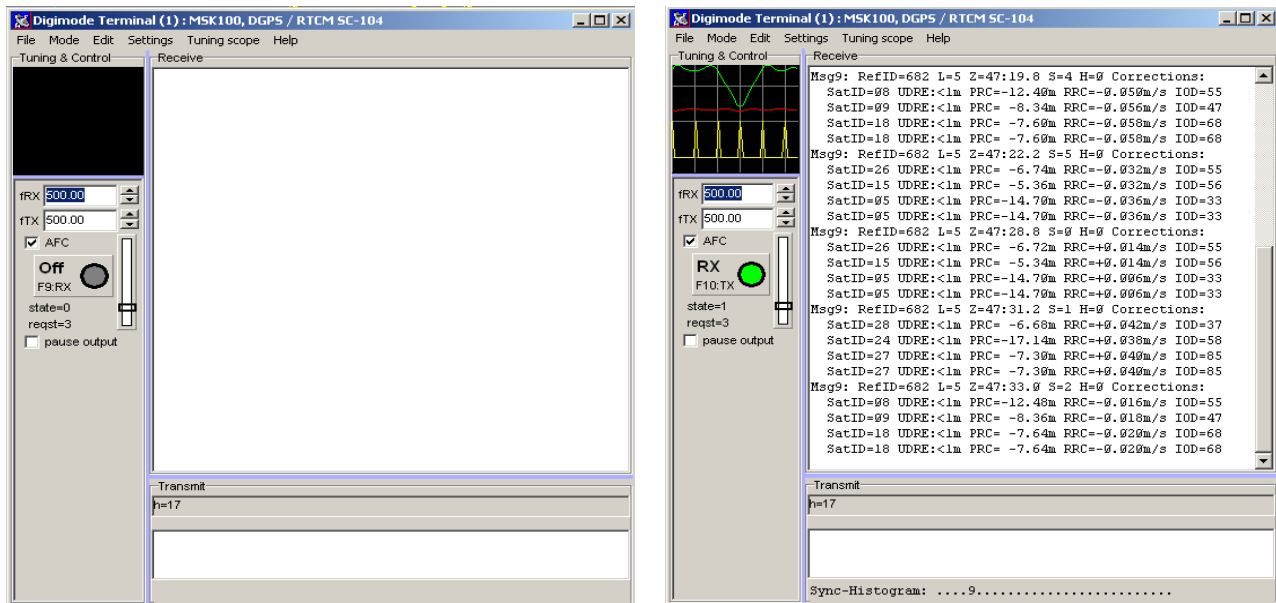

4. Now we click on the grey button marked 'Off' and if all is well it should then turn green and display the letters 'RX' next to it, you should also see the data now start to appear in the 'Receive' window as can be seen in the image above right. If your window now looks like this one you are now decoding DGPS signals – congratulations!

