RX014
User Manual

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PREFACE

Thank you for purchasing the RX014 FM R(B)DS receiver/decoder/monitor.

The RX014 will give you the opportunity to do detailed investigations on reception conditions by observing and logging detectors for RSSI, USN and Multi-path.

The RX014's small form factor and included accessories are ideally suited for checking the coverage area of a transmitter in the field; included in the package is a rod antenna with magnetic base, which attaches to the roof of your vehicle, making it easy and convenient to log the reception conditions to your laptop or notebook.

At the same time also all R(B)DS and **RDS2** data can be viewed in great detail and recorded while actual statistics and quality are shown. The RX014 data recording feature is particularly useful for later playback and investigation in the laboratory.

I make continuous improvements to the RX014 Control Program and updates are available from the download page on the web-site www.RX014.com
As always, updates and new Control Program versions are free for products developed and manufactured by MacBe bv.

This manual refers to firmware and GUI versions 1.9 and later. The latest GUI can always be downloaded from the site (www.RX014.com) and should you require a firmware update, just drop me an e-mail and I'll send you a special program with instructions to update your unit.

I hope you will enjoy using your RX014 as much as I did designing it.

Joop Beunders

MacBe bv NL

www.MacBe.nl
www.RX014.com

DOCUMENT PURPOSE AND SCOPE

In this document the capabilities of the RX014 and the functionality of the Control Program are described.

To get the most benefit from your RX014, I recommend you read through the specifications of the RDS system which is described in the document "IEC 62106 ed2:2009" and the RBDS specification in document "US NRSC-4-B". In June 2016 the RDS specification is updated and now also includes the RDS2 system.

Both documents are included on the installation disk.

The RBDS Specification can also be freely downloaded from the following:
http://nrscstandards.org/standards%20accept/standards-download%20NRSC-4-B.asp

Unfortunately the RDS specification is still not freely available, but can be obtained via the following:
http://webstore.iec.ch

Some PTY codes of the RBDS system were modified in 2011 and more information on these changes can be found on:
http://www.radioworld.com/article/new-program-codes-for-rbds-hd/273648

PROGRAMMERS INFORMATION

Since the product communicates with the PC using an HID interface, it is possible to capture the data directly using additional programs. Also, experienced software developers can write applications to control an RX014 using its API. All details related to this functionality are described in a separate document called RX014-API, freely available from the **www.RX014.com** web site.

INSTALLATION

Before starting, please check the contents of the RX014 package. On the box and inside is a listing of everything that comes with your RX014 purchase. If your package is not complete, please let me know immediately via email to **info@RX014.com**

The actual installation is simple and straightforward.

Plug the RX014 unit into a free USB slot. If needed, you can use the USB extension cable which is also supplied in the package.

Microsoft Windows® will recognize a new HID device and "install" it, which might take a few seconds. No drivers are required! During that time you can attach the antenna or use the supplied coax cable to connect the RX014 to your existing antenna system using one of the supplied adapters.

On the memory stick is a setup file which should be run to install the RX014 GUI on your hard drive. An icon named RX014 will be created. Click on that icon to start the RX014 GUI.

ABBREVIATIONS

Abbreviation	Meaning
GUI	Graphical User Interface (= the Control Program)
CRC	Cyclic Redundancy Check
NMEA	National Marine Electronics Association
RSSI	Received Signal Strength Indication
USN	Ultra Sonic Noise
WAM	Wide band AM or Multi-path
IF	Intermediate Frequency
EAS	Emergency Alert System
EWS	Emergency Warning System
R(B)DS	Radio (Broadcast) Data System
RDS2	Improved version of the R(B)DS system, where 3 additional carriers are inserted into the multiplex
AF	Alternative Frequency
PI	Programme Identification
PTY	Programme TYpe
PS	Programme Service name
LPS	Long Program Service name
RT	Radio Text
eRT	enhanced Radio Text using the UTF-8 coding system
RT$^+$ & eRT$^+$	(enhanced) Radio Text Plus: tagging system for radio text
TP	Traffic Programme
TA	Traffic Announcement
ODA	Open Data Application
ECC	Extended Country Code
EON	Enhanced Other Networks
MAF	Mapped Alternative Frequency
TMC	Traffic Message Channel

LTN	Location Table Number
TISA	Traveler Information Services Association
FIPS	Federal Information Processing Standard

1. MAIN WINDOW

When you click the RX014 icon on your desktop, the main window of the Control Program will appear and will look like in the figure below, when no antenna is connected or station is received:
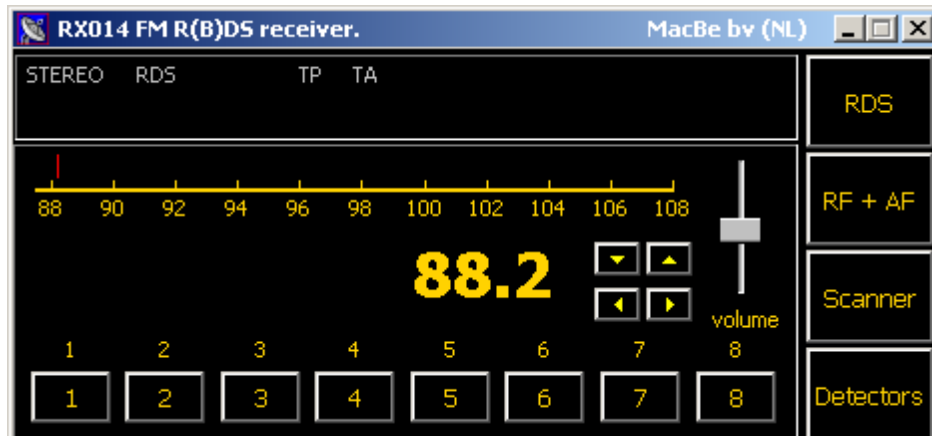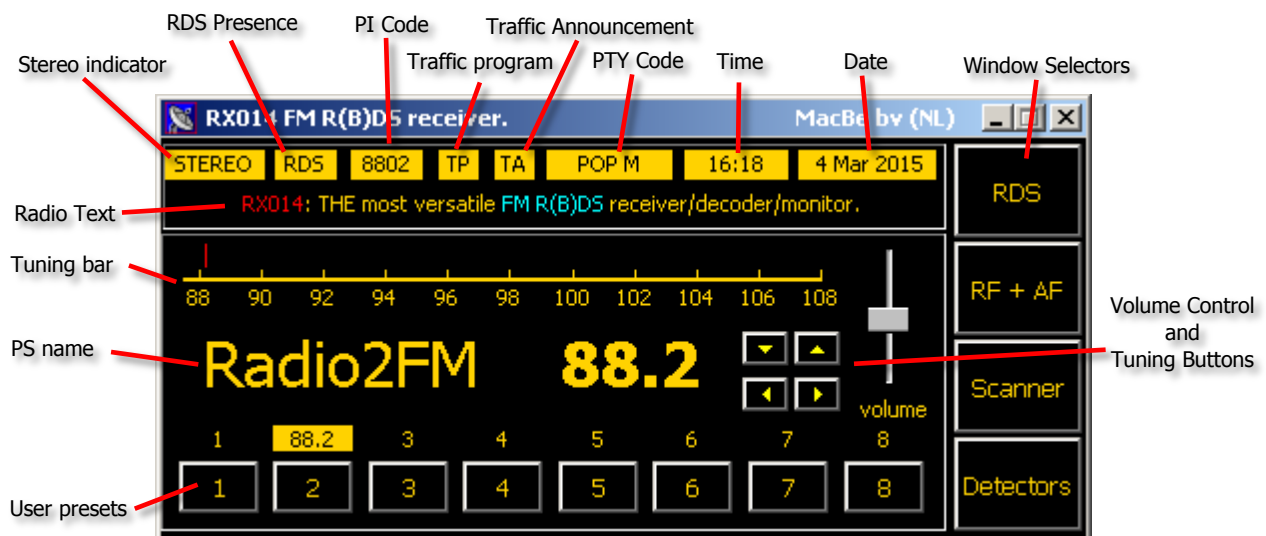
Figure 1. *RX014 GUI on Startup.*

Figure 2A.
Display when the RX014 is tuned to a station that is transmitting RDS data.

When tuned to a station which transmits RDS2, the upper section of the window may look like:

Figure 2B.
Display when the RX014 is tuned to a station that is transmitting RDS2 data.

In this figure streams 0..2 are receiving and decoding R(B)DS data.

1.1.   RECEIVER CONTROL

Tuning

Tuning to a station may be accomplished in several ways:

1.   Use the mouse to hover over the tune bar. A small balloon will show the exact frequency where the receiver will tune to when the left mouse button is pressed.

2.   Click on the large frequency indicator in the center of the screen. A calculator style window will pop up and you may enter a valid frequency manually. Valid means between the upper and lower limit of the tuning range.

3.   Use the up and down buttons to step in grid steps through the band.

NOTE: When clicking with the right mouse button, tuning will be using steps of 10 kHz. The frequency display will turn red as a warning that tuning in OFF grid.

4.   To let the receiver find the previous or next station that meet your requirements (see Chapter 3), use the left and right buttons.

5.   When a specific frequency has been stored, you can select it by clicking on the button. The indicator above will light up as confirmation showing the tuned frequency (In Figure 2, 88.2 MHz is displayed).

Presets

Up to 8 frequencies may be stored for easy later retrieval using the 8 preset keys. Initially the indicator above the keys will show the numbers 1..8 as in the Figure 1. This means that no frequency is stored and a mouse click on such a key will have no effect.

When you want to store a frequency in a preset, click and hold down the mouse button over the preset button (the key turns yellow) and then release when indicator shows the tuned frequency and the key color returns to black.
A confirmation tone will be heard.

Volume

   The audio level may be changed by sliding the volume control (right next to the tuning buttons) up and down. By clicking on the word **volume** below the slide bar, the function may be toggled to mute the RX014 headphone output without affecting the volume level setting.

This completes the tour of the general control of the RX014. I expect the RX014 often will be used in a vehicle, so mouse control is not always easy. Therefore, several functions may also be controlled via the keyboard.

Keyboard control

Volume	Function key **F1** to decrease the volume level Function key **F2** to increase the volume level
Mute	**TAB** key toggles the mute function
Step UP	**UP** arrow key
Step DOWN	**DOWN** arrow key
Search UP	**RIGHT** arrow key
Search DOWN	**LEFT** arrow key
Manual entry	The **SPACE** bar will invoke the calculator type entry.
Station Presets	Press number key 1 through 8 on the main keyboard (not the keypad)

1.2.   INDICATORS

Indicator Bar

When tuned to a station broadcasting in stereo (yes, there are still operators who only use mono) the top left STEREO indicator will light up.

