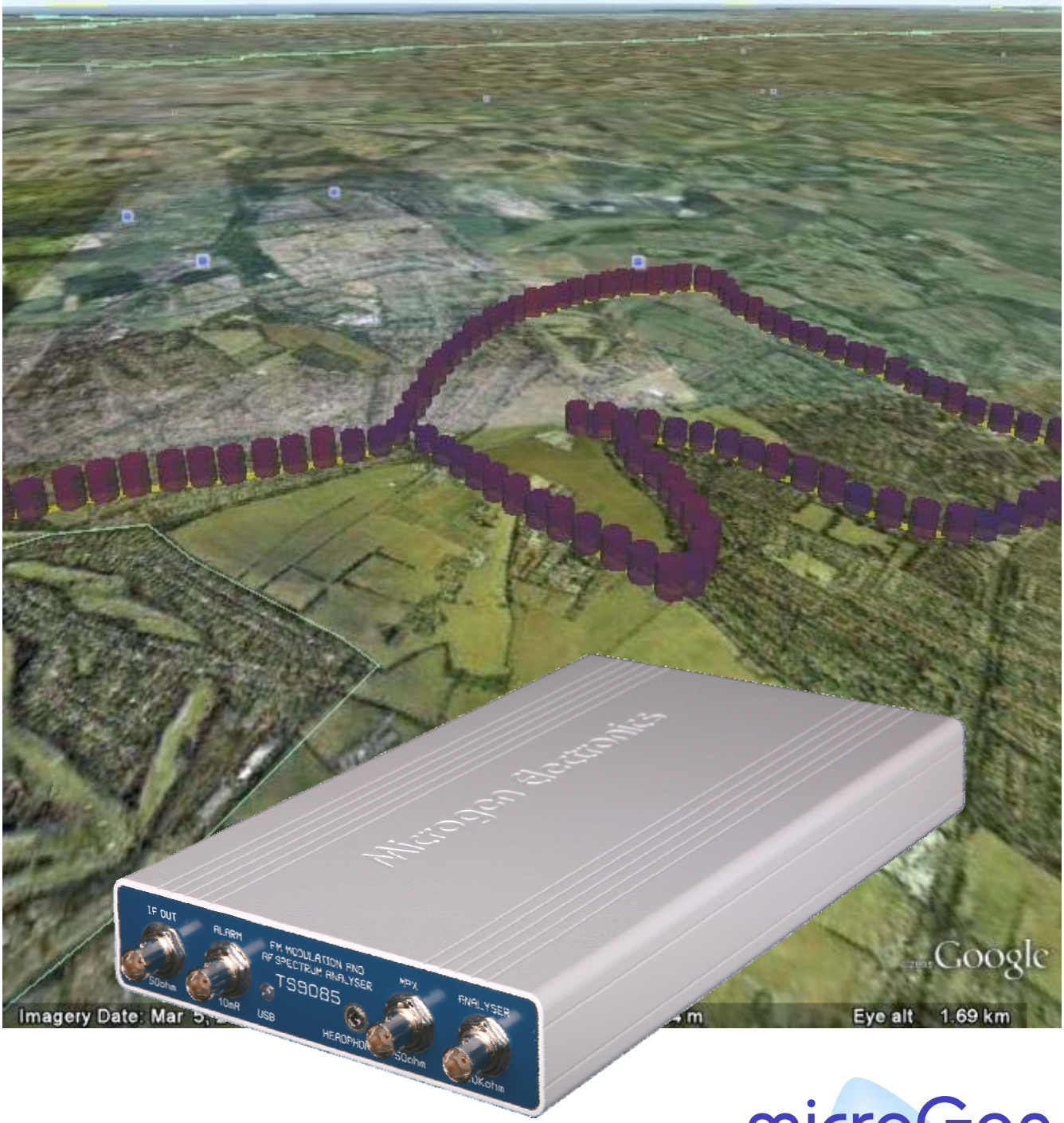
TS9085 TS9085G GPS
TS9065 TS9065G GPS

FM Modulation and AF Spectrum Analyser



2010 Technical specification
Issue 2.4

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Specification Document:
TS9085_65_spec_08jun10.pub

The TS9085 and TS9065, FM Modulation and AF Spectrum Analysers, have been designed for precision monitoring of FM Radio Broadcasts. Connected to a standard Windows PC, via a USB port, their user friendly interface displays all modulation data on screen for analysis.

Audio outputs are provided for high quality headphone or loudspeaker monitoring, with full RDS decoding available, with live 'off-air' data recording. Extensive automatic logging of broadcast data with the included **iLog** software. Remote control is possible with simple text file commands allowing the unit to be controlled from 3rd party software applications.

Unique to this class of product is a **FFT Spectrum Analyser** for precise audio analysis.

GPS

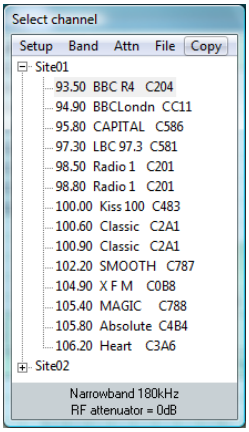
With the introduction of V5.00, the iLog software now includes GPS decoding to the NMEA global standard. It will automatically scan the PC for any connected GPS NMEA compliant devices. Google Earth .kml files are generated for GPS tagged field measurement. The TS9085G and TS9065G units are supplied with their own USB GPS receiver module.

The enclosure is a custom designed dual-chamber aluminium extrusion, providing excellent screening between the analogue and digital circuitry and providing a extremely robust case for field use.

This combination provides broadcast engineers, whether working on-site or as a mobile unit, with a competitively priced instrument, compatible for use around the world.

Digital phase FM demodulator an ultra linear design. Two feedback loops maintain accuracy over time and temperature by comparing deviation amplitude and phase to a 20ppm voltage reference band-gap diode. This provides a virtually calibration free instrument.
All measurements of deviation, modulation power, pilot level and RDS sub-carrier are referenced to this, as are any other baseband measurements made with the spectrum analyser.

FFT Spectrum Analyser 10Hz to 100kHz with 16 bit sampling, achieves a 100dB dynamic range. This can be extended to greater than 110dB with waveform averaging, allowing signals below noise to be observed and measured.



IF Amplifier, dual band. The narrowband is set with multistage selected ceramic filters and the wideband is set with a proprietary Gaussian response LC filter, computer optimised and equalised for minimum overshoot.
These filters allow precise 'off-air' measurements, offering low levels of distortion for high quality audio monitoring, via the headphone output or loudspeakers.

Software DSP stereo decoder with excellent phase matching between channels, with lower distortion and noise than traditional analogue types.

Stereo monitor with left and right channels shown on a time domain display. An additional 2D vector stereo quality display gives a visible guide to left and right channel behaviour.

Multiplex record and playback with full stereo audio monitoring using PC sound system. This feature records the raw USB data from the TS9085/65 directly to hard disk. This can then be replayed at any time, giving a live 'off-air' monitor. A recording can be made from any frequency on the channel list and is only limited by the hard-disk size.

Antenna attenuator providing up to 30 dB attenuation, with user selectable 10dB steps. Different attenuator values can be assigned to each frequency on the channel list.

IF input at 10.7MHz on standard BNC 50 ohm socket provides flexible monitoring with the front-end shut down automatically. This is achieved with a simple software switch.

IF filter output at 10.7MHz from a standard BNC 50 ohm socket, allows the user to feed external equipment.

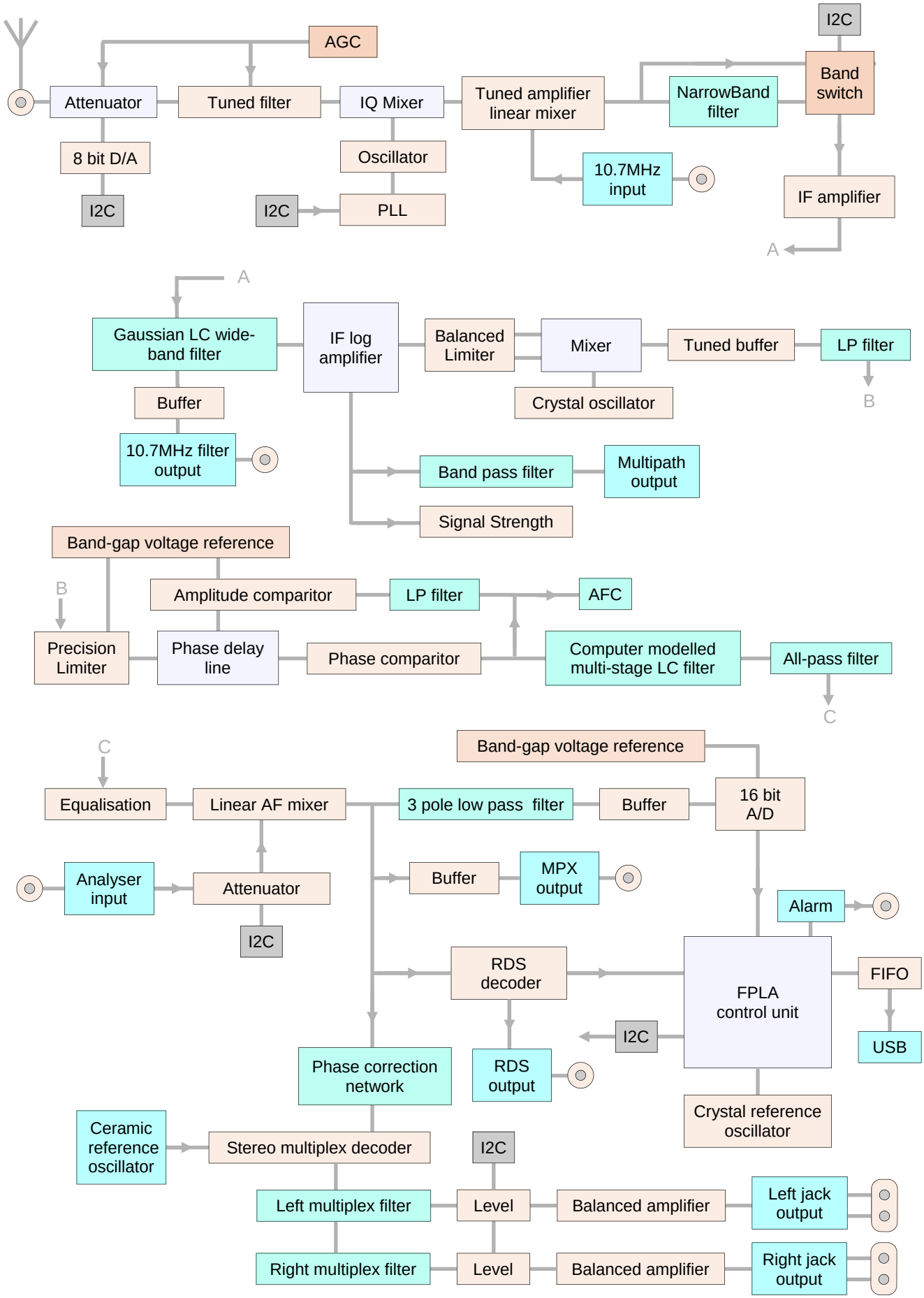
Balanced audio outputs for left and right channels

Class AB audio amplifier for high quality audio monitoring on headphones or external loudspeakers. Additional audio stereo monitoring is available on the PC sound system.

USB powered, means that no other power source is required. Running from a Laptop computer, provides for mobile monitoring and logging of radio broadcasts.