Note# To change your bps/baud rate settings from 100bps to 200bps you will need to bring the 'Digimode Configuration' window back up, so to do this click on 'Settings' on the Digimode Terminal window and select 'Digimode Configuration' from the drop-down menu, you can now change the symbol rate/baud rate from 100 to 200 or vice versa as required. You can see how to do this from the examples below:
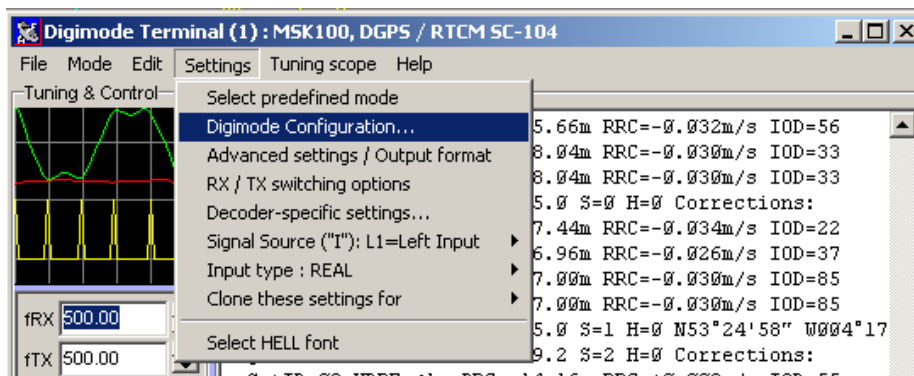
To change the baud rate, bring up the 'Digimode Configuration' window and then change the 'Symbol Rate ; Baudrate' setting as shown below from 100 to 200 as required. Click 'OK' to remove the window again.
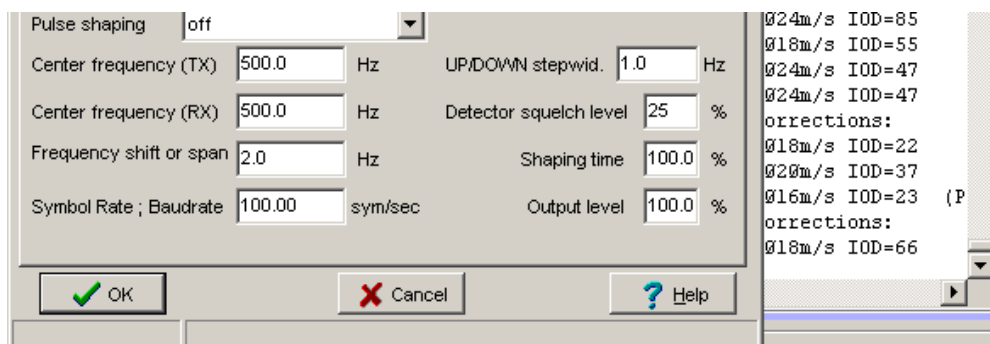
Hopefully you are now successfully decoding DGPS signals, and the relevant bits are shown next to the Msg9: Ref ID, the number (shown 682 in the example below) is the Ref ID of Point Lynas in Wales, and as you can see from this example, a Type 3 message was also transmitted showing the coordinates of the

transmitter (this is not always sent though, read elsewhere in this article for more information about the various message types in use):


```
Msg3: RefID=682 L=4 Z=00:15.0 S=7 H=0 N53°24'58" W004°17
Msg9: RefID=682 L=5 Z=00:19.2 S=0 H=0 Corrections:
    SatID=08 UDRE:<1m PRC=-15.08m RRC=-0.004m/s IOD=55
    SatID=09 UDRE:<1m PRC= -7.60m RRC=-0.010m/s IOD=47
    SatID=18 UDRE:<1m PRC= -7.50m RRC=-0.010m/s IOD=68
    SatID=18 UDRE:<1m PRC= -7.50m RRC=-0.010m/s IOD=68
```

In the example shown on the left you can see both Type 3 and Type 9 messages displayed. Most of the data such as SatID aren't relevant to us, but the Message Types are required to identify the station.

AMALGAMATED DGPS – A whole new approach to decoding DGPS:

Another new program appeared in which would also decode the DGPS mode, but in a different way to the usual decoders that required a receiver to be manually tuned by the operator. Produced by Chris Smolinski at Black Cat Systems in the USA, the creator of many different types of decoder software for Apple Mac users, this program is not only available for Macs but also in a version for Windows machines as well, which is good news. The software is described as 'Software To Decode The Entire DGPS Band From WAVE, and I/Q Recording Files', which is good new for listeners who use SDRs (Software Defined Radios), which can scan whole chunks of the radio spectrum. Amalgamated DGPS can decode the entire 285 to 325 kHz DGPS beacon band at the same time, from I/Q recording files made by several SDR (Software Defined Radio) programs such as: SpectraVue, SdrDx, Perseus, Studio1, SDRUno , ELAD and SDR-Radio. The Black Cat website says that "This app creates up to 164 parallel DGPS demodulators and decoders in software, and processes the entire DGPS band at once, looking for DGPS transmissions, decoding them if they are found, and adding timestamps to a log."

Users also have the option of decoding data from an audio file, or decoding from live audio, and this program can operate in a way that none of the other decoders can, and may be just what you are looking for if you prefer to work in this way, or record chunks of spectrum at a time when you are unable to listen 'live'. It's very sensitive, and it can also produce a 'station map' showing where the signals heard are located, so there is much to like about this program. A lot may depend on how you go about your listening, and whether or not you prefer a more tradition 'hands on' approach, but it does at least give you a fantastic new tool to add to your DX armoury, and best of all, you can download a trial version before you make your purchase. A fully registered copy is just $19.99 US, and this will also entitle you to all updates and new versions released over the next full year. As I write this the version available is 1.1.0, and that is in both Mac and Windows formats.