When also R(B)DS data is received, the RDS indicator will light up to indicate "something" is being broadcast.

The part that is supposed never to change in an R(B)DS data stream is the so called PI code, which is the next indicator 8802 (short for **P**rogramme **I**dentification). This is a unique code identifying the actual programme that is being listened to. In Europe this code is widely used for the "Keep Tuned" feature; in the USA the code is translated into the call sign of the station. Further details can be found in the RDS and RBDS specifications.

Some stations give more or less regularly traffic information. They can indicate that in the R(B)DS data stream by setting the TP flag TP (**T**raffic **P**rogramme).

When an actual traffic message goes on air also the TA flag may be set TA (**T**raffic **A**nnouncement). Many consumer radios will react to the presence of both flags by increasing the volume level temporarily to make sure the listener will get the message. Should he be listening to another source (CD, USB stick, …) many consumer receivers will then activate the receiver as source for the duration of the announcement. This is either a fine feature or annoyance depending on your point of view.

The next important item is the **P**rogramme **TY**pe indicator: POP M 30 different types of programmes can be signal led with this PTY indicator, like Pop Music, Classics, Sport, News, and so on. Some consumer radios have the option to set a specific PTY code in the search algorithm, so the radio will only stop at stations which match that PTY code.

Unfortunately not all operators are using this very valuable option.

Most operators also send the time 17:23 and date 4 Mar 2015 information on the R(B)DS data stream. Unfortunately however, the values cannot always be trusted. According to the specifications the time and date information should not only be correct but also sent once per minute ON the minute so receivers may apply an exact synchronization.
The goal is to send the time, date, and time zone, so wherever you take the radio, it will always show the correct time and date.

In the left middle center of the window, the **P**rogramme **S**ervice name (PS) is shown. This is an 8 character identity of R(B)DS intended to make stations more recognizable. Unfortunately, lots of operators sell this bandwidth to put very short advertisements on air, and the original intent of the PS feature vanishes.

Nowadays however, most consumer radios have larger displays and the introduction of RT+ (see Radio Text below) has increased the ability to advertise on the FM radio display.

When the RX014 is tuned to a station which broadcasts RDS and RDS2 data, the indicator bar will change to:

showing in this case that all 4 streams (0..3) are receiving data.

Radio Text

Just below the indicator bar, space is reserved for the Radio Text (RT) information as shown below:

Originally RT was just a line of text with a maximum length of 64 characters. Since the introduction of RT+ however, the texts can be made much more meaningful as parts of the text can be tagged and given one of 64 identities, so receivers can show advertisements, artist name and song title, URLs, and so on.

In each line of text, two parts of the text can be tagged as shown below

Naturally, the RX014 R(B)DS decoder incorporates this RT+ technology.

The latest improvement is the use of enhanced Radio Text or eRT. In eRT characters are coded using the UTF-8 coding scheme, which allows the presentation of text in all languages as shown below. Further details can be found in the RDS specification of 2016.

Selector buttons

On the right side of the window are 4 selector buttons. Each of these buttons shows or hides its respective window where more in-depth information is displayed.

RDS	When the **RDS** button is clicked, a new tabbed window will open where all RDS parameters can be studied in great depth.
RF + AF	When the **RF + AF** button is clicked, a window will open where the RF parameters are shown in a graphical form. Every 200ms (approximately) a sample of the RF conditions is taken and shown in the graph. If Alternative Frequencies are present, AF update results may be shown as well.
Scanner	The scanner opens when clicking the **Scanner** button. A graph can be made of the full FM landscape. Also a full RDS scan can be made, where for each station the PI and PS are evaluated. Also the "live update" feature can be found in this window: A continuous landscape updated every second!
Detectors	Finally the detectors window opens after clicking the **Detectors** button. Each detector, RSSI, USN, WAM, IF offset and modulation is shown in this window and also updates every 200ms. In this window, the user search preferences may be set.

In the following chapters, each of these windows is described in detail.

2. DETECTOR WINDOW

Approximately every 200 ms an RF sample is taken by the RX014 firmware and sent to the GUI, which displays it to you as shown in the figure below.

Figure 3. *The Detector Window*
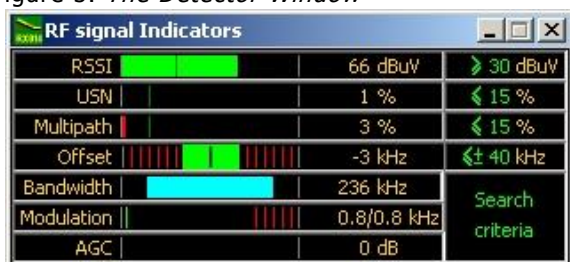
The data is not only shown in a bar graph style but also in text for easier comprehension. The small, vertical, 1 pixel wide lines inside the bars indicate the RX014's current search values that caused a scan to stop at that station.

The USN and WAM indicators will hardly ever have a constant value of 0; both have a very high sensitivity so a low level indication can be caused by the modulation itself.

USN or Ultra Sonic Noise is usually caused by the presence or modulation of neighboring stations. Also co-channel stations can cause high USN distortion. A co-channel station is a station transmitting on the exact same frequency, but with another audio content.

WAM or Wide band AM but better known as Multi-path is caused by the effect that the antenna receives signals from the same transmitter via more than one path, usually caused by reflections to buildings, mountains, large water surfaces or even passing vehicles.

Offset is usually caused by modulation and does not harm the audio or RDS quality as long as it is below the actual bandwidth value. Over-modulation and weak reception will create audible distortion. According to internationally accepted specifications the modulation of an FM carrier should never exceed 75 kHz. Some operators however have no qualms about going well over this value to create a "louder" audio level for the user. The offset may also be slightly off without any modulation, due to tolerances in the transmitter and/or the receiver, so 101.1 MHz is not exactly 101.1 MHz on both sides.
As long as this value is below 10..15 kHz there is no problem.

Bandwidth shows the actual and momentary value of the IF bandpass filter. Modulation of neighboring stations can cause severe distortion if the bandpass filter always has the same width. The receiver in the RX014 however has the ability to constantly adjust the bandwidth of this filter. The system is also known as the PACS system, which is short for **P**recision **A**djacent **C**hannel **S**ystem causing a variable bandwidth based on the momentary reception conditions.

Because of the presence of this system it is possible to listen to weak stations even when they are close to a strong station.

Modulation is an indication of the current modulation level. As this level shows the actual audio content it is very hard to read and therefor a small vertical bar shows the "peak" value for a few seconds. When this value often exceeds the 75 kHz limit, the operator is not working according to the standards and specifications.

AGC is an indicator for the automatic gain control of the tuner. This control kicks in at very high RF levels (>90 dBuV). Often this indicator might give an indication as to why reception f R(B)DS gets disturbed. The range of this indicator runs from 0..42 dB in steps of 6 dB.

Search Criteria are shown on the right side of the window. The values there cause the RX014 to stop at a station during a search. RSSI must be higher than the set value, USN and WAM should both be below the set level and the offset should be within the set window.

To change these values, click on the number and a calculator style window pops up that allows you to modify and save the value. These values are also saved in the non-volatile flash memory of the RX014.

3. SCANNER WINDOW

The scanner options are very powerful tools to graph the FM landscape. The screenshot below is taken at my home in Belgium using the supplied antenna which was placed at a height of 3 meters in an area with lots of trees near the Dutch border.

Figure 4. *The Scanner Window*
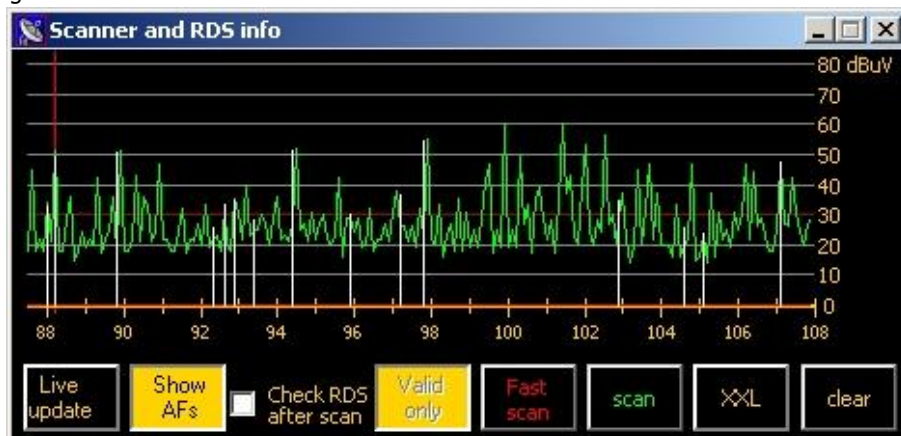
After pressing the **scan** button a graph is generated in about 10 seconds. The RX014 will step through the band in 100 kHz steps and take an RSSI sample at each step, resulting in an image similar to the one at left.

As can be seen, a lot of stations are present and shown as rather narrow "needles". This is due to the PACS system, which constantly adapts itself to the conditions found.

In fact in this picture, 28 valid stations are present which comply with RSSI >= 30 dBuV and USN and WAM both <= 15%.

The red vertical needle shows the tuned position (88.2 MHz).

As this is a Dutch national transmitter, it also transmits the Alternative Frequencies, which can be displayed by checking the **Show AFs** button. When the station has been tuned for a while, the picture will look like:

Figure 5 *The Scanner Alternative Frequency display*
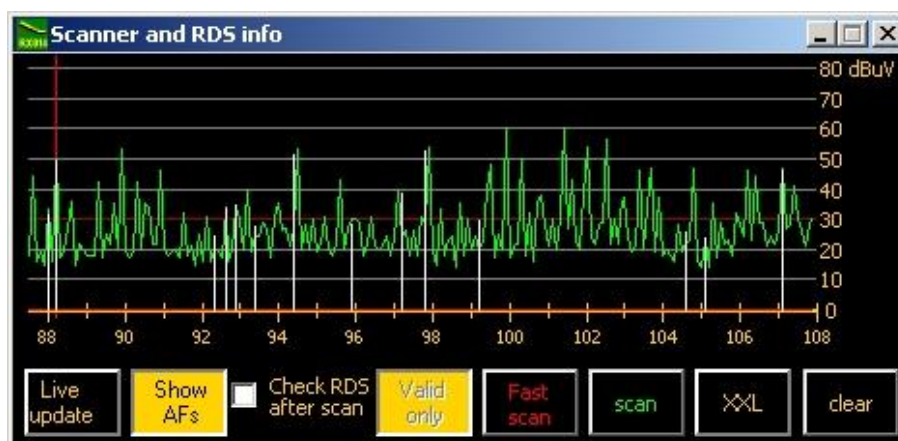
The white vertical bars are on the AF frequencies and appear after the AF has been checked at least one time. Please note that this display shows only AFs related to the station's audio programming; Alternative Frequencies for TMC and other data services are not shown in this display. These data services can be discovered using the tools within the RDS window (see Chapter *5* - RDS Window).