Windows iLog software is supplied with the unit, providing complete control and display of all measurements. This will run on a standard desktop or laptop PC.

TS9085 system diagram



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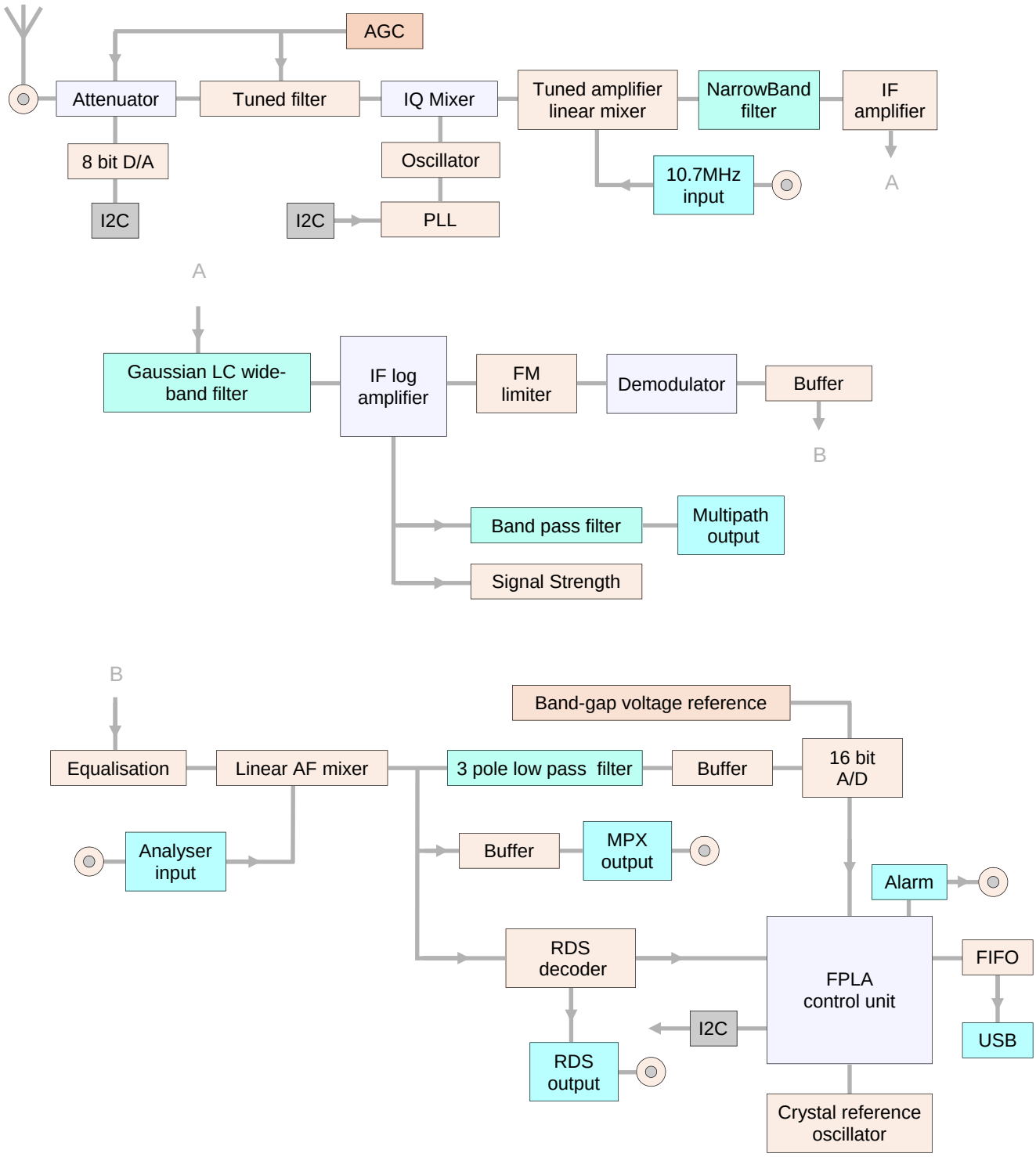
TS9065 system diagram



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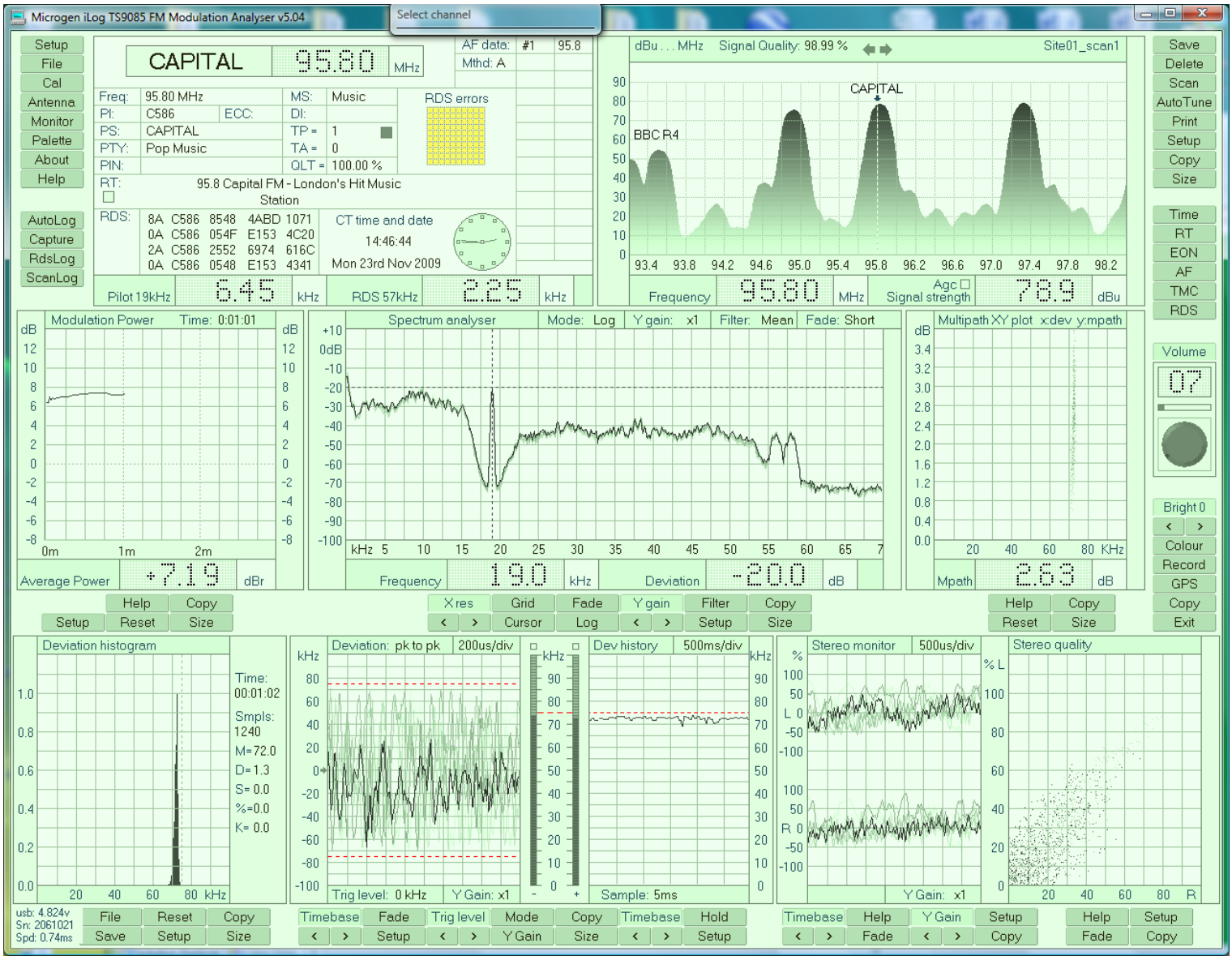
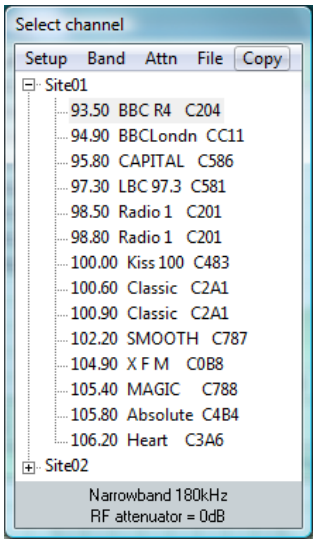
iLog Windows software

iLog application iLogV5.00 . . . screen dump at 1280 x 1024 screen resolution



FM Modulation analyser features:

- High performance FM receiver and Modulation Analyser providing broadcast measurements over the band 87.5 to 107.9 MHz in 10kHz steps
- Signal strength with 80dB range and frequency scanning
- FM deviation 0 to 100kHz with histogram
- Modulation Power calculated with 32bit floating-point precision
- Multipath with XY plot
- Pilot 19kHz amplitude
- RDS 57kHz sub-carrier
- Left and right channel decoding, with stereo quality graphical readout
- Automatic logging of signal strength, pilot and RDS carrier
- Remote control with simple text file commands



RDS/RBDS decoder features:

- Full RDS/RBDS decoding, with signal quality readout.

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Information: www.microgenelectronics.com

iLog application iLogV5.00 . . . screen dump at 1680 x 1050 WSXGA screen resolution

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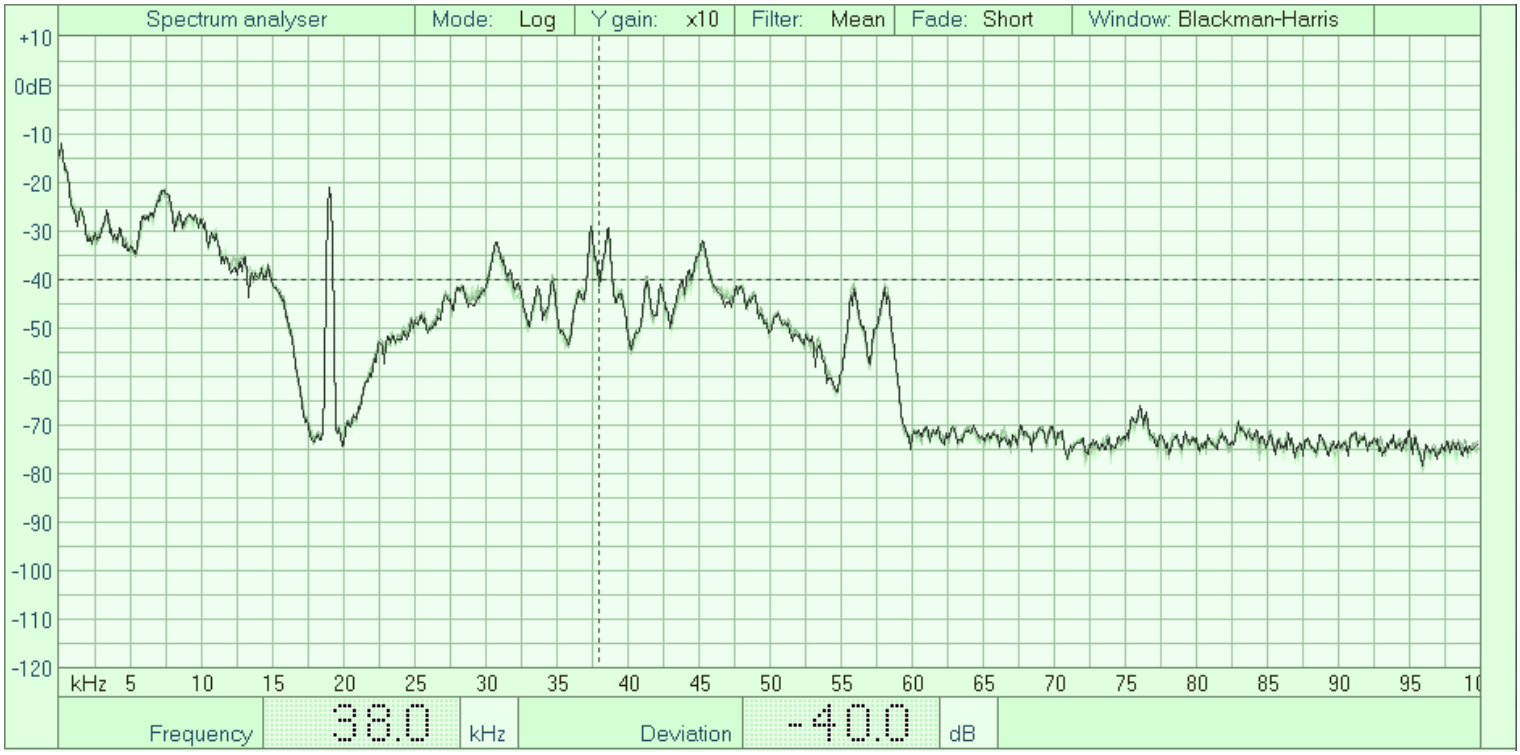
FFT Spectrum Analyser

This 32bit FFT Spectrum Analyser, takes advantage of the high quality 16 bit SAR A/D converter, extracting frequency detail well into the noise of the signal.