The place to find out more about is at the following webpage:

https://www.blackcatsystems.com/software/dgps_decoding_software_sdr.html

Count	ID	RefID1	RefID2	kHz	Baud	City	Country	Lat	Lon	km	Deg	Last
1	746	132	133	298.0	200	Pulau Satumu (Raffles)	Singapore	1.165	103.746	10,948	77	05/01/2019 181...
1	701	001	001	304.0	200	Karratha WE	Australia	-20.712	116.779	13,745	80	05/01/2019 181...
1	611	622	623	304.0	200	Haozhi Gang	China	32.017	121.717	9,112	45	05/01/2019 181...
1	890	280	281	305.0	100	Biorka, AK	Alaska	56.858	-135.546	7,091	334	05/01/2019 181...
1	635	670	671	305.0	200	Hamada Ko	Japan	34.881	132.047	9,283	36	05/01/2019 181...
2	520	800	830	305.5	200	Vardo Lt	Norway	70.393	31.169	2,543	28	05/01/2019 181...

A quick word about receivers and IF filters:

One of the questions I'm most often asked is the one about which receivers are the best to use for this mode, and in most cases my answer would be "The same one that gets you the best results with your NDB DXing!". Unlike many data modes such as RTTY and SSTV, DGPS doesn't require such a wide bandwidth, and an IF Filter capable of passing both the 'Mark and Space', so your 'normal' CW or SSB filter will work just fine in most cases. The DGPS signals use MSK (Minimum Shift keying) and operate in Mode G1D, and so the signals appear on the listed 'carrier' frequencies, e.g. a signal on 291.0 kHz would appear on exactly that when tuned in, using the CW mode on your receiver, and a good narrow CW IF Filter will in most cases handle these signals just fine as well. As a rule of thumb for 100bps signals a filter around 125 Hz or wider will be fine, while for 200bps, a 250 Hz filter should do the trick.

I mentioned filtering, and by using this term I mean both the IF filtering in the receiver, and any external audio filtering as well, which is something that I am great fan of. Getting this right is very important if you are a Skysweeper user, and from my own observations I have found that too 'tight' a filter will cause it to struggle to decode many of 200bps (bits per second) signals, so if any of your IF filters are narrower than 250 Hz you need to be wary of this. My receiver has several IF filters fitted, the narrowest of these being a 125 Hz INRAD type IF Filter, and when decoding the 100bps signals I find that this filter will usually work without any problems, and despite its high insertion loss, it gives excellent separation from any nearby signals, or remaining Marine and Aero NDBs, which still appear in this part of the band. When tuned to a 200bps signal though no decodes could be obtained, and I had to then switch in a wider 300 Hz wide Collins filter. If your receiver contains any narrow bandwidth filters, then it's well worth trying a few experiments using 'local' beacons with known baud rates and see which ones perform the best before you get going. If you have an audio filter of the analogue or DSP variety, care should again be taken not to make the filters so narrow that it will prevent your decoder from getting a good lock.

Additional audio filtering:

I love to make good use of my many audio filters when listening to datamodes and have covered this in great depth in other publications and articles, so needless to say, I make similar good use of such filtering with this mode as well, and run the audio output from my receiver through my Timewave DSP-599zx and MFJ-784B DSP audio filters, both of which are cascaded together. Normally I will 'centre' both filters on the incoming signal, and then narrow the bandwidth until it is narrow enough to reduce any adjacent noise or hiss, but not too narrow to prevent proper decoding taking place. It was several years before I started to operate like this, but the cascaded filters certainly made a big difference once I did begin.

After using this system for some months, I realised that whilst the signals now coming from my loudspeaker were greatly improved by this set up, that didn't necessarily mean that the signal travelling from the line output on the DSP filter to the computer's sound card line input were as good as they could be. I won't go into the ins and outs of how this is done here, but you can find an article called "Connecting Your Radio To Your Computer" on the Datamodes and Navtex pages of the NDB List website, and these cover this subject in greater detail, and should be consulted if you are planning such a set up. Instead I decided to make better use of an old Technics Graphic Equaliser, which was underused in its old position between the two DSP filters, and instead moved it into the line input lead to the sound card set up.