When the "Show AF's" button is disabled ![Show AFs], it means the function first needs to be enabled in the RX014 firmware (see Chapter *5* - RDS Window).

Being a national transmitter in the Netherlands means the program can be received in the entire country, and although The Netherlands are not very big, it cannot be accomplished by just one large transmitter. Therefor 13 AFs are present in the RDS AF list giving the frequencies of all 13 transmitters which broadcast

this same program. A car radio will check at intervals all 13 AFs and when one looks to yield a better quality, (based on RSSI, USN and WAM readings) the radio will switch to that frequency. Before staying there it will look at the PI code as both PI codes should match exactly. When a match is found the radio will stay on the new frequency and checking continues.

The first time a PI code is being checked the mute will be activated because it also could be a different station altogether and the listener would all of a sudden hear a different program. When the PI code is verified, subsequent switches will be made without activating the mute function. Different PI codes on frequencies from the AF list are often found in border areas.

When the **Check RDS after scan** checkbox is checked before activating the scan, the RX014 will check at all positions where the search criteria match, the PI code and the Programme Service name, both with a time-out. The PI code should be present within 1 second and the PS within 5 seconds. Both time-out periods are shown in a little horizontal bar above the checkbox (Red for PI check and Black for PS check). With a "busy" landscape this might take a while, but the result could be as shown below:

Figure 6. *Alternative Frequency Display with RDS after scan*
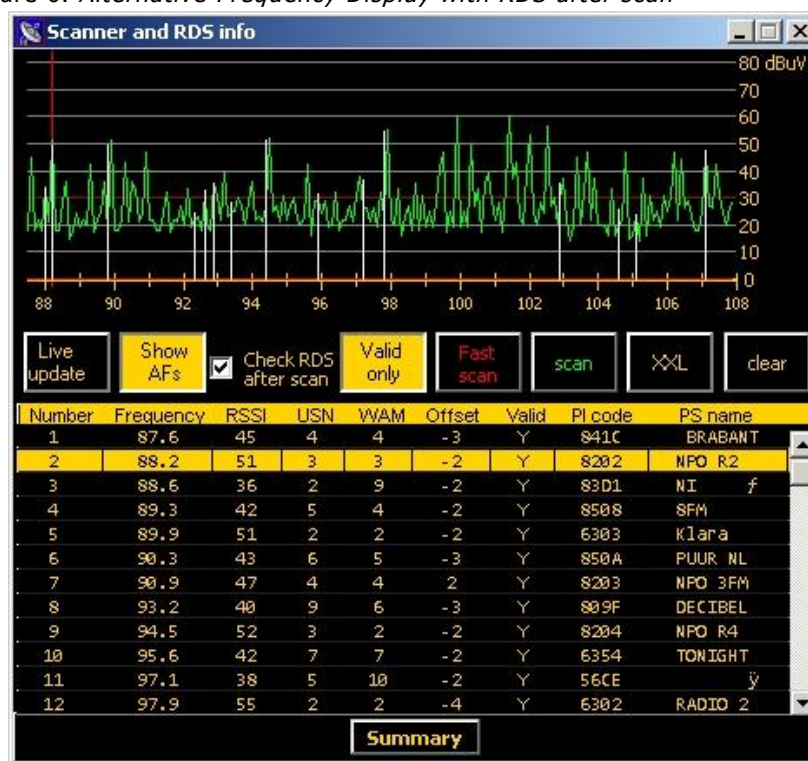

The PS is validated before being shown in the table. The RX014 decoder wants to receive 2 identical PS readings before providing it to the GUI. While waiting, every received character is shown but at the end the entry could be blank again---this often happens with stations which are using the PS as advertising or information medium.

When completely done, you may scroll through the list using the track bar on the right or the scroll wheel on your mouse.

When you hit the Summary button [Summary] you will get a list sorted on PI code as shown on the picture on the next page.

Pressing the Copy button [Copy] will copy the contents to the clipboard so it can be pasted into Word or so.
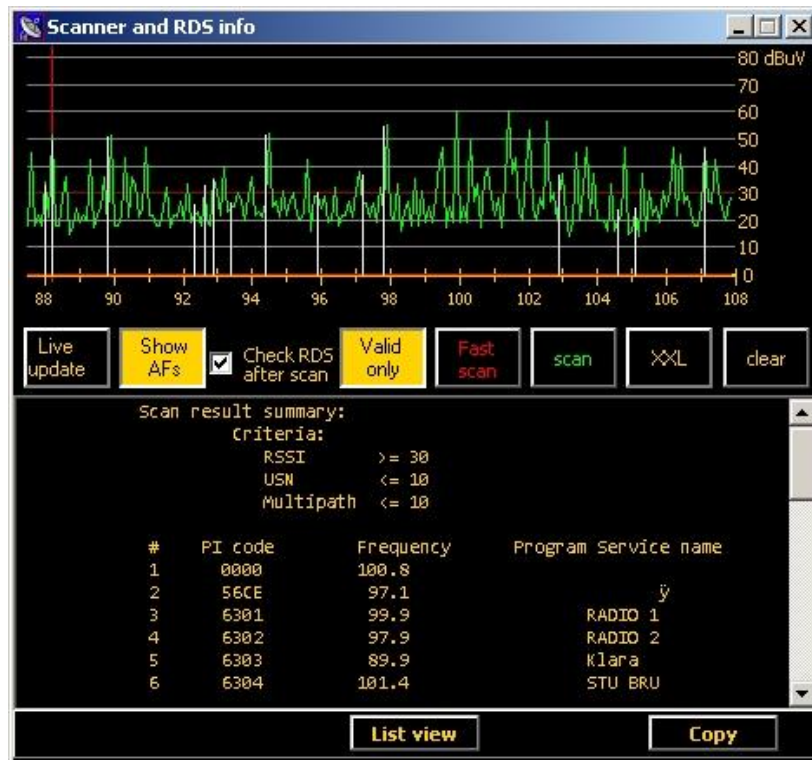
Below is the result of the copy action:

```
Scan result summary:
        Criteria:
            RSSI        >= 30
            USN         <= 10
            Multipath   <= 10

    #   PI code         Frequency       Program Service name
    1   0000            100.8
    2   56CE            97.1                            ÿ
    3   6301            99.9            RADIO 1
    4   6302            97.9            RADIO 2
    5   6303            89.9            Klara
    6   6304            101.4           STU BRU
    7   6305            102.0             MNM
    8   6306            102.5            Qmusic
    9   6353            99.5           ⊤c  Q3 c
   10   6354            95.6           TONIGHT
   11   63FF            103.4            JOE fm
   12                   103.7            JOE fm
   13   6508            103.0
   14   8059            107.4           UOS FM
   15   809F            93.2           DECIBEL
   16   8201            104.8          NPO R1
   17   8202            88.2           NPO R2
   18   8203            90.9           NPO 3FM
   19   8204            98.7             ROTRO■
   20                   94.5           NPO R4
   21   82A5            99.4             SLAM!
   22   83D1            88.6           NI      ■
   23   83E0            107.1          HORIZON
   24   841C            87.6            BRABANT
   25   841D            100.3             L1
   26   8508            89.3           8FM
   27   850A            90.3           PUUR NL
   28   D391            106.4                       ÿ
   29   ----            101.9
   30   ----            102.7
   31   ----            106.2

        31 stations found.
        28 stations with PI code.
        26 different PI codes.
         3 stations without PI code.
```

You will notice that the **scan** button caption changes to "ABORT" when the RDS features are being checked. As may be expected, the evaluation can be stopped at any time while reading RDS data by clicking "ABORT".

When the "Valid only" button is highlighted, the RX014 will only check stations that fully match the search criteria on RSSI, USN, WAM and Offset. When not highlighted only RSSI and Offset are evaluated before reading RDS data. This button will be enabled after checking the "Check RDS after scan" option.

Clicking on an entry or clicking inside the graph area will change the tuned frequency. Although a change of frequency usually means a complete reset of all RDS data, the table and scan will not be cleared as they are related to the entire FM landscape and not just to one frequency. The entries for PI code and PS name will be updated when tuned to that station in both the List as in the XXL picture (see at the end of this chapter).

When clicking the **fast scan** button, the RX014 takes a snapshot of the entire FM landscape in about 1 second. It will increment using 100kHz steps through the band and uses a different, somewhat less accurate algorithm to collect the RF data. This algorithm is called "AF update" and is also used when the AF update function is activated (see Chapter **4** RF + AF Window).

The combined picture will then look like that in the figure below:
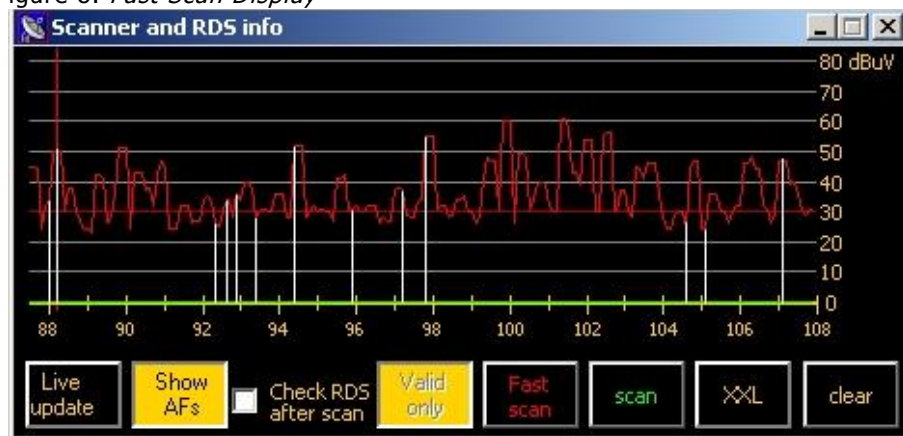
Figure 7. *Fast Scan and Scan Display*
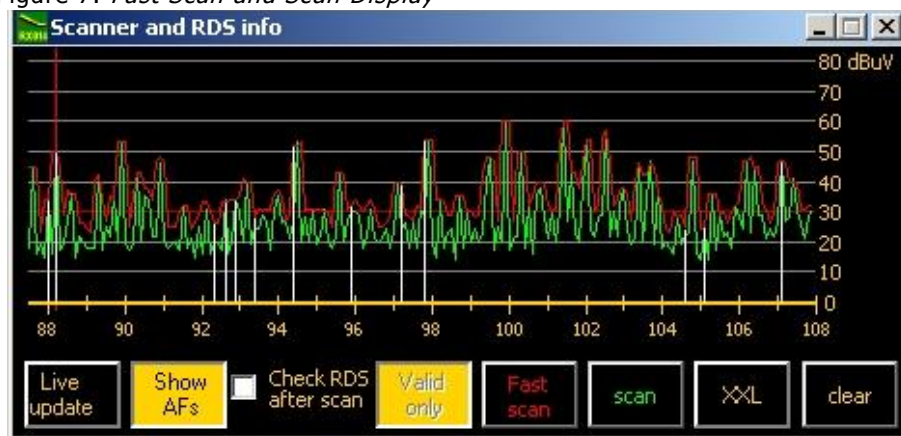
As can be seen clearly the "needles" in the red graph are just about everywhere a little "higher" and "wider" in comparison with the green graph. This due to effect that the AF update algorithm uses a fixed bandwidth.