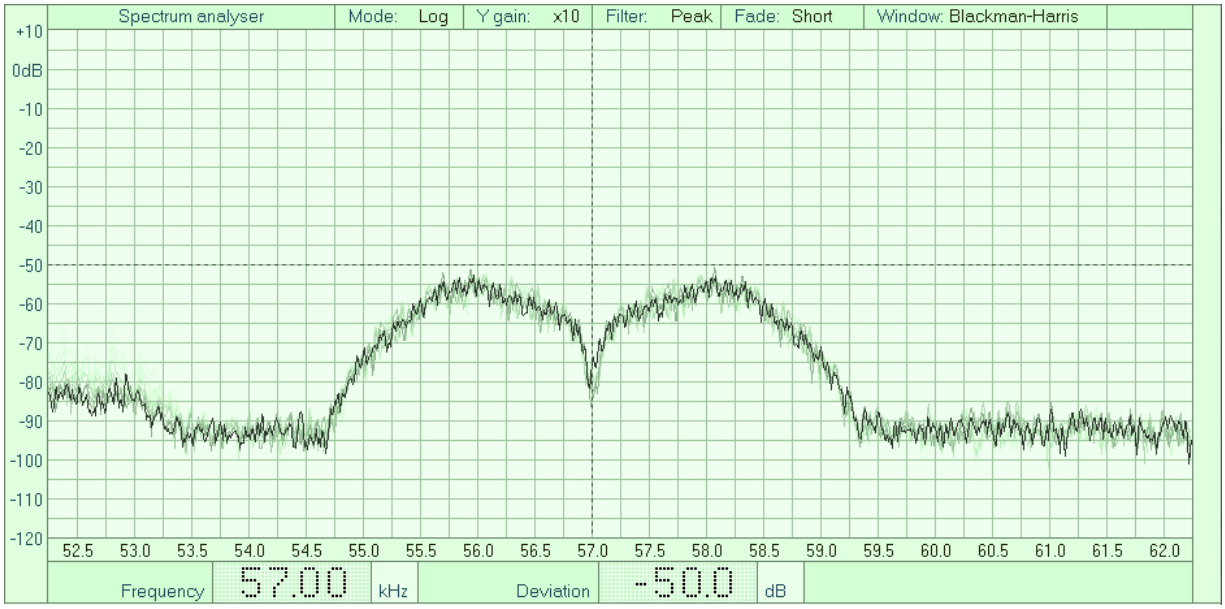
This converter is fed by an ultra low distortion buffer, with less than 0.0006% distortion+noise, and a computer optimised LC anti-alias filter. A software controlled passive input attenuator network, allows for scaling of the signal under measurement for greater flexibility.

Any measurements taken can be cut and pasted into other applications. This high quality analyser can also be used for general purpose AF spectrum analyser over a bandwidth of 100kHz.

- 16 bit sampling
- Precision base-band FFT Spectrum Analyser covering 10Hz to 100kHz
- Dynamic range of 100dB with a resolution of 20Hz
- Multiplex signal analysis
- External Multiplex analyser using the external BNC input
- Audio analyser using the external BNC input
- Linear or logarithmic scale with full cursor measurement



The FFT spectrum analyser feature, provides a valuable tool for examining the FM multiplex signal. The TS9000 units sampled at 12 bits, but on the new TS9085 and TS9065 this has been increased to 16bits using a very high quality A/D converter. This converter has a very low spurious output, coupled with low distortion and noise. With signal averaging it is possible to detect signals below noise. This will extend range to greater than 110dB. Various sample windows can be applied, Hanning, Ham-

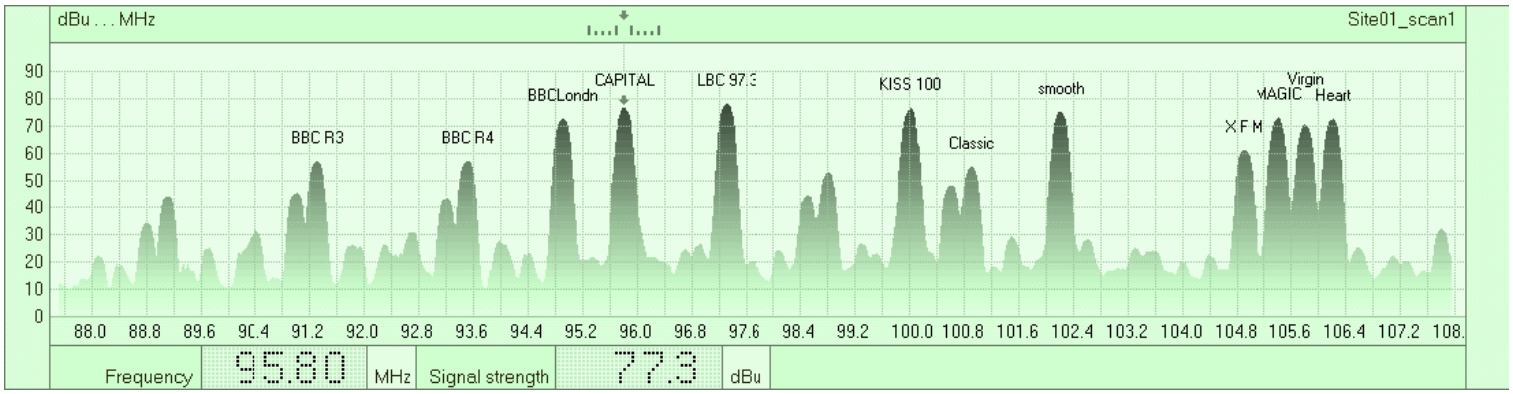


The spectrum shown left details just the FM broadcast 57KHz RDS sub-carrier. It shows the sideband modulation at a resolution of 250Hz per division.

FM BROADCAST RF SPECTRUM

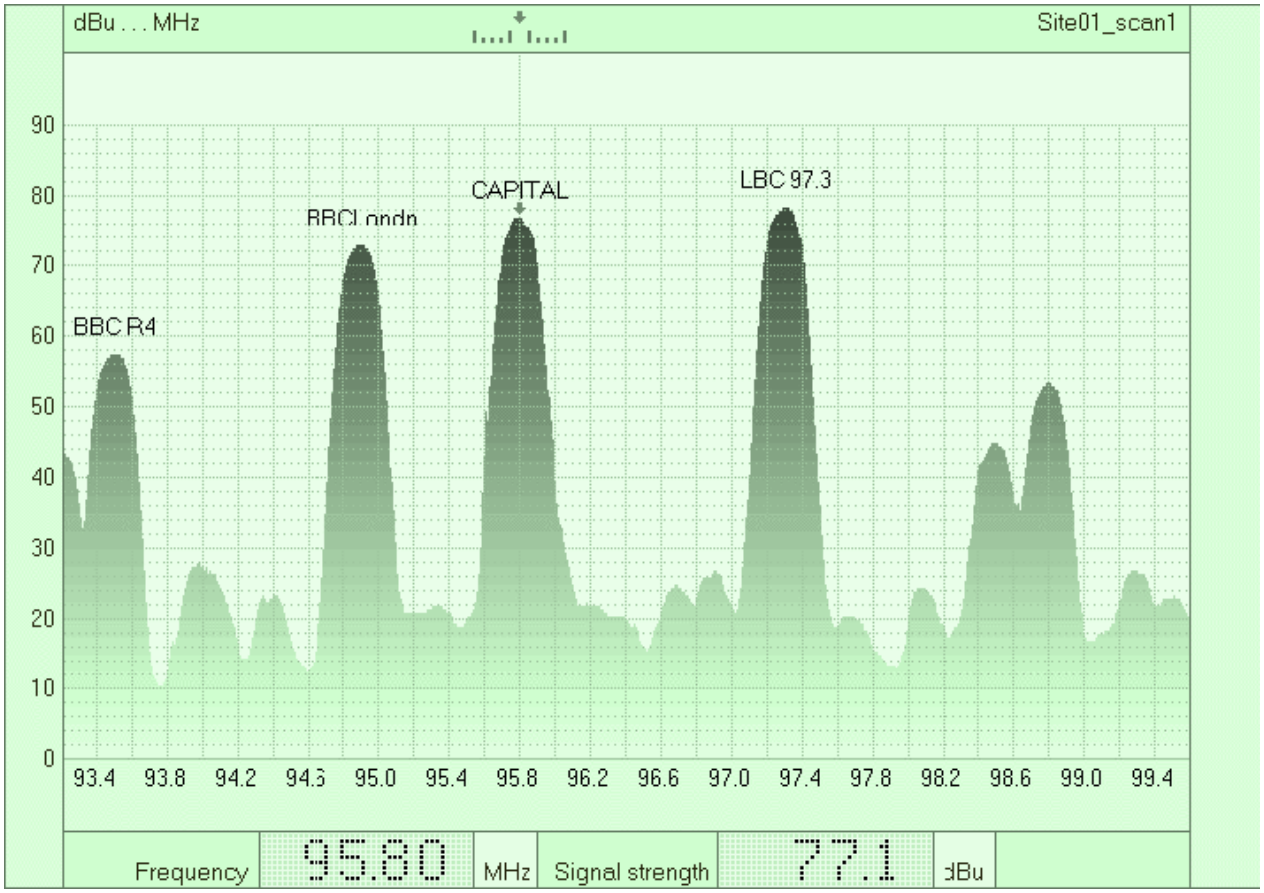
- The FM Broadcast frequency band can be scanned from 87.5 MHz to 107.9 MHz. This window can be resized to view any particular frequency. If the radio channel is transmitting it's PS name then this will be automatically displayed
- The AutoTune feature provides a completely automatic channel search and save function
- The Windows **iLog** software provides extensive logging, manual or automatic, with an alarm on error.