The results of this experiment were immediately noticeable, and made quite a big difference, especially on weaker signals. This also worked very well with my Navtex decoding and other data modes as well and seems so obvious now that I'm amazed that I never thought of doing it before. I have recently taken this one step further and have now connected my underused Datong FL-3 analogue filter to this circuit, and this is now connected in series with the equaliser between the MFJ-784B's line output socket and the computer's line isolator transformer at the sound card input. Initial tests show that this too makes a big difference, and since both can be easily by-passed when not required, they have no detrimental effect on any of the other signals that pass through it (in fact they improve voice and audio recordings from my scanner as well and are proving very useful additions in many other ways too!).

Audio filtering is not obligatory, but it can be a great help and is well worth trying, and the nice thing about having these filters in circuit is that they can be easily bypassed, and you can try experimenting with receiving signals with or without them switched in. Graphic Equalisers can often be obtained very cheaply from second hand shops or flea markets, and these are also well worth trying too, as they can give a lot of improvement for very little outlay when compared to the more expensive DSP filters. eBay may also be a source worth trying, since cheap hi-fi equipment is often listed for sale in many of their auctions.

On the next page we will see an image showing just how much improvement can be made by adding some audio filtering and processing, so do give it a try, you won't be disappointed with your results.

Below is a screen dump taken from Cool Edit Pro showing what the 'raw' signal looks like, and then the signal with the equaliser switched in as well. The final signal shows what is reaching the soundcard when both equaliser and Datong FL-3 are switched into circuit:
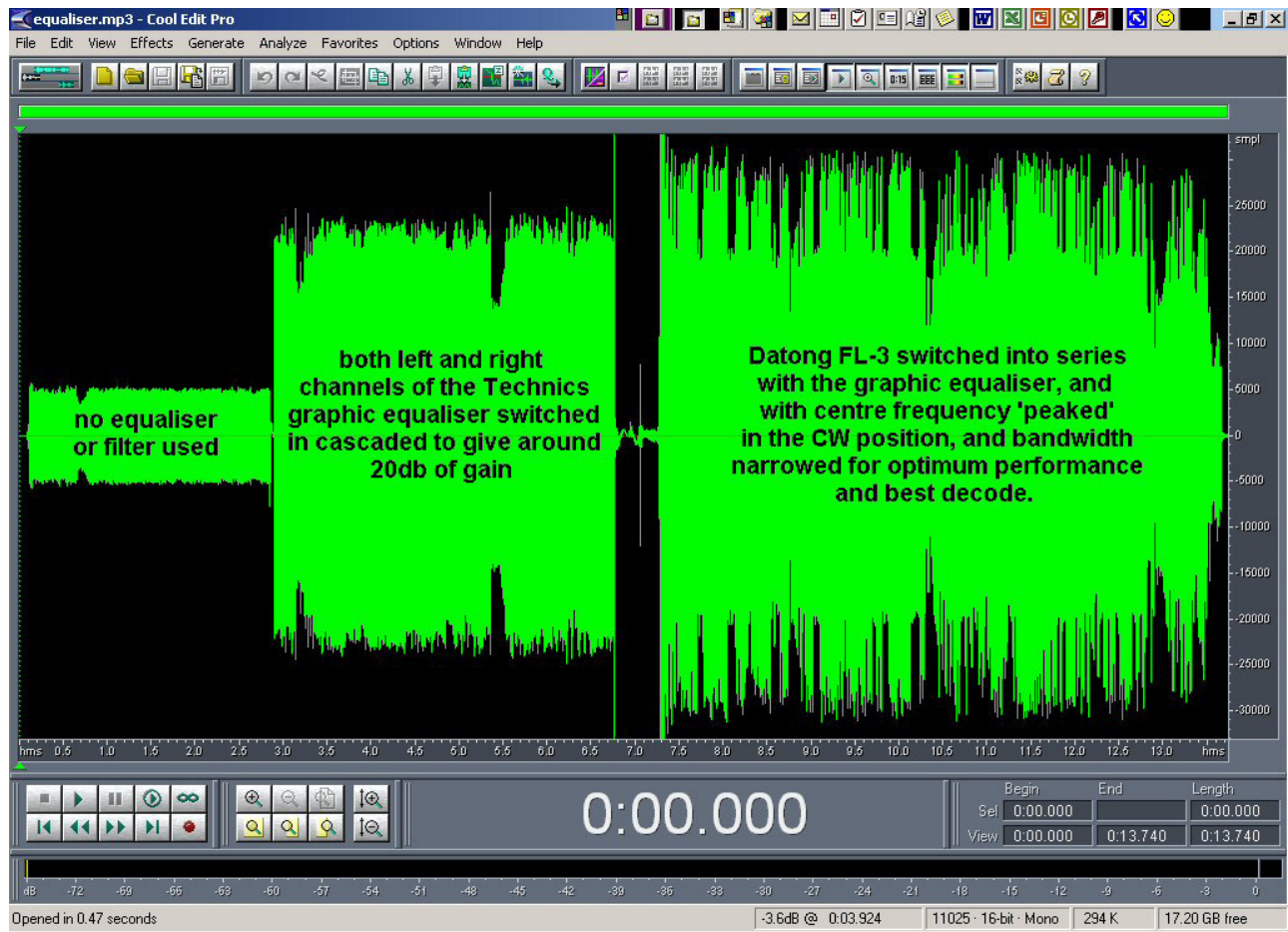
As you can see from the above example, it pays to improve your line input circuit, and this will give improvements in whatever mode you are feeding into your decoder, just if you remember to select the correct bandwidths for the mode in use that is!