A solitary fast scan could look like the figure below:

Figure 8. *Fast Scan Display*

Clearly less resolution, but still useful for getting a clear picture of the entire landscape in a very short time.

When the "Live update" function is selected, the graph color changes to yellow and every second a new scan is made, like below:

Figure 9. *Live Update Scan with Alternative Frequency Display*
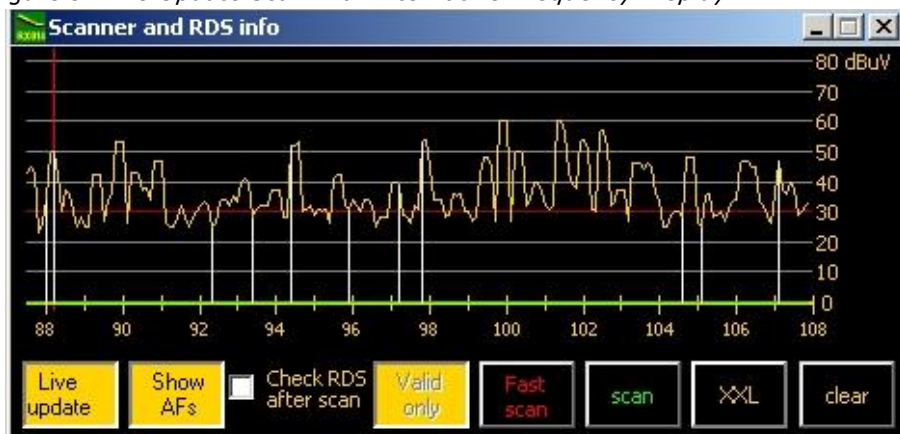
The "Show AFs" function has also been activated in this picture to show the actual usefulness when you drive around in an area where AF switches occur frequently. While driving you will see which AFs are bound to be chosen shortly.

Safety First: Needless to say that when you are doing this kind of testing, it needs to be performed by at least 2 persons:

One person <u>driving</u> and one person <u>checking</u>!

The **clear** button opens a new window where you can select what you want to be cleared, or you may cancel the clear operation.
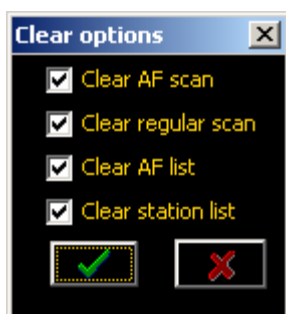

After making your selection by checking or un-checking the individual checkboxes (which speak for themselves I guess) you can either click OK or Cancel

Your checkbox selections are recalled the next time you click the **clear** button.

As an convenient shortcut, clicking the **clear** button with the *right* mouse button will clear the display without showing the clear options dialog box.

When the XXL button is pressed another, sizable window appears showing the scan results including PI codes and PS names of all stations found during the scan
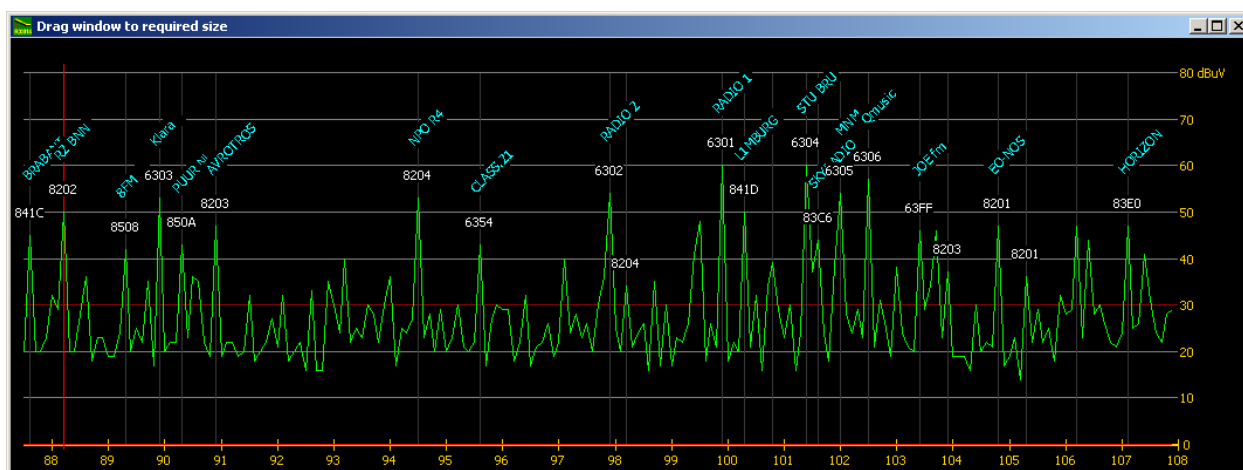

You may wonder why not all stations that rise above the search level are showing PI and PS codes. This is due to the fact that the valid stations only function was activated during the scan. "Strong" stations could easily be disturbed by USN and WAM which makes reading RDS impossible.

4. RF + AF WINDOW

The RF + AF window is *extremely* useful for road testing. Graphs are shown for RSSI, USN, WAM and RDS quality. The RDS quality graph is updated at each new arriving RDS group every 87.6 ms. In contrast, the other graphs are updated at the RX014 "usual" interval of about 200 ms. The graphs are less interesting for stationary reception. The figure below shows the detector values at some search and step events.

Figure 10. *RF+AF Events Display*
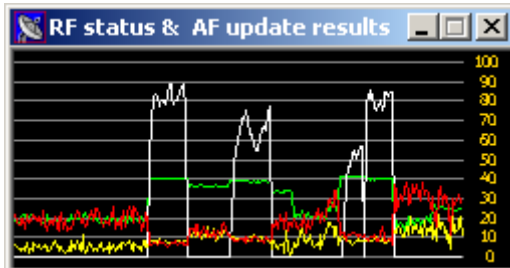
When tuned to a station which has an AF list while AF update mechanism is activated, the figure below shows the individual update processes that can be monitored.

Figure 11. *RF+AF Events With AF Display*
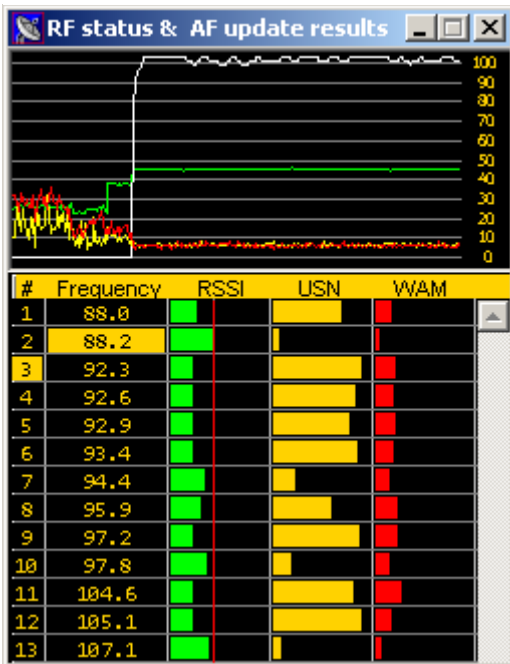
The highlighted number in the **#** column indicates which frequency is being checked/updated at that time.
The highlighted frequency in the **Frequency** column shows the tuned frequency.
When you click and hold the mouse button over a frequency in this column, the RX014 will temporarily switch to that frequency and freeze the R(B)DS database; only the PI code and PS are being read so you can make an instantaneous status check.
When the mouse button is released, the previous frequency is restored.

The next 3 columns show the last readings of the AF update mechanism. The vertical red bar in the **RSSI** column marks the actual RSSI value *of the tuned frequency*, so you can easily see if there are signals available with a higher value for the RSSI.

Combining the readings of **RSSI**, **USN** and **WAM** columns is the "magic trick" to create algorithms that seamlessly produce good audio quality while switching between transmitters. In Europe, this makes the difference between a good and a bad car radio.

When the RX014 AF update mechanism is activated samples are taken at irregular intervals from the AFs in the AF list.
The sample procedure is the following: Tune to the AF, read the detectors, then tune back to the original frequency. This procedure, often called an "inaudible update", is performed within 6 ms. In general, it will indeed be inaudible, but when broadcasting music with pure sine wave tones (violin, soprano singer, and the like), one could hear a very little "dip".

5. RDS WINDOW

In the RDS window a collection of pages is available where most if not all received R(B)DS data is presented in a easy to understand way.