RF Broadcast spectrum 87.5MHz to 107.9MHz



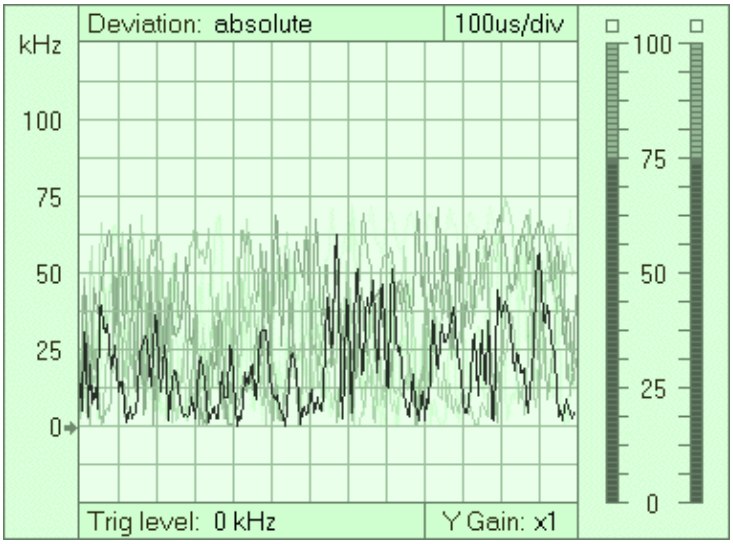
The window above shows a complete frequency scan from 87.5MHz to 107.9MHz. The digital readout gives the frequency and signal strength of the channel tuned. This spectrum can be printed out as a hard copy for future reference.

RF Broadcast spectrum detailing 95.8MHz



The window shown here, details just a small frequency range at 10kHz resolution. The vertical scale has doubled to show 2dB increments. This frequency scan can be dragged with the computer mouse to show any frequency of interest. For strong signal areas, a user settable antenna attenuator can be selected. This has three settings of -10dB, -20dB and –30dB. These windows can be copied and pasted into any suitable application.

FREQUENCY DEVIATION



Oscilloscope:
The FM multiplex signal can be viewed in the time domain with a standard type oscilloscope display.

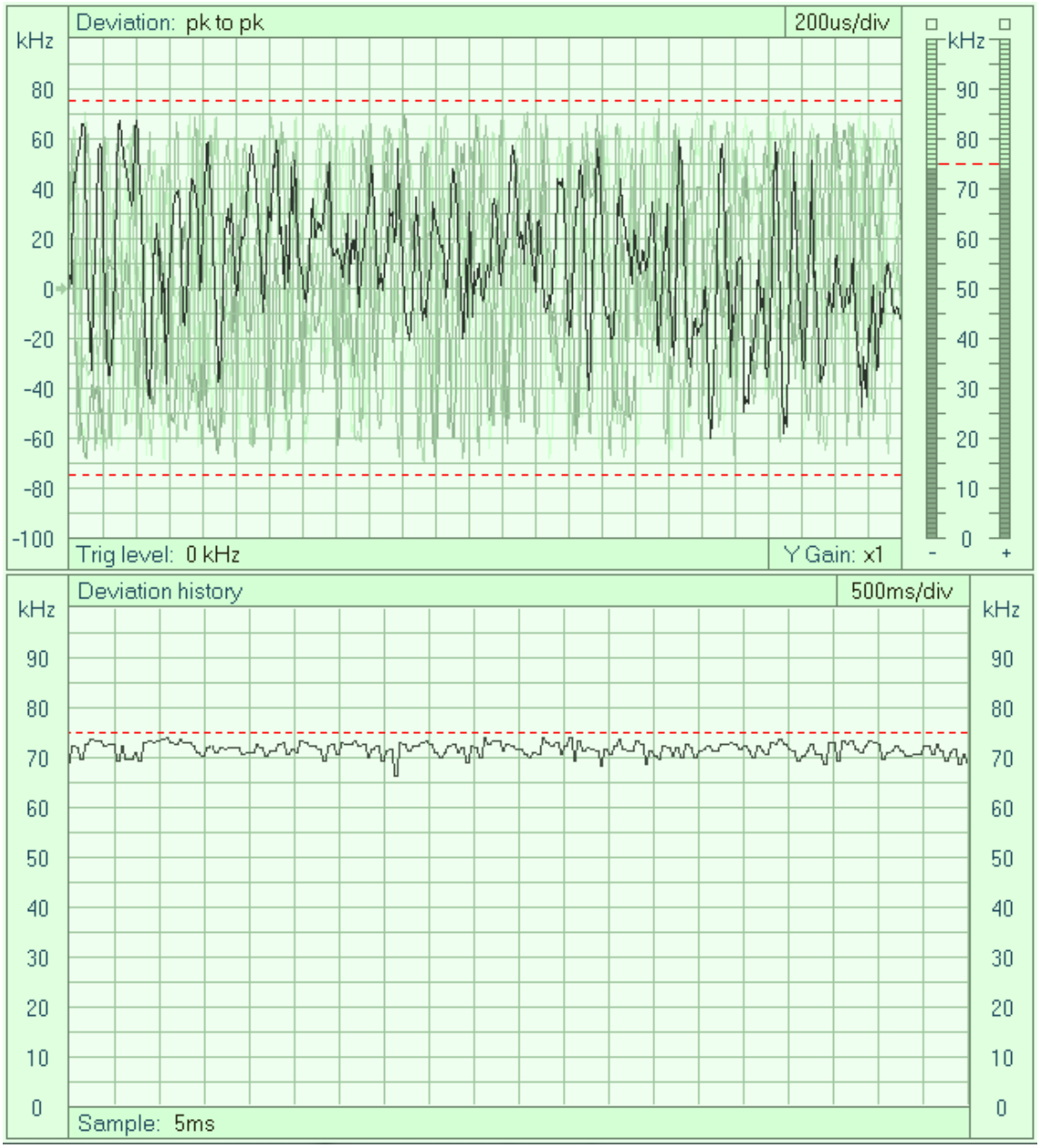
The Y-axis has been calibrated for frequency deviation measurement, with a user selectable x10 function. The X-axis time-base can be set from 10ms/div to 10us/div.

The waveform trigger point is automatic or user settable.

The deviation window, shown here, is a typical broadcast trace set for absolute signal readings. Alternately the display can be set positive and negative deviation.

A bar graph is also provided for a convenient peak style reading for absolute or positive or negative deviation.

FREQUENCY DEVIATION HISTORY



Deviation history:
With the introduction of iLog V5.00 a new frequency deviation history window has been added.

This graph has a much slower time-base, with a sample accumulator. The sample algorithm takes the highest value of deviation within the sample period. This ensures no modulation peaks are missed.

The time-base can set from 100ms/div to 10sec/div, displaying absolute frequency deviation.

This history feature allows the operator to assess frequency deviation over a very long period of time. This makes it very easy to spot over modulation peaks.

The display can be set for a normal left to right update or can be configured to automatically scroll continuously.

FREQUENCY DEVIATION HISTOGRAM AND ACCUMULATED DISTRIBUTION

Frequency deviation histogram:
The frequency deviation histogram method provides an accurate way to asses deviation levels over any period of time.

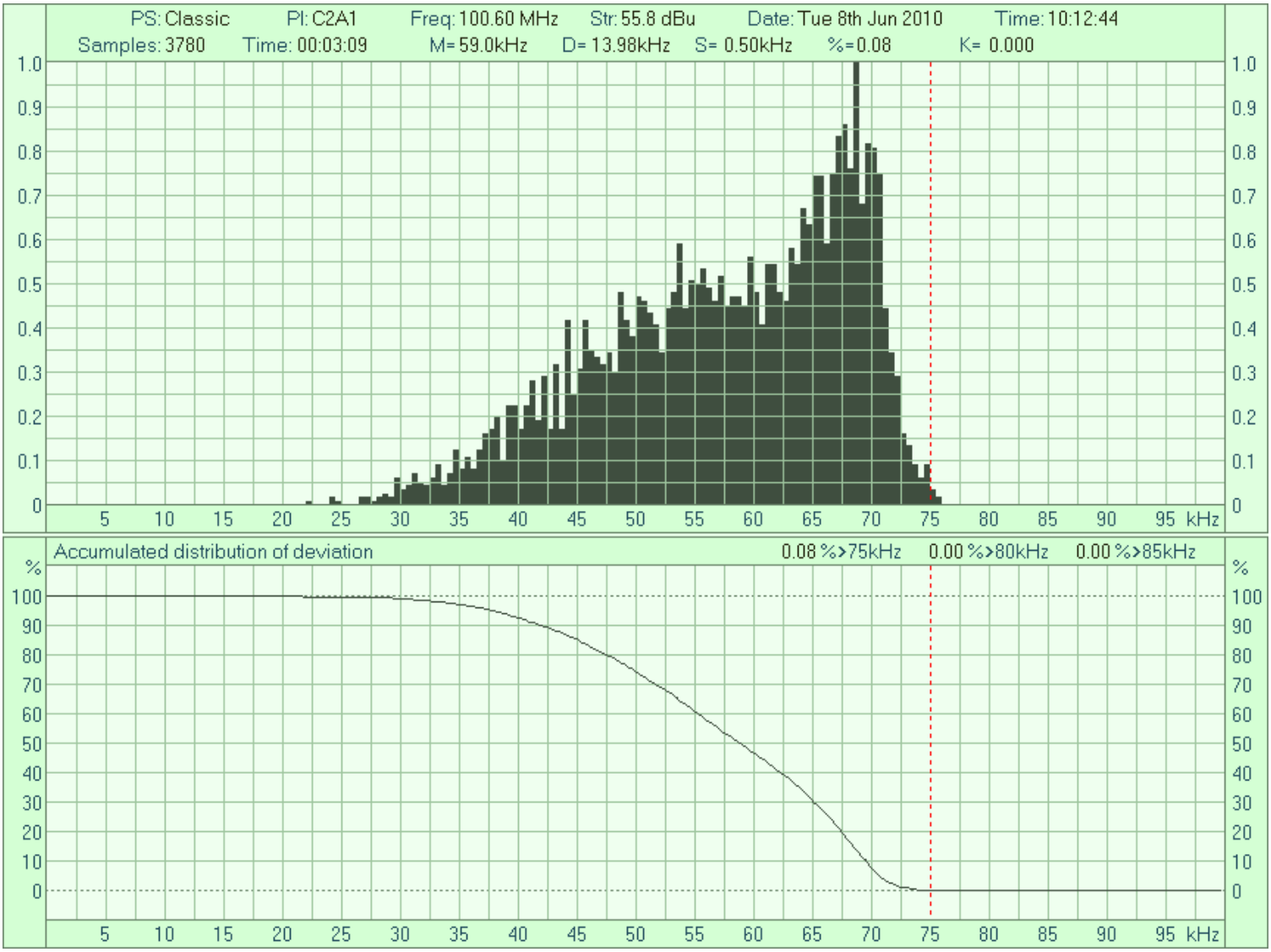
The multiplex signal is sampled with a peak hold system, to the recommended standard size 50ms bins. These samples are normalised and then separated into frequency bins over a range of 100kHz.

The histogram resolution can be set for 0.25kHz, 0.5kHz and 1kHz bins. The graph shown below, was sampled with 0.5kHz bins.

The histogram window is updated in real time, with the following deviation variables calculated once per second, from the accumulated data.