DGPS Message Types:

There are a number of different 'Message Types' broadcast by the various DGPS beacons, and below is a list of what these are, what they mean. If the message you are decoding (especially with Skysweeper) is not in this list you may well have a 'phantom' decode on your hands, and for more information about these I would strongly recommend that you read an article called "DGPS Formats", by Brian Keyte, G3SIA, which can be found in the Datamodes Section of the NDB List website.

TYPE 1 MESSAGE: -   Now mostly replaced by Type 9 messages, but still used by some countries.

TYPE 2 MESSAGE: -   No longer required.

TYPE 3 MESSAGE: -   Contains information on the identity and surveyed position of the active reference beacon in the DGPS beacon. Broadcast at H +15 & +45 mins.

TYPE 4 MESSAGE: -   Not used.

TYPE 5 MESSAGE: -   This message type will notify the user equipment suite that a satellite that is deemed unhealthy by its current navigation message is usable for DGPS navigation.

TYPE 6 MESSAGE: -   Filler message, only used when no other message to broadcast.

TYPE 7 MESSAGE: -   This message provides information of its broadcasting DGPS beacon and the other two or three adjacent DGPS beacons. Broadcast at H + 7, then at 10-minute intervals on some beacons.

TYPE 8 MESSAGE: - Not used.

TYPE 9 MESSAGE: - This message type has been selected for broadcasting pseudo range corrections instead of the Type 1 Message. Two methods of transmitting the Type 9 message are possible.

TYPE 10 MESSAGE: - Not used.

TYPE 11 MESSAGE: - Not used.

TYPE 12 MESSAGE: - Not used.

TYPE 13 MESSAGE: - Not used.

TYPE 14 MESSAGE: - Not used.

TYPE 15 MESSAGE: - Atmospheric Parameters (not yet used).

TYPE 16 MESSAGE: - Type 16 messages will be utilised as a supplement to the notice to mariners or shipping, regarding information on the status of the local DGPS service that is not provided in other message types. Additionally, the Type 16 Message may provide limited information on service outages in adjacent coverage areas or planned outages for scheduled maintenance at any broadcast site.

There may seem to be a lot of different types, but in practice you will mostly find the Message 3, 7 or 9 types on many beacons, though there are still a few beacons using the older "Message One" types. A few examples of 'real' decodes, and a few "phantoms" are shown below:

A typical TYPE 1 Message:

```
July 19, 2006  03:05:23

Preamble                   : 102
Message Type               : 1 Differential GPS Correction
Beacon Number              : 466
Z Count                    : 555
Sequency Count             : 2
Num of Data Words          : 15
Health                     : 0 UDRE scale factor = 1.0
SatID      UDRE      Pseudorange Corr.    Range Rate Corr. Issue of Data
 3         < 1 m           -3.56 m          -0.086 m/s         142
 7         < 1 m          -11.12 m          -0.090 m/s          24
 8         < 1 m          642.96 m          -0.216 m/s          57
SatID      UDRE      Pseudorange Corr.    Range Rate Corr. Issue of Data
26         < 8 m           71.36 m          -3.488 m/s         145
24         < 8 m         -649.94 m           0.040 m/s         111
16         < 1 m          -12.88 m          -0.074 m/s         149
SatID      UDRE      Pseudorange Corr.    Range Rate Corr. Issue of Data
22         < 8 m        -10418.88 m         -1.376 m/s         221
26         < 1 m         3928.00 m          -1.824 m/s          32
13         < 1 m        -8405.76 m           2.528 m/s          79

Message Contains Parity Errors
```