Clicking the "RDS" button in the main window will open the window below:
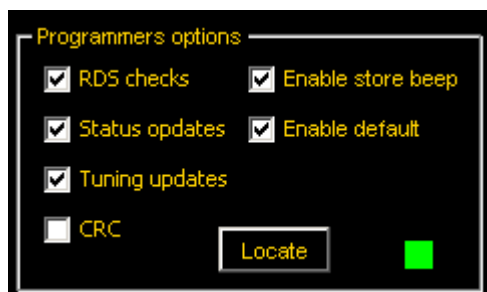
Figure 12. *The RDS Window*
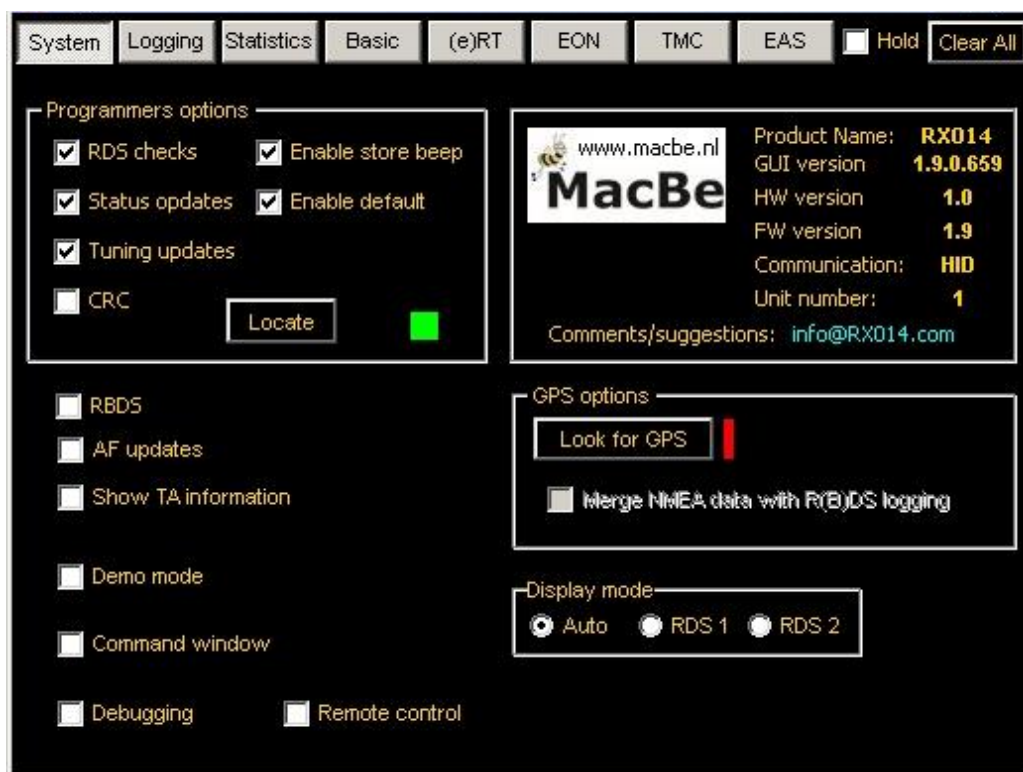
On the top of the window you will find a number of buttons, each dealing with a specific part of the program. I will describe each of these in detail in the following sections.

5.1. SYSTEM

In this window some general information is given and some "global" selections can be made.

The part at the top left is mainly intended for programmers who wish to make their own GUI using the RX014 hardware. The API describing the protocol and possibilities of the RX014 is freely available and also present on the installation memory stick. When you can talk "HID" you can communicate or follow the RX014 activities in great detail. Several parts of the firmware may be disabled in order to give your own look and feel to the RX014.

The green marker on the right shows the GUI is connected to an RX014 unit. When multiple units are connected to your PC and you want to determine the RX014 the current GUI is controlling, just click the **Locate** button and the RX014 connected to the current GUI will flash its red LED a couple of times times.
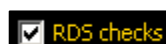
The RX014 continuously checks for new RDS data using a 40 ms timer. When a new valid group is available, it is send to the host for further processing. Some primary decoding is

done inside the RX014, such as PI code and raw PS retrieval. Also an AF list is assembled (if present) which is used for the AF update mechanism (if enabled).

☑ Status updates Using the same 40 ms timer as the RDS reader, the status update runs at a slower pace of about 200 ms. At every pass the RSSI, USN, WAM, IF offset and modulation values are read and send to the host. Disabling this and the previous feature will stop the data stream to the host, but control is still possible.

☑ Tuning updates The scan and search functions generate a different output data stream than the Status update. This function does not run on a timer but is a result of a user command.
This data package can be suspended by disabling this checkbox
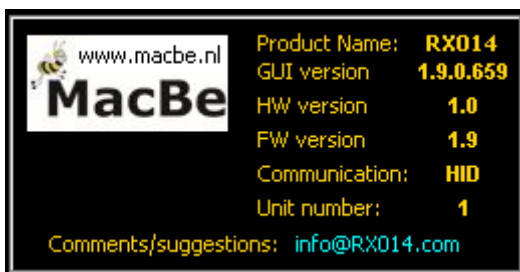
☑ Enable default When the **Enable default** checkbox is unchecked all control is disabled, not only reading but also user commands. In this state the programmer can fully control the receiver chip by sending and reading I^{2}C commands which directly control the receiver chip.
Of course, the RX014 keeps listening to USB commands.

☑ Enable store beep Every time a frequency preset is stored, the RX014 will generate a beep tone as confirmation. Unchecking the **Enable store beep** checkbox disables the beep completely and only visual feedback is shown on the GUI.
When a preset key is clicked (or the number key on the computer keyboard is pressed momentarily) the preset will turn yellow and the frequency is changed.
When the user clicks and holds the mouse button on a preset (or presses and holds the keyboard number key) after about 1 second the preset is stored in flash memory and the button color will revert back to black. The stored preset frequency is shown in the caption above the preset key.

The communication protocol which is used for the communication between host and RX014 allows using a
☐ CRC CRC check in case long and potentially unreliable layers are used. By default the CRC check mechanism is disabled in the RX014. When the CRC function is enabled both host and RX014 should check incoming packets and refuse them if the CRC code is not correct. The CRC code is the XOR value (single byte) of all bytes in the packet, without the CRC byte itself.

www.macbe.nl MacBe	Product Name:	**RX014**
	GUI version	**1.9.0.659**
	HW version	**1.0**
	FW version	**1.9**
	Communication:	**HID**
	Unit number:	**1**
Comments/suggestions:	info@RX014.com	

At the right side of the **System** tab information regarding hardware/firmware/software versions is displayed and a clickable URL link is shown for emailing product comments and suggestions to me. Clicking on the MacBe logo opens a web browser and takes you to my MacBe home page.

Using an HID protocol means other programs can communicate with an RX014 at the same time as the GUI. Likewise, all commands issued by the RX014 can be captured by other programs besides the GUI.

Replies to commands from the host are also sent to all connected RX014 receivers, but they can be directed to a specific RX014 by assigning the host command a **Unit number**. Other programs can then see if a reply is meant for them or not. The **Unit number** may be entered by clicking on the default number 1.
Any value between 1 and 64 is acceptable.

☐ RBDS The **RBDS** checkbox modifies not only the RBDS data decoding/display but the receiver behavior

as well.

In RBDS mode, the tuning range is 87.9 to 107.9 MHz using a 200 kHz grid.

In standard RDS mode a tuning range of 87.5 to 108 MHz using a grid of 100 kHz is used.

When presets are stored and you switch from RDS to RBDS mode, all presets which end on an even number will be cleared, and if the current tuned frequency is even (such as 88.2) the frequency will change.

The most important difference between RDS and RBDS is the list of PTY codes which can be found in the respective specifications. Furthermore, the use of the PI code is quite different between the 2 systems. Because of the use of networks in Europe this code is used to identify a specific programme which is broadcast on a number of transmitters (in Germany one can find AF lists with 32 entries!). In the USA the PI code is usually converted into the call letters of a specific station and not a programme. The main window will always show the PI code (in hexadecimal notation), but in case of RBDS mode, the Basic page shows the call letters of the station.

The notation of time and date, which in principle has nothing to do with RDS or RBDS, changes depending if the **RBDS** checkbox is checked or not. In general, Europe uses the "24 hour" format and a "day-month-year" notation for the date, while in the USA it is more common to use the "12 hour AM/PM" time format and "month-day-year" date format. Changing the **RBDS** checkbox will also have impact on the various indicators in the GUI.

☑ **AF updates** When a station has an AF list in the RDS data stream it can be very convenient to know the status of the various AFs while driving in an area where one can expect regular AF switches. When this checkbox is activated (it is off by default), the RX014 runs the AF update mechanism fully autonomously. The AF updates will occur at irregular intervals as regular disturbances of the audio might get audible to the user. More details on the mechanism were given in the section of the "RF + AF" window.

☐ **Show TA information** R(B)DS has a very sophisticated system to notify users of spoken traffic messages (not to be confused with the TMC system). When tuned to a station which broadcasts such messages the TP (**T**raffic **P**rogram) flag will be activated. When a message is active also another flag, the TA (**T**raffic **A**nnouncement) will be activated. To notify the receiver a message will be on air usually a burst of 15B groups will be transmitted. In such a case the receiver might turn up the volume or switch from another audio source to radio reception.

When the checkbox "Show TA information" is activated an additional window will be shown in which all burst related groups are shown:

Some stations send just a burst of a specific number of groups, others send other groups in between and so on. In this special TA window all details are shown.


In situations where stations are organized in a group or "network" (like in many countries in Europe), the service even goes further. You can tune to a station in that network which does not send traffic messages, but "knows" which stations in the network do transmit these messages. Such a station has its TA flag set permanently and receives information of the other stations via the EON channel (**E**nhanced **O**ther **N**etworks). When a message is about to go on air, a burst of 14B groups will be transmitted. Using the information from this burst and from earlier EON information, the receiver tunes to the correct station for the duration of the message and then returns to the original station. The user can of course decide whether or not he/she is interested in the messages. See also the EON tab for more information.

[✓] Demo mode In the setup package a number of prerecorded files are included which show most of the R(B)DS features. Using "Demo mode" these files can be played, thus allowing users to get acquainted with R(B)DS features which are not readily available in his/her area or even without having RX014 hardware. By default these files are played at about the same speed as the original R(B)DS system (87.6 ms/group), but the speed may be adjusted for user convenience.

[✓] Command window The "Command window" option is for experienced programmers only, who have in-depth knowledge of the receiver chip of the RX014. This option will not be further explained in this manual.
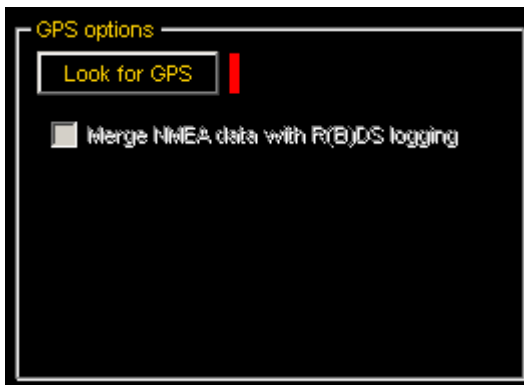
When making road tests it is often very convenient to include a GPS reader in the measuring setup. The GUI allows for this option. When a GPS device is connected to one of the COM (serial) ports or a serial USB interface attached to the PC, click the "Look for GPS" button and the GUI will try to find your device. Scanning will be done at both 4800 as 9600 Baud.

When a GPS device is found, the indicator turns green and the COM port to which the device is connected is shown together with an activity monitor which moves each time a NMEA string is received. By checking the **Merge NMEA data with R(B)DS logging** checkbox, the NMEA data will be merged with the RDS data when logging is enabled (see next tab). As can be seen, the caption of the **Look for GPS** button has changed. You can disconnect the GPS device by pressing the button again.

This is a very powerful option as RDS data and location data are recorded in the same file and are thus always synchronized within the 87.6 ms group rate of the R(B)DS system..