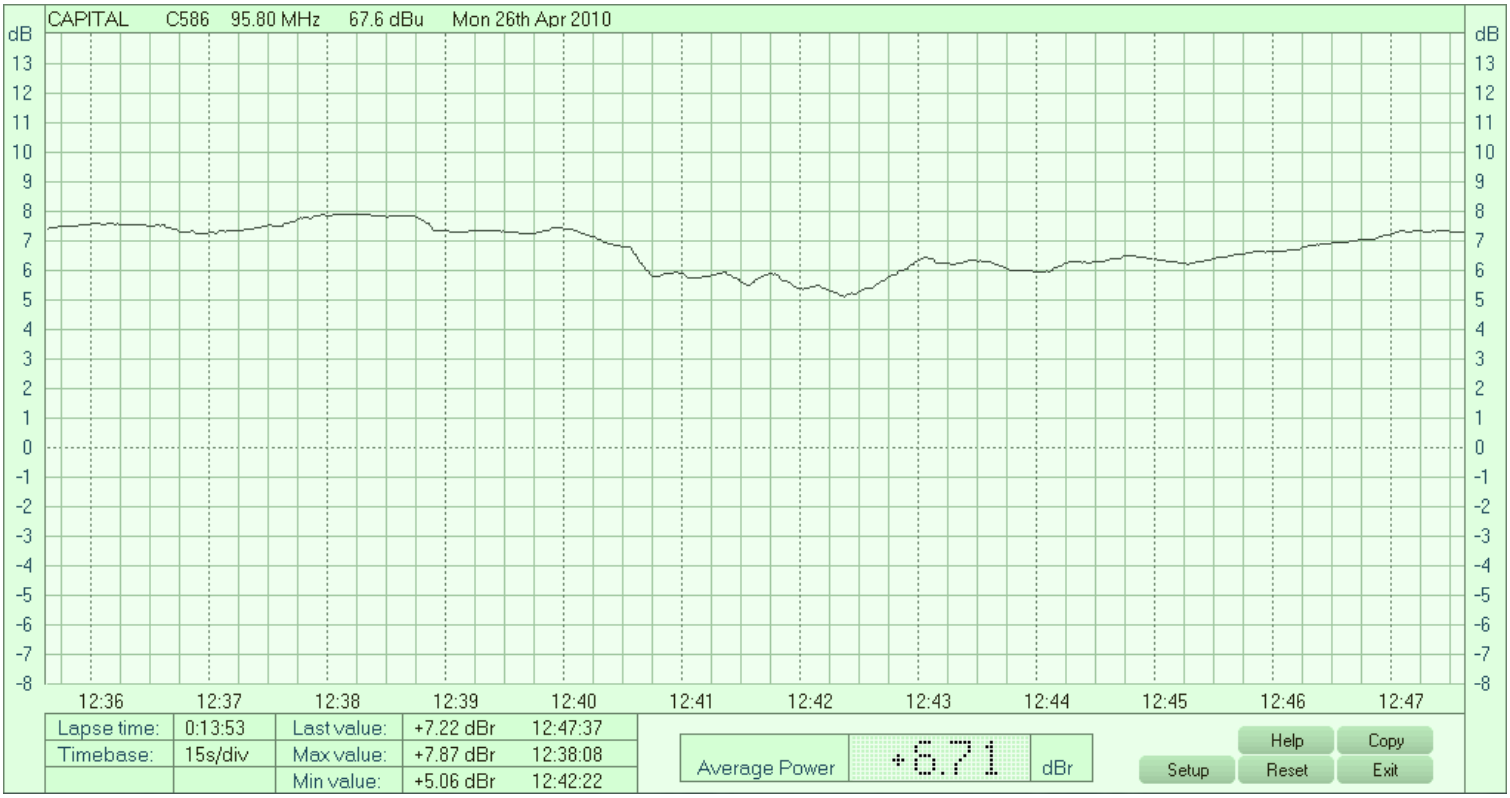
- T Lapse time measured in minutes and seconds
- The number of samples taken
- M The mean value of deviation
- D The quadratic mean value of deviation
- S The mean of samples above 75KHz
- % The percentage of samples above 75KHz
- K Equals S*(%/100)

The frequency deviation histogram meets the CEPT/ERC REC 54-01 E standard.



Accumulated distribution of deviation:
The accumulated distribution of deviation, is calculated by summing all bins in ascending order. These are normalised to the total number of samples taken and shown graphically over a range of 100kHz. The percentage of samples over 75kHz, 80kHz and 85kHz are calculated every second.

MODULATION POWER



- Modulation Power is calculated with 32bit floating-point precision from the 16bit sampled multiplex signal. This provides the most accurate way of calculating modulation power compared to the more traditional analogue methods with their inherent problems of dynamic range and temperature drift.
- The full scale measurement range is from –8dB to +12dB
- The average power is calculated with reference to the EBU standard 0dBr.
- The time-base can be set to run from 15sec/div to 10min/div and automatically resets on channel frequency change, or can be user reset at any time. There are lapse time or real time x-axis options.
- The graph continuously scrolls over any period of time and can be printed as required
- Every minute the minimum and maximum values are recorded, with the last value shown for the previous recorded minute.
- The Lapse time gives the recorded time from frequency change or user reset.
- By simply clicking the Copy button the graph can be copied, via the clip-board, and pasted to any other application.

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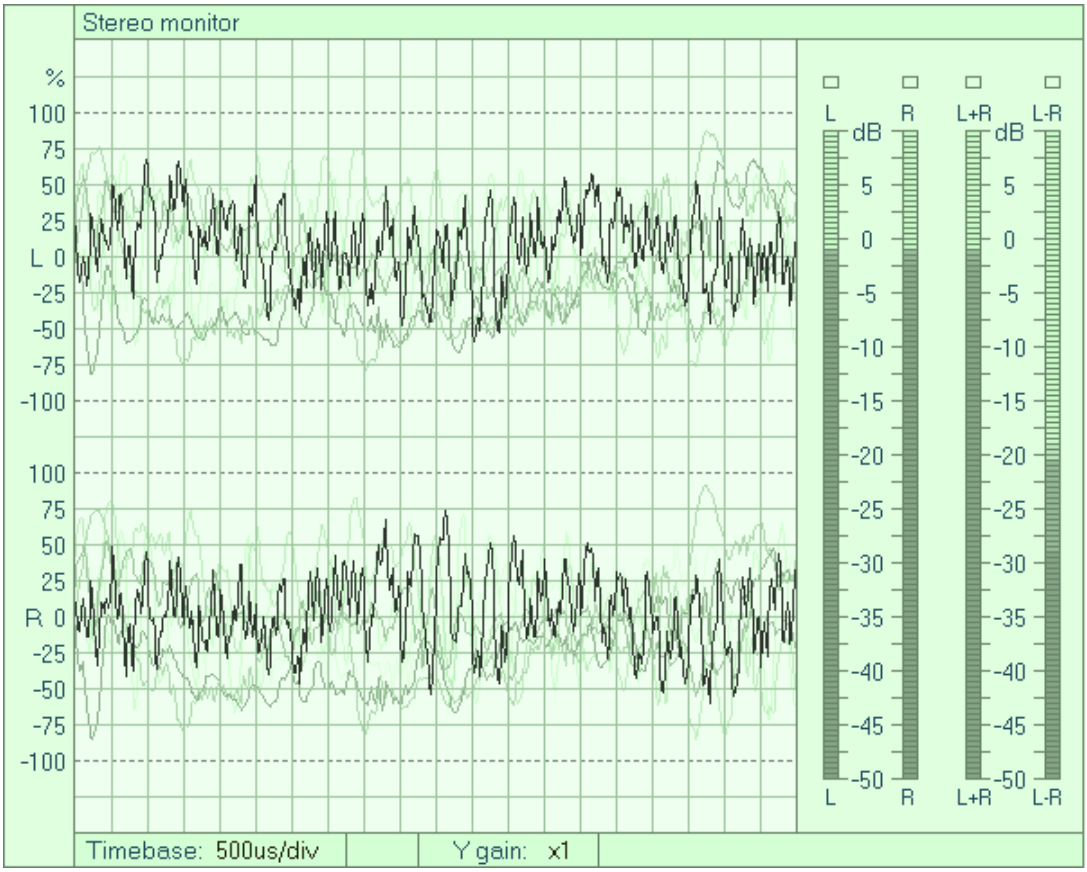
STEREO MONITOR

- Unique to the TS9085 and TS9065 analysers, is that the stereo multiplex audio is decoded by a software algorithm. The 19kHz pilot is detected and phased locked to a narrowband filter. The left and right channels are then extracted with a synchronous detector. This new method of decoding gives excellent phase matching between channels. De-emphasis is finally applied with a further digital filter. Since all this processing is achieved using DSP techniques, no hardware close tolerance components are required or any alignment necessary. The extracted 16 bit left and right audio signals are then passed, via Windows, to the Sound Card for audio monitoring.

- The stereo monitor software also provides for digital recording of the USB data. This allows the complete monitoring of a Radio Channel, i.e. it's multiplex data is decoded for deviation, RDS data, and it's stereo audio signal. This gives an engineer the opportunity to take a snap-shot of a radio channel, save it to file, and later play it as a live 'off-air' broadcast.

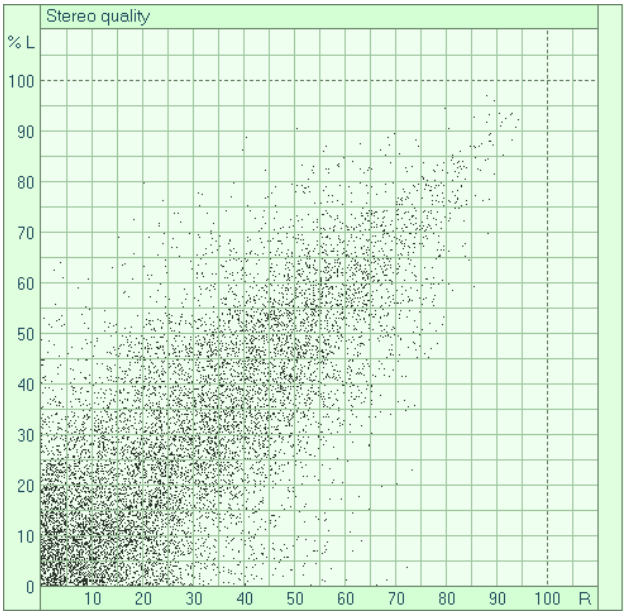


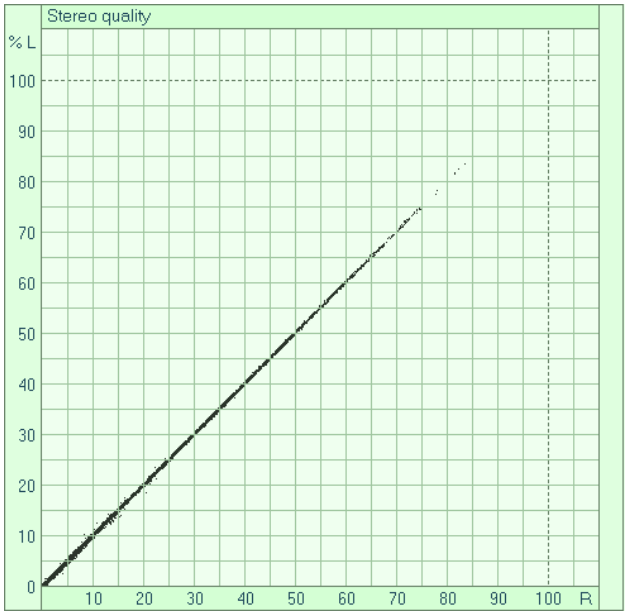
Shown here is a typical 'off-air' music broadcast of the left and right channels.