A typical TYPE 3 Message:

```
July 19, 2006  02:45:19

Preamble                   : 102
Message Type               : 3 GPS Reference Beacon Parameters
Beacon Number              : 693
Z Count                    : 4550
Sequency Count             : 1
Num of Data Words          : 4
```

```
Health                      : 0 UDRE scale factor = 1.0
ECEF X-Coordinate           : 3559572.50 m
ECEF Y-Coordinate           : -252669.16 m
ECEF Z-Coordinate           : 5269294.50 m
Latitude                    : 056 deg 04 min 17 s North
Longitude                   :  -4 deg 03 min 37 s West
Altitude                    : 497.1 m
```

A typical TYPE 7 message (Beacon Almanac):

```
February 8, 2006  01:30:38

Preamble                    : 102
Message Type                : 7 DGPS Radiobeacon Almanac
Beacon Number               : 660
Z Count                     : 3073
Sequency Count              : 1
Num of Data Words           : 12
Health                      : 0 UDRE scale factor = 1.0
Broadcast Beacon Id         : 430
  Latitude                  :  51 Deg 28 Min North
  Longitude                 : 009 Deg 49 Min West
  Radiobeacon Range         : 276 km
  Frequency                 : 284000 Hz
  Radiobeacon Healt         : radiobeacon operation normal
  Broadcast Bit Rate        : 100 bits/sec
  Modulation Code           : MSK
  Synchronization Type      : asynchronous
  Broadcast Coding          : no added coding
Broadcast Beacon Id         : 441
  Latitude                  :  49 Deg 58 Min North
  Longitude                 : 005 Deg 12 Min West
  Radiobeacon Range         : 185 km
  Frequency                 : 306000 Hz
  Radiobeacon Healt         : radiobeacon operation normal
  Broadcast Bit Rate        : 100 bits/sec
  Modulation Code           : MSK
  Synchronization Type      : asynchronous
  Broadcast Coding          : no added coding
Broadcast Beacon Id         : 432
  Latitude                  :  52 Deg 34 Min North
  Longitude                 : 009 Deg 56 Min West
  Radiobeacon Range         : 276 km
  Frequency                 : 293000 Hz
  Radiobeacon Healt         : radiobeacon operation normal
  Broadcast Bit Rate        : 100 bits/sec
  Modulation Code           : MSK
  Synchronization Type      : asynchronous
  Broadcast Coding          : no added coding
Broadcast Beacon Id         : 449
  Latitude                  :  51 Deg 24 Min North
  Longitude                 : 003 Deg 33 Min West
  Radiobeacon Range         : 185 km
  Frequency                 : 309500 Hz
  Radiobeacon Healt         : radiobeacon operation normal
  Broadcast Bit Rate        : 100 bits/sec
  Modulation Code           : MSK
  Synchronization Type      : asynchronous
  Broadcast Coding          : no added coding
```

A typical TYPE 9 message:

```
July 20, 2006  03:06:57

Preamble                    : 102
Message Type                : 9 GPS Partial Correction Set
Beacon Number               : 332
Z Count                     : 715
Sequency Count              : 3
Num of Data Words           : 5
Health                      : 2 UDRE scale factor = 0.5
```

```
SatID       UDRE      Pseudorange Corr.   Range Rate Corr. Issue of Data
 8         < 1 m           6.22 m          0.016 m/s         237
20         4 - 8 m       2785.92 m         2.112 m/s           9
27         < 1 m          -1.20 m          0.000 m/s         229
Message Contains Parity Errors
```