Remote control "Remote control" is a very powerful option of the RX014 control program. You can connect to a PC anywhere on the globe and take control of the RX014 which is connected to that PC or you can connect to the DS016, which is a docking station for the RX014, meaning no PC is required at the location of the RX014. When you press this button, the pane below appears:

The IP address of your own PC is shown at the top under "This computer". This address can be entered manually or you can press [---] to get the address of your primary network connection.

On the "Remote" PC a small "bridge" program (present in the setup package) must be running which communicates with the RX014 and "talks" to your PC using an internet connection.

In the field next to "Bridge address" you need to fill in the IP address of the "Remote" PC to which the RX014 is connected. But there is a catch. When you check the IP address of a computer you will get the address used in your own or business network. This address cannot be used as "Bridge address" (unless both PC's are on this same network). This "Bridge address" is the IP address which is assigned to your (ADSL) modem/router by your provider. A small utility, which I found on the internet, is present in the setup package to retrieve your public IP address getmyip.exe).

Finally you also need to fill in a "Port" number which is unique for your sessions with the "Remote" PC.

On the remote side (where the Bridge program is running), this port number should also be set in the configuration section of your modem/router in a chapter usually called "Port Forwarding" or something similar. In this configuration setting you "tell" the modem/router it must send all received packets which are addressed to this port number must be sent to the PC which hosts the RX014. Make sure you use a port number which is not blocked by your provider!

A similar approach should be taken when you want to connect to a remote RX014 which is plugged into the DS016 docking station. The DS016 address and port number should be identical to the values which are entered in the configuration utility of the DS016. When the DS016 is connected to the same network segment you can press the [Find] button to get the DS016 address. Port number should always be entered manually.

When done setting up the "Bridge" session, check the [Connect] checkbox in the "Bridge" section to start a remote session. When the connection with the remote PC AND the Bridge program is established the indicator light will turn orange. When the Bridge program on the remote PC is not running, the indicator will flash orange/red until the program is running and the link between both PCs is fully operational.

When you want to connect to the DS016, check the [Connect] checkbox in the DS016 section to start the session. When a connection is established the indicator will turn green. When it turns orange, most likely the port number is not correct or the DS016 is without power.

When the remote session is operational, press the [Close] button to close the remote settings window

On the right side of the window the actual connection type is shown, e.g. [Communication: DS016]

May sound complicated, but it really is not.

[Debugging] Another convenient option for the experienced programmer is the **Debugging** option. When checked, an additional window appears showing all communication between the RX014 and the GUI, including the user commands. As communications runs rather fast the user commands start with a blank line and also end with a blank line so they can be easily traced in the logging. The user may select which parts of the total data stream should be made visible. A sample is shown in the figure below:
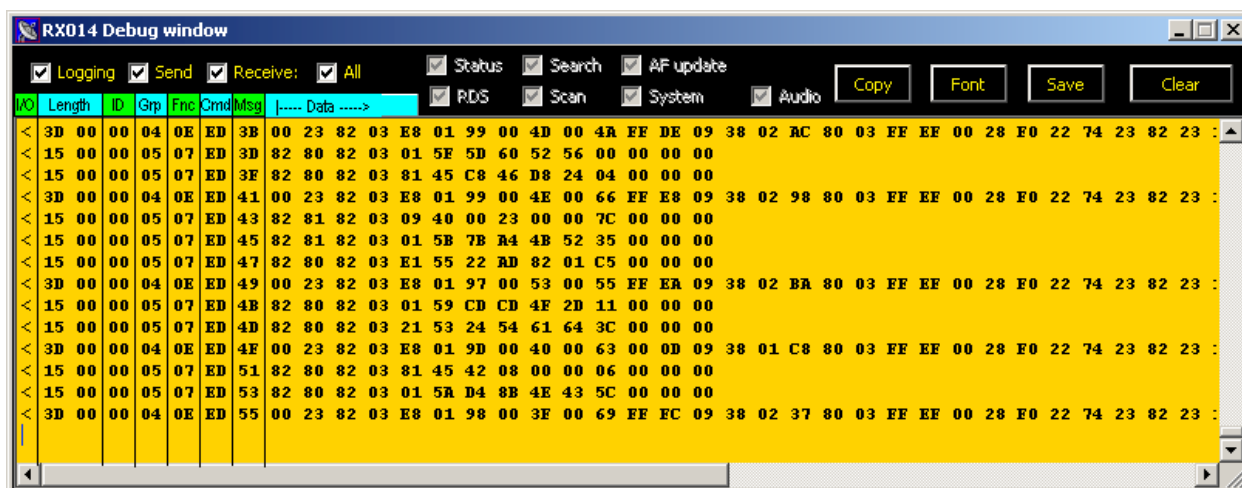
The meaning of the various logging traces is beyond the scope of this document and described in the API document. Logging traces are usually of no interest for the regular user, and are intended for software developers.

The RX014 fully supports the new RDS2 system. In the system 3 additional RDS carriers are added to the multiplex, which all can carry RDS information. To remain compatible with existing equipment, usually only

new ODA's will be used on these carriers. More information on RDS2 can be found in the RDS specification of 2016.

 The RX014 will automatically adjust several windows when RDS2 is being received. The user may however also select the lay-out manually using this selection box.

Finally at the very top right of the RDS window you'll find another 2 controls which are available from all pages:

 Pressing this button clears all received R(B)DS and RF data.

 Checking the "Hold" control stops the R(B)DS decoding system and also stops displaying RF updates. Debugging however just continues.

5.2. LOGGING

On the logging tab you'll find a number of options to log, view and filter the incoming data. This window has different views for RDS and RDS2. Functionality however is the same.

Figure 13. *The main RDS Logging Window*
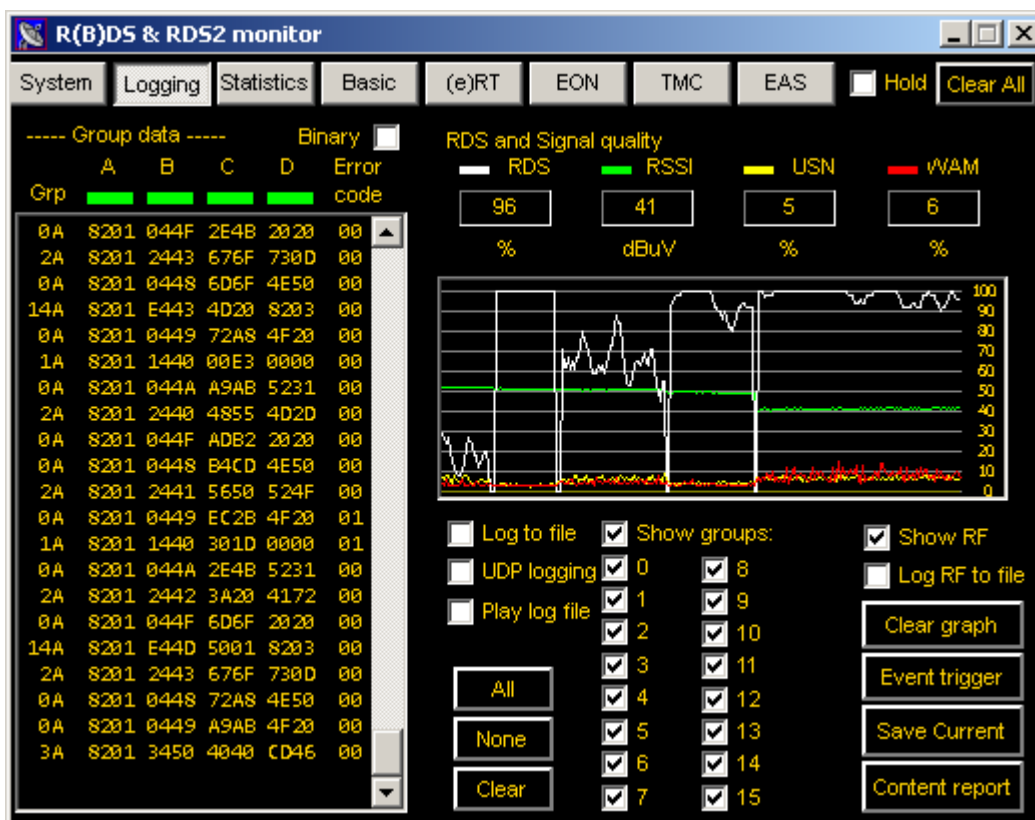
The left part of the window is reserved to show all unfiltered R(B)DS data as it arrives. The first column shows the group number and the next 4 columns show the 16 bit data from the A, B, C (or C') and D block from a single group. The last column is the error code for each block. Each block has a 2 bit error code and the "error byte" is organized as shown below:

bit 7..6: error code block A

bit 5..4: error code block B

bit 3..2: error code block C

bit 1..0: error code block D

The Error codes and indicator colors associated with block errors are listed in the figure below.

Figure 14. *The RDS Block Error codes and RX014 Error Color legend.*

00	No error; block data was received with matching data and syndrome.
01	Small error; possible 1 bit reception error detected; data is corrected.
10	Large error; theoretically correctable error detected; data is corrected.
11	Uncorrectable error; no data correction possible.

The decoding engine of the GUI only accepts error-free blocks. Although the receiver chip does handle error correction, it is in general not advised to use corrected blocks of data. The coding algorithm of the R(B)DS system is unfortunately not powerful enough to guarantee successful correction.

When you want to have a closer look at the details in the logging window, you can momentarily "freeze" the logging in the window by pressing and holding the Shift key on your keyboard and a the same time clicking inside the logging window with your mouse. The colors in the logging window will be inverted and you can scroll using the scroll wheel of your mouse. Logging will continue in the background. When done Shift-click again the logging window to revert the colors and add the logged data from the background logging to the already logged data.