The time-base can set as required and the vertical gain can be set to x1 or x10, for detailed inspection.

Left and right channel PPM style bar-graphs show program content. These are calibrated to automatically compensate for stereo pilot and RDS sub-carrier injection levels.

Additional bar-graphs show L+R and L-R channels.





Stereo quality displayed on vectored axis.

To visualise the stereo quality, the left channel is set to the vertical axis and the right channel to the horizontal axis. The resultant 2D vector display gives an instant assessment of the stereo content from the channel being monitored. The graph on the left displays a typical stereo broadcast and on the right, a good quality mono broadcast. In this case it was for speech. If either the left or right channels are missing then the display will not show symmetrically.

RDS DECODER

- The RDS decoder will decode groups PI,PTY,PS,RT,CT,PIN,AF,TA,TP,DI,MS,EON. This data can be viewed on -screen as it arrives and it can be stored to hard-disk.

Group rate: 10 sec	
0A 45	0B
1A 11	1B
2A 23	2B
3A	3B
4A	4B
5A	5B
6A 2	6B
7A	7B
8A	8B
9A	9B
10A	10B
11A	11B
12A	12B
13A	13B
14A 33	14B
15A	15B

Received Blocks	500
Block errors	0
Block error ratio	-
RDS quality %	100.0000

2A	C204	2016	656E	204E
14A	C204	E005	390D	C202
0A	C204	001F	F13C	3420
2A	C204	2017	6577	732E
0A	C204	001C	3932	2042
1A	C204	1000	80E1	6B5E
14A	C204	E005	3206	C202
0A	C204	0019	4738	4243
14A	C204	E005	4707	C202
0A	C204	001A	4243	2052
2A	C204	2018	2020	2020
14A	C204	E005	3809	C202

Group data

- Un-decoded continuous RDS data is displayed in this window.
- Group repetition rates are calculated over a sixty second period.
- RDS quality is given to four decimal places.

Group: 14A	Network: 3	TA: 0	PI: C201	PS: Radio 1
PTY: Pop Music		LINK: 8001	PIN: 6B00 13th at 12:00	

AF		Map 1		Map 2		Map 3		Map 4		AM	
ON	ON	TN	ON	TN	ON	TN	ON	TN	ON	TN	ON
		93.5	98.8	94.2	97.7						
		93.2	98.5	94.4	99.5						
		92.5	97.7								
		94.6	99.2								
		93.1	98.3								
		94.1	99.3								
		94.2	99.4								
		94.4	99.6								
		92.8	98.0								
		94.5	99.7								
		93.0	98.2								
		93.9	99.1								
		92.9	98.2								
		93.3	98.5								
		94.3	99.5								
		92.7	97.9								

Group: 14B	PI:	TP:
		TA:

EON data

- A continuous update of EON data is available for all networks received.
- When all data has been captured, it can be stepped through for inspection, or printed out for hard copy.

Radio Text ☐	Classic 100.90 MHz	Tue 13th Dec 2005
13:57:13	You can reach Classic FM by telephoning 020 7343 9000...	
13:57:28	Our address is Classic FM, PO Box 2834, W1A 5NT.	
13:57:44	Classic FM on the internet: www.classicfm.com	
13:57:59	Relaxing Classics at Two....with Nick Bailey	
13:58:14	Relax - it's Classic FM	Relax - it's Classic FM
13:58:28	You can reach Classic FM by telephoning 020 7343 9000...	
13:58:43	Our address is Classic FM, PO Box 2834, W1A 5NT.	
13:58:58	Classic FM on the internet: www.classicfm.com	
13:59:13	Relaxing Classics at Two....with Nick Bailey	
13:59:28	Relax - it's Classic FM	Relax - it's Classic FM
13:59:43	You can reach Classic FM by telephoning 020 7343 9000...	
13:59:59	Our address is Classic FM, PO Box 2834, W1A 5NT	
14:00:13	Classic FM on the internet: www.classicfm.com	
14:00:28	Relaxing Classics at Two....with Nick Bailey	
14:00:43	Relax - it's Classic FM	Relax - it's Classic FM
14:00:58	You can reach Classic FM by telephoning 020 7343 9000...	

RT history

- Sixteen RT messages are captured and displayed in the RT window.
- These messages can be logged directly to hard disk.
- Any number of messages to capture can be set and they will be stored as ASCII text.
- These can be cut and pasted into any text file. Any repeat messages can be ignored.

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GPS log

The iLog software includes GPS decoding to the NMEA global standard. It will automatically scan the PC for any connected GPS NMEA compliant devices. Google Earth .kml files are generated for GPS tagged field measurement. The TS9085G and TS9065G units are supplied with their own USB GPS receiver module.

The GPS software decodes the following standard NMEA messages:

- GPGSV
- GPGGA
- GPGSA
- GPRMC

These will provide latitude, longitude and altitude along with comprehensive satellite information:

The bar graph displays the active satellites with their relative signal strengths.

ID: Unique satellite ID
Ev: Satellite elevation in degrees
Azi: Satellite azimuth in degrees
SN: Signal noise ratio in dBHz

The scrolling data displays all the GPS groups transmitted by the GPS antenna/ decoder

Fix Mode: 2D or 3D

Altitude: This displays altitude of the GPS antenna.

Speed: Gives speed over ground

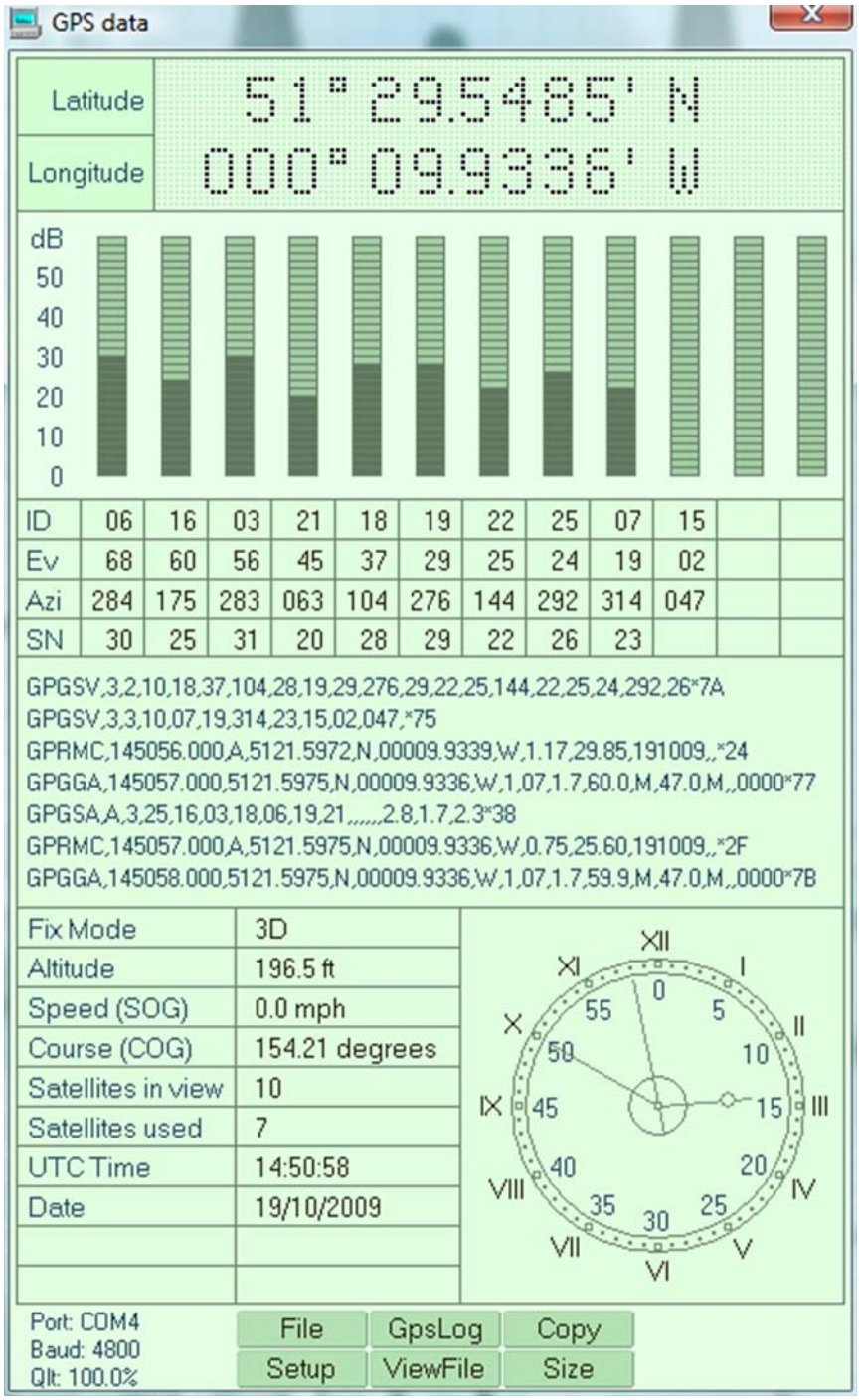
Course: Course over ground

Satellites in view: Number of satellites being received

Satellites used: Number of satellites actually being used for calculating position