Below are a few examples of Skysweeper's infamous "Phantom" decodes:

```
July 23, 2006  04:31:10

Preamble                    : 102
Message Type                : 56 Undefined
Beacon Number               : 885
Z Count                     : 1716
Sequency Count              : 0
Num of Data Words           : 12
Health                      : 2 UDRE scale factor = 0.5
Message Word 1              : 0660755012
Message Word 2              : 0615891015
Message Word 3              : 0946363982
Message Word 4              : 1049867445
Message Word 5              : 0193011258
Message Word 6              : 0383933674
Message Word 7              : 0117158115
Message Word 8              : 0160535223
Message Word 9              : 0003674924
Message Word 10             : 0324725318
Message Word 11             : 0449576363
Message Word 12             : 0859570741


Message Contains Parity Errors




July 14, 2006  04:14:53

Preamble                    : 102
Message Type                : 18 RTK Uncorrected Carrier Phases
Beacon Number               : 325
Z Count                     : 8186
Sequency Count              : 2
Num of Data Words           : 19
Health                      : 6 transmission not monitored
Message Word 1              : 0138242378
Message Word 2              : 0277159393
Message Word 3              : 0516945049
Message Word 4              : 0774041286
Message Word 5              : 0000237926
Message Word 6              : 0190481698
Message Word 7              : 0944598595
Message Word 8              : 0183667007
Message Word 9              : 0278705480
Message Word 10             : 0706749289
Message Word 11             : 0344985060
Message Word 12             : 0472564429
Message Word 13             : 0039804814
Message Word 14             : 0908722175
Message Word 15             : 0010805819
Message Word 16             : 0705003575
Message Word 17             : 0427075063
Message Word 18             : 0044598379
Message Word 19             : 0856661098


Message Contains Parity Errors




July 14, 2006  04:15:52

Preamble                    : 102
Message Type                : 32 Differential GLONASS Ref Beacon Parameters
Beacon Number               : 752
Z Count                     : 2221
```

```
Sequency Count               : 1
Num of Data Words            : 16
Health                       : 7 reference beacon not working
Message Word 1               : 0361663033
Message Word 2               : 0268576453

Message Word 3               : 0792565823
Message Word 4               : 1017906453
Message Word 5               : 0827338227
Message Word 6               : 0866878230
Message Word 7               : 0535449271
Message Word 8               : 0655624016
Message Word 9               : 0044824511
Message Word 10              : 0626321028
Message Word 11              : 0073468781
Message Word 12              : 0541020943
Message Word 13              : 0000571820
Message Word 14              : 0308280639
Message Word 15              : 0285757413
Message Word 16              : 0163887063


Message Contains Parity Errors
```

Footnote:

As can be seen from the above examples, these 'phantom' decodes can easily be mistaken for real ones, if such clues as the "Message Type" number and general appearance are not taken into consideration. An experienced user very quickly gets a feel for whether or not these are genuine or false, but newcomers to this mode should take care to ensure that they are able to recognise whether or not a signal is correct, because it can be very embarrassing to post logs of 'false' signals and find yourself being very quickly corrected by other DXers. With a little patience, and a few copies of the guides recommended in this publication, you will very quickly learn to recognise these, and avoid any problems with them.

In the final section we will take a good look at a number of useful data sources for DGPS DXers:

Useful DGPS data-sources for enthusiasts:

There used to be a lot of files relating to this mode to assist both aspiring and experienced DGPS DXers on the Beaconworld website, but due to its closure in May 2010 these can no longer to be found there. I have however, uploaded some of the files to new NDB List Info website, and these should be available from the link shown below. Many of these files are updated at frequent intervals and can be downloaded there for free, but please note that these are not guaranteed to be 100% accurate but should offer a reasonably up to date source to work from. I have placed a link to the page where you should be able to obtain them, and if reading this document has whetted your appetite you should find plenty of extra reading there to increase your knowledge base.

http://www.ndblist.info/datamodes.htm

There are also a number of 'official' sites, where up to date information can also be obtained, and for North American DGPS enthusiasts, two very important sources are always well worth checking out. The first is the US Coastguard website, this is regularly updated, and not only carries a list of current DGPS Beacons, but also carries status reports and details of any new, or future planned beacons.

The second one is run by the Canadian Coastguard, and has a similar list showing which DGPS beacons they operate, and where they are in the various Canadian provinces. To make life even easier these also include a number of maps. The CSI Wireless site which has an excellent .pdf database of active DGPS beacons around the entire world. All of these can be found at the sites listed below, be sure to check them out for further information relating to this mode:

Website:	**URL:**
Canadian Coastguard DGPS:	**http://www.ccg-gcc.gc.ca/dgps/**
C.O.A.A DSCdecoder:	**http://www.coaa.co.uk/dscdecoder.htm**
Commissioners for Irish Lights:	**http://www.cil.ie/**
DGPS Mailing List :	**https://groups.io/g/dgpslist**