Binary ☑ This checkbox is shown above the logging window. When checked a new window appears where all data is also shown in binary format and the textual data from groups 0 (PS name) and 2 (RT) is also shown as can be seen below:
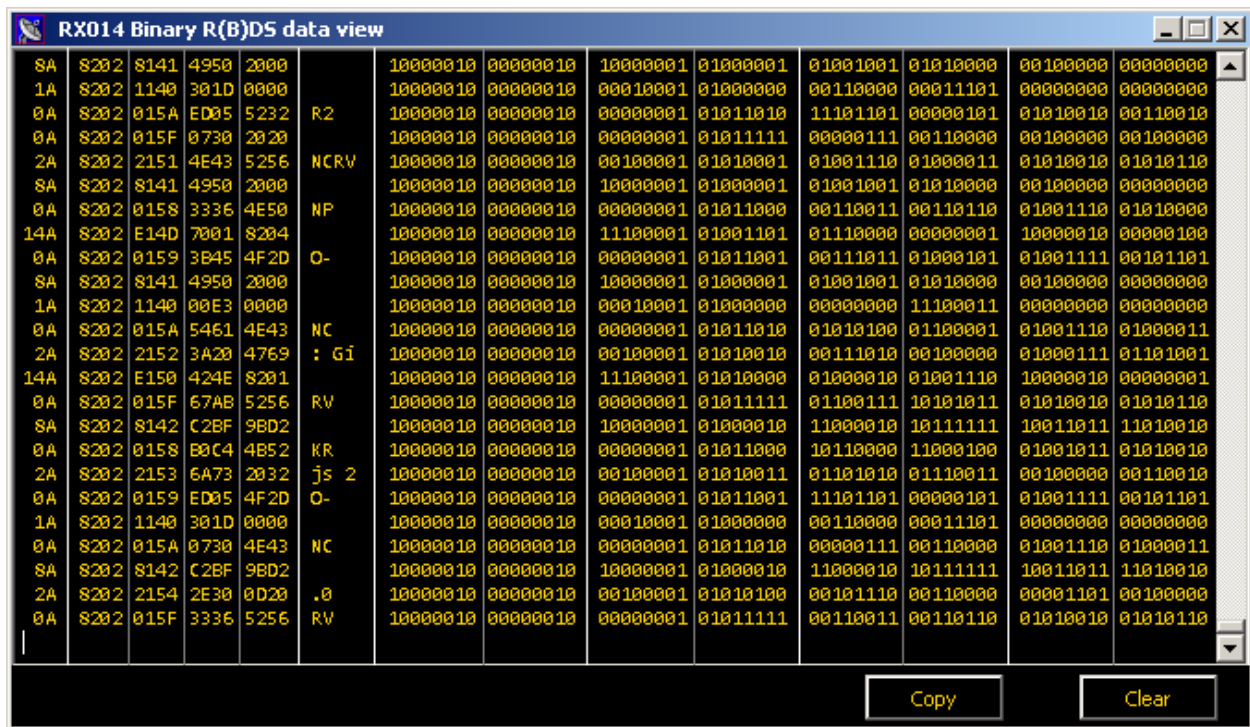
☑ Show RF While observing the scrolling data, the actual RF conditions are shown, just as on the "RF+AF" window. This option can be disabled by un-checking the **Show RF** checkbox. The RF display can be cleared by clicking the **Clear graph** button.

☐ Log to file To capture data while performing a road test for later investigation in the laboratory, just click the **Log to File** checkbox. You will be prompted to enter a filename, which defaults to the date-time-PI code of the tuned station.

To stop recording just uncheck the **Log to File** checkbox. The file stores more data than shown in the logging window; the detector values are recorded for later RF condition evaluation:

FORMAT HAS CHANGED SLIGHTLY COMPARED TO BELOW

```
8202 8144 493F 2000 00 2F 00 00 04 05 64 0   88.2
8202 2140 4156 524F 00 2F 00 00 04 04 64 0   88.2
```

From left to right the logging shows:

Blocks A, B, C, D	: 8202 8144 493F 2000
Error code	: 00
RSSI	: 2F
2 compatibility fields	: 00 00 (ensuring compatibility with the TRX011)
USN	: 04
Multipath (WAM)	: 05
RDS quality	: 64
Stream number	: 0
Tuned frequency	: 88.2 MHz

All readings are in hexadecimal notation, except for the tuned frequency.

When combined with GPS information a full picture can be made "why" at some points the signal quality might deteriorate.

When something weird or unexpected is observed while recording data, you can tag it by pressing the **F8** key. A comment marker will be placed in the log file (starting with $CMT) and a small edit window is presented which allows you to enter some text describing the phenomenon you observed. While typing, logging just continues and is never interrupted. When done, close the edit window by pressing the ESC key on the keyboard and a file is created in the same folder as the logging file with a name matching the $CMT line in the logging.

Play log file With the **Play log file** checkbox, a "prerecorded" file may be selected for playback. When using my other product, the TRX011 FM R(B)DS transceiver, the file may be used to transmit the prerecorded data via antenna. The files from both products are compatible, although the log files from the TRX011 contain less RF information.
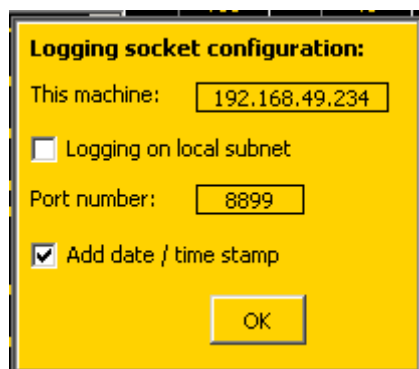
Log File format example (all data is in hexadecimal format):

A, B, C and D block data and the error code	RSSI	Not used by RX014	USN	WAM	IF offset
8202 8145 4CE0 2400 04	2C	00 00	07	07	05
8202 2144 2053 6C61 00	2C	00 00	08	07	08
8202 015F 3336 2020 00	2C	00 00	08	07	08

The values in the column labelled "Not used by RX014" are always 00 00 and exist for compatibility with TRX011 log files.

In stead of logging data to file, the RX014 can also log data to another PC via a network connection using a UDP protocol:

UDP logging When this option is selected a hew w pane appears as shown below:

Logging socket configuration:

This machine: 192.168.49.234

☐ Logging on local subnet

Port number: 8899

☑ Add date / time stamp

OK

When the machine to log to is connected to the same "subnet" (like your own or business network) select the checkbox and enter a Port number.

Additionally a date/time marker may be added to every line.

On the "other" machine another program must be running to receive the data. Name of this program is "RemoteLog.exe" and is also part of the setup package.

Address fields should be entered using the same rules as explained under "Remote control".

When properly installed a window like shown below will appear at the remote site:
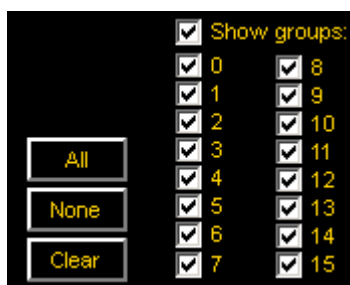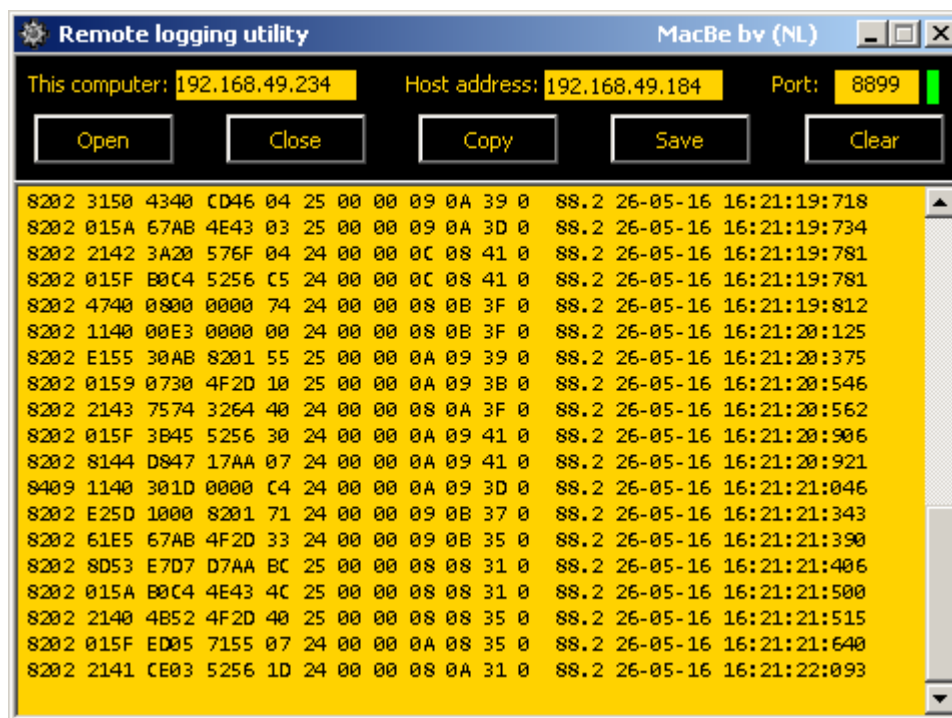
When developing ODAs or checking special R(B)DS features it often comes in handy to log only selected groups.

Selecting the different checkboxes allows you to choose which groups should be shown in the left pane and logged.
To enable or disable your selection temporarily, you can click the **Show groups** checkbox.
The **All** button selects all groups, the **None** button unselects every group, and **Clear** clears the scrolling display.
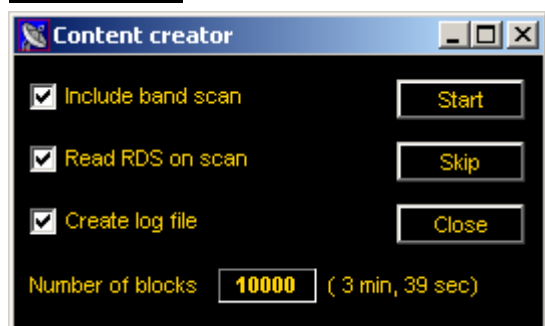
The entire R(B)DS database may be exported to a well formatted Microsoft® Excel® file. All parameters of the current status are exported in full detail. Pressing the **Save Current** button opens a window in which you can enter a filename.
The default filename is created using the date, time and PI code information.

An even more convenient logging feature is activated by clicking the **Content report** button. Using this function allows you to take a recording of a number of blocks over a period of time (as opposed to a snapshot) and save the results to an Excel file.
Clicking this button opens a **Content creator** window where the preferences for the data recording can be set. Personally, I always like to have a full and clear picture of the entire situation in the band, so the report will start with a band scan followed by an RDS scan. You may also select the **Create log file** option to store all recorded data in a file, which can be read later.
Finally, the total number of blocks to record should be entered. By default, the number of blocks is set to 10000, which makes a data recording duration of around 3½ minutes. If an operator adheres to the R(B)DS standards, all non-variable information should be transmitted within this timeframe. Scrolling PS and changing RT are *not* included in this time.
You can set your own recording duration by clicking on the **Number of blocks** value and entering a new value on the pop up number pad. The display will show the expected recording duration in minutes and

seconds.
When the **Start** button is clicked, a window appears where for selecting the filename.