UTC Time: Universal time code. This is not local time

Date: The current date



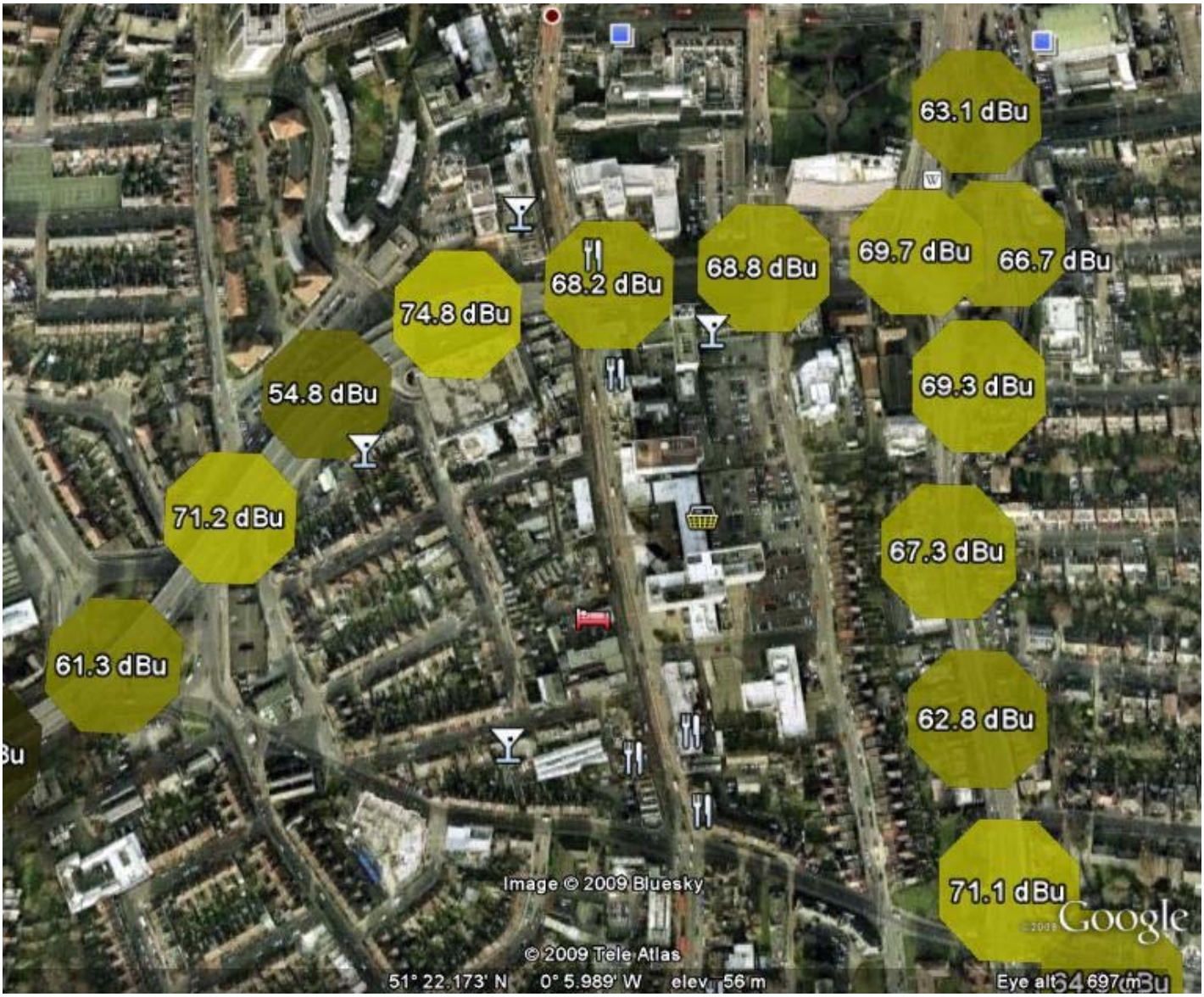
GPS Google Earth

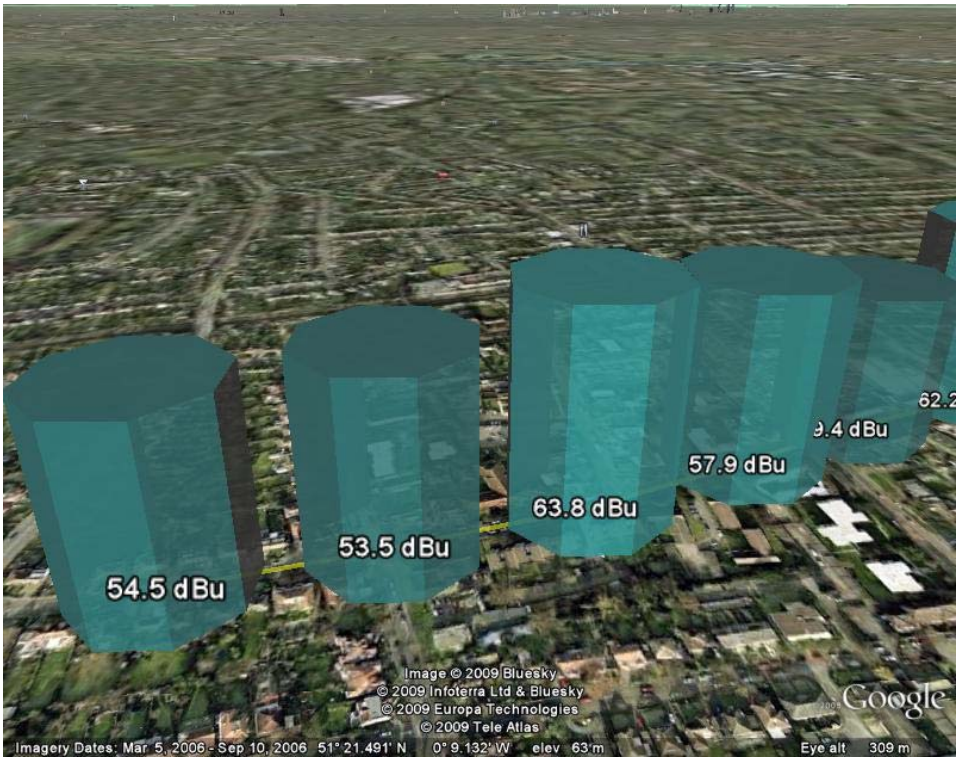
The iLog software will generate standard Google Earth mapping .kml files. These will contain signal strength measurement at each sample point, say every 100 metres, and can be tagged with channel frequency, PS name and PI code.

These files can be displayed at any time during the logging process, or they can automatically displayed at each sample point. This gives a real-time update of signal parameters, whilst logging a particular geographic area.

With it's auto incrementing file name feature, a large area can be mapped with ease, with all results saved to hard disk.

GPS Google Earth Mapping





The iLog software includes GPS decoding to the NMEA global standard. It will automatically scan the PC for any connected GPS NMEA compliant devices. Google Earth .kml files are generated for GPS tagged field measurement.
The TS9085G and TS9065G units are supplied with their own SiRFstarIII USB GPS magnetic receivers.

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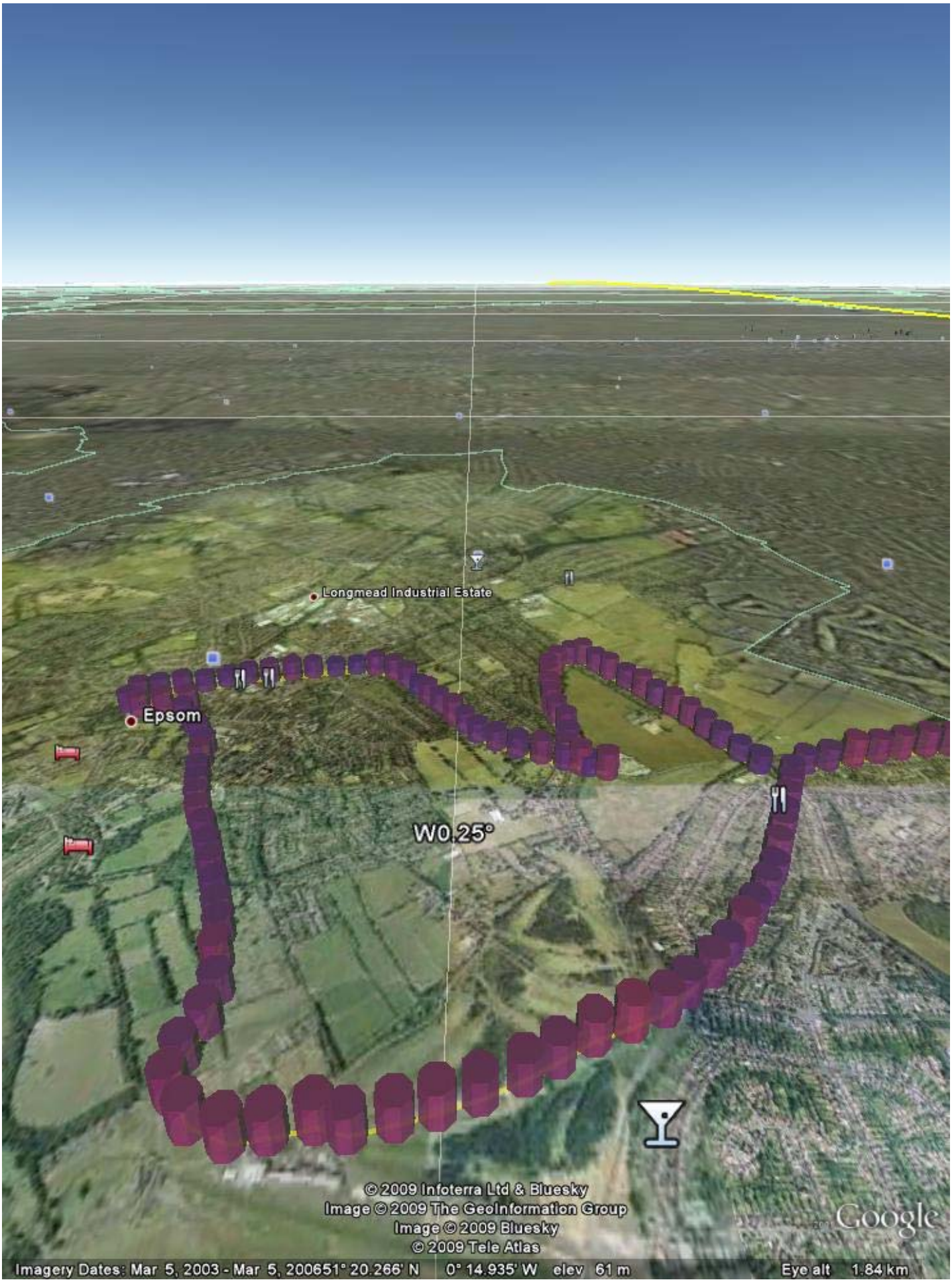
GPS Google Earth Mapping



iLog Remote Control

Background:

We have many requests to control the TS9085 from remote software. This has been possible in the past by providing the USB software protocol for the hardware. However, the control commands and the complexity of the returned data has posed considerable problems for would-be software developers. To solve this a new and extremely simple shared text file system has been introduced into the iLog software.

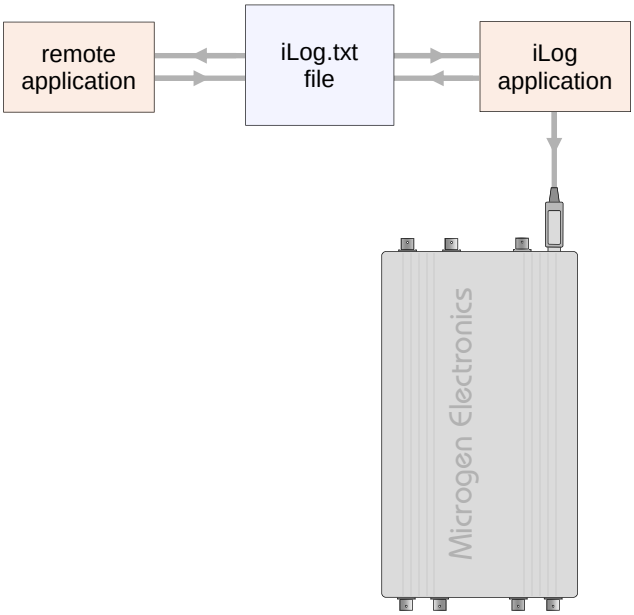
Basic operation:

When the iLog application is run, it automatically generates a simple text file called iLog.txt

An application can now control the TS9085 or TS9065 by writing a single line of text to this file.

The iLog application automatically reads this line of text every 1 to 100ms, executes its commands and returns an acknowledge by overwriting this control text with an 'action complete code'.

If the application has requested data, the iLog application will write this data back as a single line of text.



To control the TS9085 and TS9065

Tx=Control code, frequency, attenuator, volume, screen size, clear histogram, clear modulation power
Control code: 2
Frequency: frequency x100
Attenuator: 0=0dB 1=-10dB 2=-20dB 3=-30dB
Volume: 0 to 63
Screen size: 0: normal large screen 1: collapsed small window
Clear histogram: 0: clear histogram data 1: normal operation
Clear modulation power: 0: clear modulation power data 1: normal operation

Example:
Tx=2,9580,2,40,1,0,0 This will set frequency to 95.8MHz, attenuator -20dB, volume 40, small screen, and clears histogram and power

To receive data from the TS9085 and TS9065:

Tx=3 This will request to receive information, in the format:

Info: frequency, PS, PI, signal strength, pilot level, rds carrier, multipath level, average modulation power, time, date,TA

Example:
Info: 95.80 MHz,CAPITAL,C586,72.6 dBu,6.45 kHz,2.47 kHz,1.2 dBu,3.86 dBr,20:33:54,Tue 17th Mar 2009,0

TS9085 and TS9065 what's the difference?