European Differential Beacons :	**http://www.effective-solutions.co.uk/beacons.html**
Homebrew DGPS receiver :	**http://www.abnormal.com/dgps**
IALA Website:	**https://www.iala-aism.org/**
NDB List Datamodes Section:	**http://www.ndblist.info/datamodes.htm**
Northern Lighthouse Board:	**http://www.nlb.org.uk/dgps/dgps.htm**
Pervisell (Skysweeper & RadioRaft supplier):	**http://www.pervisell.com**
Radio Raft 3.2 Decoding Software	**http://perso.wanadoo.fr/radioraft/**
Trinity House (England & Wales DGPS):	**https://www.trinityhouse.co.uk/**
US Coastguard DGPS Status:	**https://www.navcen.uscg.gov/**
WSV - German Waterways DGPS List:	**http://www.wsv.de/fvt/dgps/index.html**

DGPS List E-mail Reflector:

I can't finish without giving a mention of the new 'DGPS List' e-mail reflector, which is a 'private group' for DGPS, LORAN and Time Signal enthusiasts, and is a new offshoot created by the members of the NDB List. With the growth in the popularity of these modes it was decided that it would be a good time to move these from the NDB List and place them in their very own dedicated group, where they can grow and prosper. If you are really interested in getting more heavily involved in these modes, you can find out a lot more about the group from our information page at Yahoogroups. The link is given below:

https://groups.io/g/dgpslist

And Finally:

UK comedy legends 'The Two Ronnies' always ended their shows with an 'and finally' so I thought I would do this as well. In the early editions of this publication I suggested that I suspected that DGPS beacons could really become a good DX mode, and not just another source of QRM, and now nearly twenty years later I am totally convinced that I was right in my assumptions. With the current solar minimum here regular DX catches being made by many European DXers on an almost daily basis, and this mode as a hobby has really come of age, and members of the ndblist reflector have played a big part in proving that this is so. In my early editions I was pleased to find that it was possible to hear Canadian DGPS Beacons over here in the UK, and it seems that the frontiers are being pushed back further and further every week in what can and can't be received in this mode. One UK listener, Peter Conway of Sussex, even heard one of the Brazilian DGPS beacons during the last Solar Minimum, so who know just what is possible in the coming years, especially with newer types of receivers such as the SDR types now making it much easier to monitor for long periods at unsociable hours of the day.

In the last two decades a large number of listeners in Europe have received the beacon from Isabella in Puerto Rico, and I have also heard a number of US beacons here in north-west England, with some of these being in places as far inland as Tennessee, Michigan, Missouri, Wisconsin, North Carolina, and New England. We have found that in the summer months especially, the period around Dawn often gives a good signal enhancement to the west, and with most of Western Europe in daylight at that time, a clear path of darkness direct to North America exists from here.

In my first edition I asked if DGPS was a DXable mode, and some 135 beacons and 35 countries later I have to say the answer is: 'MOST DEFINITELY YES' – DGPS DXing is here to stay!

Alan Gale / DGPS List, 2019

Credits & thanks for this publication must go to:

Admiralty List of Radio Signals Volume 2
Alex Wagner, Austria
AMSA (Australia) Website
Andy Robins, USA
Bev M Ewen-Smith (C.O.A.A DSCdecoder)
Bob Zyskowski, USA
Brian Keyte, England
Canadian Coastguard Website
Chris Smolinski, USA
Commissioners for Irish Lights Website
DGPS List
Ferdinand Lenhardt, Germany
Fred Mooney, South Korea
Fritz Raab, USA
FVT - German Federal Waterways Website
GIS Forum Danube
Henrik Thiil Neilsen, Denmark
Herman Schoemaker - Editor: "QSL Review", "Section NDB" (Benelux DX-Club)
IALA World Database
Jean Jacquemin, France
Karl-Erik Stridh, Sweden
Klaus Betke, Germany
Martin Francis, Canada
Michael Oexner, Germany
NDB List e-mail reflector
Northern Lighthouse Board Website
Patrick Robic, Austria
Patrick, F6CTE
Pav Lucistnik, Czech Republic
Peter Selwyn, New Zealand
Radionavigation News
Roger Caird, Ireland (thanks for all the additional data and suggestions!)
Starlink DGPS Website
Steve Ratzlaff, USA
Tom Becker, USA
Torbjorn Ericson, Sweden
Tjaerand S.Bauge, Norway
Trinity House Website
US Coastguard Nav Center
Vesa Heinonen, Finland
Vincent Lecler, France
Walter Blanchard, England
Weekly Notices to Mariners
Wolf, DL4YHF