	TS9085	TS9065
Digital phase demodulator	yes	no
Baseband spectrum analyser	yes	yes
Wideband IF	yes	no
Narrowband IF	yes	yes
IF BNC input	yes	yes
IF BNC output	yes	no
Hardware stereo decoder	yes	no
DSP linear phase stereo decoder	yes	yes
Stereo monitor amplifier	yes	no
Balanced stereo output	yes	Unbalanced via Sound card
Headphone output	yes	via Sound card
Sampling depth	16 bit	16 bit
Sampling rate	200kHz	200kHz
Multipath measurement	yes	yes
MPX accuracy @100kHz dev	+/- 0.5 kHz	+/-1.5 kHz
Sub-carrier accuracy	+/- 2.0%	+/- 3.5%
MPX distortion	0.015%	0.25%
MPX BNC input	yes	yes
MPX BNC output	yes	yes
MPX input attenuator	yes	no
Alarm BNC output	yes	yes
Antenna attenuator	-10/-20/-30dB	-10/-20dB
Signal strength range	5 to 85dBu	5 to 85dBu
Precision Audio 100dB analyser	yes	yes
Digital audio sampling	yes	yes
Audio streaming and recording	yes	yes
Modulation Power measurement	yes	yes
High quality aluminum enclosure	yes	yes
GPS option	yes	yes
GPS Google Earth live tracking	yes	yes

TS9065 overview:

The TS9065 unit has been designed as a low cost alternative to the TS9085.

It gives up the digital phase demodulator for a temperature compensated FM discriminator. This has higher distortion, but is still respectfully low for this class of instrument and sacrifices nothing in terms of signal to noise ratio.

The hardware stereo audio channel has also been removed, but stereo audio monitoring is still available via the USB link to the iLog application. This employs the advanced DSP stereo decoder, as used by the TS9085. The majority of audio monitoring is achieved with headphones, and as most recent PC's or laptops come with integrated sound, they have a headphone socket for this purpose.

It should be noted that the TS9065 relies on it's DSP software to decode the stereo signal. It therefore requires a reasonably fast PC to achieve this without interruption of the audio signal. For this reason it is recommended that the unit be run on a machine with a 2GHz or above processor.

Full USB signal recording to hard disk has been retained so off-site measurements can be made. These recordings can be replayed back at base to assess signal parameters.

We have kept the sampling depth the same at 16bits, so TS9065 users still have access to the high performance audio spectrum analyser.

The latest iLog application V5.00 will run either the TS9085 or the TS9065, so current users will be familiar with the interface.

The new GPS mapping feature is identical for both units. For signal strength measurements there is no difference between them, except the TS9065 attenuator has a –20dB maximum.

Both the TS9085 and the TS9065 are housed in the same high-quality aluminium enclosure.

For a quick assessment of the differences between the units see the table listed here.

TS9085 I/O connections

I/O connections front:

- BNC multiplex signal unbalanced output.
- BNC analyser input, for external multiplex signal or any AF signal for evaluation with the internal Spectrum Analyser.
- BNC alarm output. This will sink 10mA.
- BNC IF 10.7MHz filter out. This is the signal fed to the internal IF log amplifier.
- 3.5mm jack for AF stereo headphone monitoring.
- USB power blue LED

I/O connections rear:

- BNC 50 ohm unbalanced antenna input.
- BNC External IF 50 ohm 10.7MHz input
- BNC RDS 57kHz band-pass output
- 3.5mm stereo jack balanced output for left and right channels. These outputs are designed to be very low impedance, for driving balanced line or loudspeakers.
- USB connector. This is compatible with USB1.1 and USB2 standards. The unit is powered from this. All control and data signals are fed to and from this connector.

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- BNC 50 ohm unbalanced antenna input.
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TS9085 TECHNICAL DATA

System Measurements:	
Deviation:	+100kHz to -100kHz
Modulation Power:	-8dBr to +12dBr (0dBr ref 19kHz)
Pilot 19KHZ:	dB or %
RDS carrier 57KHz:	dB or %
Signal Strength:	85dBu full scale range
Multipath:	10dBu full scale range
Stereo:	0 to 100% modulation

Multiplex signal:	
Bandwidth: wideband	0.1Hz to 80kHz < 0.4dB 0.1Hz to 100KHz < 1.0dB
Bandwidth: narrowband	0.1Hz to 80kHz < 1.0dB 0.1Hz to 100KHz < 4.0dB
Deviation accuracy:	0 to 75kHz < +/-0.5% (1kHz test sinusoid)
Sub-carrier accuracy:	+/-2.0% Wideband +/-3.5% Narrowband

System parameters	Min	Typical	Max	Units
RF Bandwidth	87.5	-	107.95	MHz
Input impedance		50		ohms
Image rejection		85		dB
Sensitivity		2.8		uV
RSSI resolution		0.1		dB
RSSI accuracy			+/-2.0	dB
Multipath resolution		0.1		dB
Pilot 19KHz range	18.95		19.05	kHz
RDS 57kHz range	55.5		58.5	kHz
THD narrowband THD wideband		0.100 0.015		% @ 1kHz
Stereo cross-talk		42		dB

Signal connections: TS9085
Front connections:
BNC 50 ohm IF filter output 100mV RMS at 10.7Mhz with 80dBu antenna signal
BNC MPX multiplex. Output 50ohms 0dBm at 75KHz
Jack 3.5mm Stereo monitor for headphone listening
BNC 50 ohm Alarm 10mA output
BNC 50 ohm IF input at 10.7MHz
BNC Analyser input >10Kohms 0dBm (FM multiplex or audio spectrum analyser)
Rear connections:
BNC Antenna input 50ohms
USB 1.1 and 2 compatible (Not suitable for non-powered hubs)
Jack 3.5mm Left channel balanced output
Jack 3.5mm Right channel balanced output
BNC RDS 57kHz band-pass output

Dimensions: TS9085
295mm x 147mm x 36.5mm
Weight 1.1 Kgm

Spectrum Analyser:	
Resolution	16 bits
Input impedance	10K ohms
Input attenuator	+/-10dB
Dynamic Range:	>100dB
Dynamic Range Averaged:	>110dB
Bandwidth	100kHz
Resolution:	20Hz

Screen resolutions:	
XGA	1024 x 768
WXGA	1280 x 800
SXGA	1280 x 1024
WXGA+	1440 x 900
SXGA+	1400 x 1050
UXGA	1600 x 1200
WSXGA	1680 x 1050
WUXGA	1920 x 1200

System requirements:
TS9085 iLog software runs under Windows98/2, Me, 2000, XP, Vista and Windows7. Minimum usable system: Windows98/2 running on a 1.5 GHz Celeron. Recommended system: XP, Vista or W7 2+ GHz Pentium/Athlon.
Temperature: Operating: 5degC to 40degC Storage: -10degC to 50degC

TS9065 TECHNICAL DATA

System Measurements:	
Deviation:	+100kHz to -100kHz
Modulation Power:	-8dBr to +12dBr (0dBr ref 19kHz)
Pilot 19KHZ:	dB or %
RDS carrier 57KHz:	dB or %
Signal Strength:	85dBu full scale range
Multipath:	10dBu full scale range
DSP stereo:	0 to 100% modulation

Multiplex signal:	
Bandwidth: narrowband	0.1Hz to 80kHz < 1.0dB 0.1Hz to 100KHz < 4.0dB
Deviation accuracy:	0 to 100kHz < +/-1.5% (1kHz test sinusoid)
Sub-carrier accuracy:	+/-3.5%

System parameters	Min	Typical	Max	Units
RF Bandwidth	87.5	-	107.95	MHz
Input impedance		50		ohms
Image rejection		85		dB
Sensitivity		2.8		uV
RSSI resolution		0.1		dB
RSSI accuracy			+/-2.0	dB
Multipath resolution		0.1		dB
Pilot 19KHz range	18.95		19.05	kHz
RDS 57kHz range	55.5		58.5	kHz
THD		0.25		% @ 1kHz
DSP stereo cross-talk		40		dB

Signal connections: TS9065
Front connections:
BNC MPX multiplex. Output 50ohms 0dBm at 75KHz
BNC 50 ohm Alarm 10mA output
BNC 50 ohm IF input at 10.7MHz
BNC Analyser input >10Kohms 0dBm (FM multiplex or audio spectrum analyser)
Rear connections:
BNC Antenna input 50ohms
USB 1.1 and 2 compatible (Not suitable for non-powered hubs)
BNC RDS 57kHz band-pass output

Dimensions: TS9065
295mm x 147mm x 36.5mm
Weight 1.1 Kgm

Spectrum Analyser:	
Resolution	16 bits
Input impedance	10K ohms
Dynamic Range:	>100dB
Dynamic Range Averaged:	>110dB
Bandwidth	100kHz
Resolution:	20Hz

Screen resolutions:	
XGA	1024 x 768
WXGA	1280 x 800
SXGA	1280 x 1024
WXGA+	1440 x 900
SXGA+	1400 x 1050
UXGA	1600 x 1200
WSXGA	1680 x 1050
WUXGA	1920 x 1200

System requirements:
TS9086 iLog software runs under Windows98/2, Me, 2000, XP, Vista and Windows7. Minimum usable system: Windows98/2 running on a 1.5 GHz Celeron. Recommended system: XP, Vista or W7 2+ GHz Pentium/Athlon.
Temperature: Operating: 5degC to 40degC Storage: -10degC to 50degC

SiRFstarIII GPS receiver USB specification

Electrical characteristics	
GPS chipset	SiRFstarIII e/LP
Frequency	L1, 1575.42MHz
C/A Code	1.023 MHz chip rate
Channels	20 all-in-view tracking
Sensitivity	-159dBm
Accuracy	
Position horizontal	5m WAAS enabled (2D RMS) 10m WAAS disabled (2D RMS)
Velocity	0.1/sec 95% (SA off)
Time	1us synchronised to GPS time
WAAS	Enabled for North America Products
DATUM	
Datum	WGS_84
Acquisition rate	
Hot start	1 sec. Average (with ephemeris and almanac valid)
Warm start	38 sec. Average (with ephemeris but not almanac valid)
Reacquisition	0.1 sec. Average (interruption recovery time)
Protocol	
Default protocol	NMEA 0183 V2.2 Secondary: SirF Binary >>position, velocity, altitude, status and control
GPS output data	Supports commands: GGA,GSA,GSV,RMC,VTG,GLL
GPS transfer rate	Default: 4800,n,8,1 for NMEA compliance
Temperature	
Operating	-40 to 85 deg.C
Storage	-40 to 85 deg.C
Humidity	Up to 95% non-condensing
Dynamic condition	
Acceleration limit	< 4g
Alitude limit	18,000 meters max.
Velocity limit	515 meters/sec (1,000 knots) max
Jerk limit	20 m/sec
Low noise amplifier	
LNA amplifier gain	27 dB typical
Filtering	-25dB (>100MHz)
Output VSWR	2.0 max.
Power	
Voltage	4.5 to 5.5 volts DC
Current	80mA typical
Physical characteristics	
Dimensions	53 mm dia. x 19.2 mm
USB cable length	1.52 meter

GPS LED status	
Steady ON	No GPS fix with satellite signals
Flashing	GPS position if fixed (Signal received)