When the RDS checks are in progress, you may cancel the operation and still continue with the logging by clicking the **Skip** button.
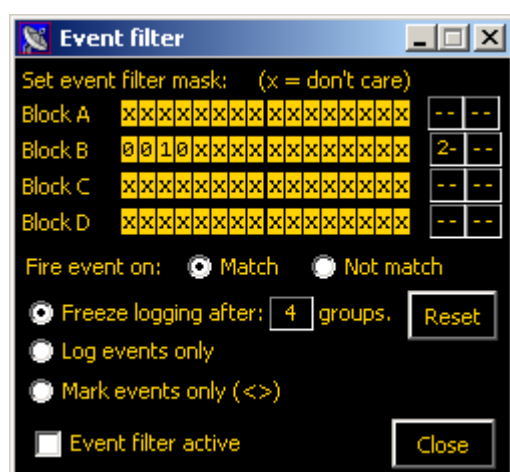
Pressing the **Close** button aborts the entire operation. The Content report configuration will be stored for the next time.

On the RX014 web site, and on the installation stick, a sample of such an Excel file can be found.

A new and very powerful feature has recently been added on customer request!

 When selecting this option a new pane is opened as shown below:

 In this window a fully programmable bit mask may be set for all 64 bits in an R(B)DS group. Each bit may be programmed to a logic "0", a logic "1" or a "don't care" (x). When a "don't care" is selection both a logic "1" and a logic "0" will match the selection.

When the entire mask has been created you may select whether the incoming data should match your mask or just the opposite ("everything but").

Also you can select whether logging should only contain masked events or you may want to "freeze" (after a programmable number of groups) an ongoing logging when a group which matches the mask is found. To start looking for the next event, just press the RESET button. Also you may just want to mark the groups that match the mask requirements. In this last case, the space between group ID and group content is replaced by "<>" for easy recognition.

Using this kind of utility enables you to find virtually all "odd" behavior of equipment or shine light on for instance invalid transmissions.

Currently this "Event trigger" option is only operational on stream 0 (main RDS carrier). All other options on the logging page are also available for RDS2 as is shown on the screen dump on the next page. All RDS data is presented in 4-fold representing stream 0..3.
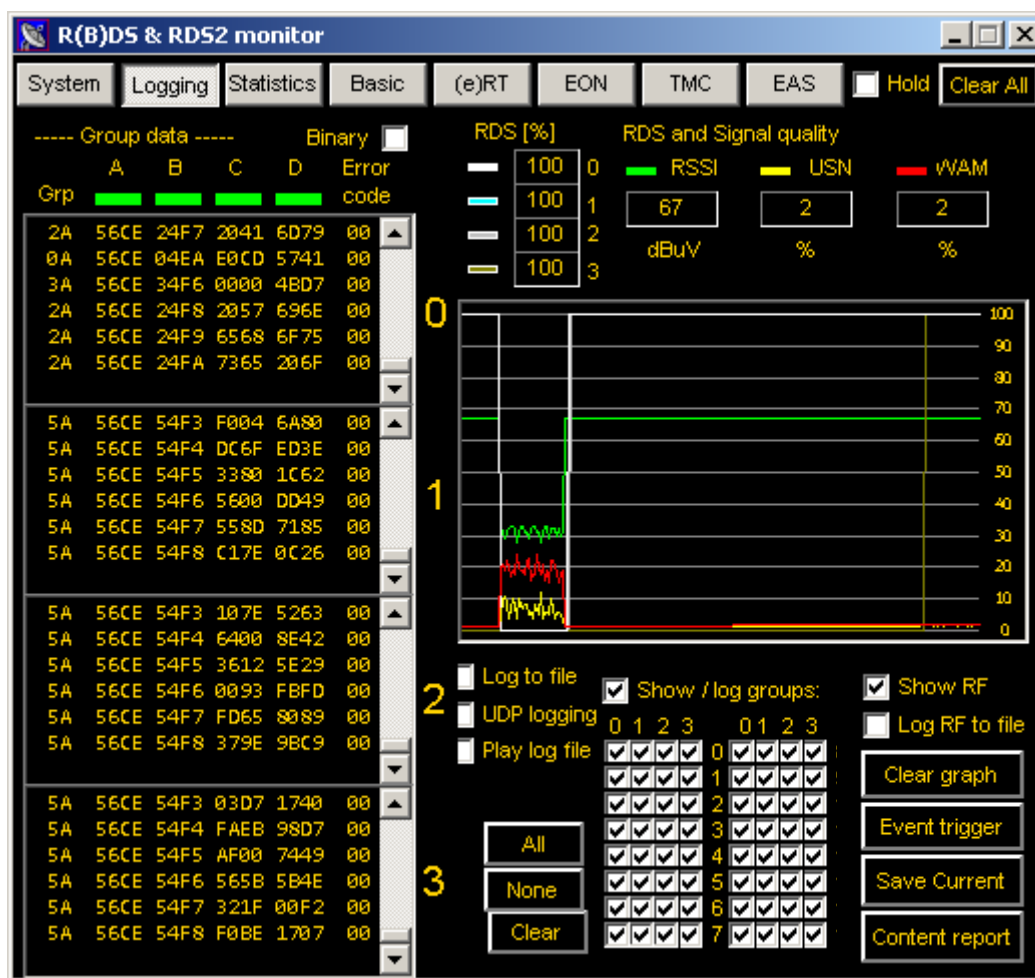
As can be seen in the RF picture, carrier 3 was added at a later moment in time.

Log RF to file When no R(B)DS is being received, no data is entered and hence no logging takes place. For users who are for instance mapping the coverage area of a transmitter, an extra logging option has been added in the form of the **Log RF to file**. When this option is checked a file is created in which all available RF parameters are logged at a rate of about 5 per second, including the presence of R(B)DS:

Freq	RSSI	USN	WAM	IF	BW	AGC	ST	RDS	Date	Time
105.3	41	7	10	-2	236	0	1	1	30-09-17	14:38:07:061
105.3	42	6	10	-3	236	0	1	1	30-09-17	14:38:07:261
105.3	42	6	10	-1	236	0	1	1	30-09-17	14:38:07:471

From left to right the logging shows:

Frequency, RSSI, USN, WAM (Multipath), IF (IF offset), BW, (Bandwidth), AGC, ST (Stereo),

RDS, Date & Time stamp.

When enabled, also GPS data is added to this file, which allows accurate mapping of the R(B)DS coverage area.

5.3. STATISTICS

The **Statistics** button opens a window showing a breakdown of the received groups and blocks both in numbers as in percentages. From this breakdown a lot can be learned, not only in terms of reception quality but also on the transmission scheme of the operator.

When a B type block is received which contains errors the C and D blocks of that group will be rejected. If they contain errors themselves they do not end up in the rejected total but will be added to their own error listing.

Figure 15. *The Statistics Window*

The table at the bottom right of the view shows the ODA's which are present in the transmission: the group number, AID and name are shown.

At the bottom of the window the sequence of the last 18 group types is shown. To have a closer look you can un-check the "Group sequence" checkbox, which will halt the update to the screen.

For the quality calculation, the rejected and error groups are first summed together and then compared to the total number of received blocks.

Also for the statistics overview another window layout will be shown in case RDS2 is being received. Like in the logging tab, all entries are more or less multiplied by 4 to show the details of all streams as shown on the next page.

The ![<-->] key in the top left of the group survey table toggles the displayed values from Number of A groups, Percentage of A groups, Number of B groups and Percentage of B groups.

In this picture stream 1 is used for enhanced Radio Text and enhanced Radio Text plus (eRT and eRT+), stream 2 is used for additional TMC information and stream 3 carries paging data which was used for an Alert system.

Again the table in the lower right corner shows the ODA's which were present at the time of recording.

5.4. BASIC

The **Basic** button opens a window showing the most common data used by most operators.

Figure 16. *The Basic Window*

For the exact details of all separate parts, I advise you open the latest (2017) RDS specification, which will be supplied on the installation stick once it is officially released.

Several new features are already present in the RX014 GUI. One of them is enhanced Radio Text or eRT for short. This is a free ODA to transmit text which is coded using UTF-8. In total 128 bytes are available for a single line of text. Depending on the language the actual number of symbols displayed on the screen may vary. Similar to RT also eRT may be combined with eRT+. Coding of RT+ and eRT+ is exactly the same. The only difference is the AID. In "normal" R(B)DS transmissions usually only one system will be used, nut when

RDS2 is used both systems may be used simultaneously. The user may select which text is shown on the main and Basic pages.

Another new feature is the Long Programme Service name or LPS. Like eRT, coding of this feature uses UTF-8. 32 bytes are reserved for this feature which uses group 15A.

In the center of the window a survey is shown of the 20 last received Programme Service names (PS). Quite often this feature is used for other purposes than showing the station name for which is was and is originally intended.

Both the RT and the PTYN fields contain a so-called A/B flag. When this flag toggles the entry should be cleared as a new entry is about to arrive. The status of both A/B flags is shown by a small indicator next to the entry. It has been noted in the field that some operators fail to use this flag. The result is that a new text is built over the old entry which often gives a somewhat garbled view.

By checking the **Simulate AB flag** checkbox (not shown in the picture above), the RX014 will note if the data coming in is part of the existing data or not. If checked, the

"real" A/B flag is not inspected. Reason for not showing it in the picture above is that in this picture I had chosen to show the eRT message rather than the RT message. eRT however has no A/B flag but uses another mechanism to notify the receiver of a new text.

Another nice option is the **Show space char. ☐** **Show space character** checkbox which replaces all spaces in the RT and eRT messages by an underscore character ("_"). Showing this can tell you whether the texts are padded with spaces or end with a 0x0D symbol.

In Europe, quite often the *Method B* AF coding mechanism is used (Germany, Austria, Switzerland,..) as shown on the right side of the "Basic" tab. The listing on the right side shows one of the lists being broadcast and with the listing to its left you can choose which list you want to check. In a well-organized setup there are as many transmitter towers as there are lists as each tower can be linked to another one. A list begins with a header pair, containing the tower frequency and the length of the list, followed by the regular entries. Normally the frequencies in the list are shown in ascending order (lower value first). In case of regional capabilities this order is replaced by descending order (higher value first) and this is shown in the list by a slightly grayed entry.

☑ Fast acquire   To speed up the assembly of all lists the **Fast acquire** checkbox should be checked. Every incoming frequency is then immediately assigned to a new list and the total assembly time will be greatly reduced.

When hovering over the ECC (Extended Country Code) and Language boxes, the actual country and language are shown in a pop-up balloon.

NEW CHAPTER: (e)RT

All details on Radio Text (RT and eRT) are shown in the (e)RT tab together, when available with Radio Text Plus and enhanced Radio Text Plus (RT$^+$ and eRT$^+$.

The "Plus" groups allow tagging of (enhanced) Radio Text, so items will be easier to recognize by a computer and can thus be displayed more clearly to the user. Items like "Artist name" and "Song title" are the most used applications to be shown in the radio display, but also events or advertisements can be highlighted as shown in the picture below:
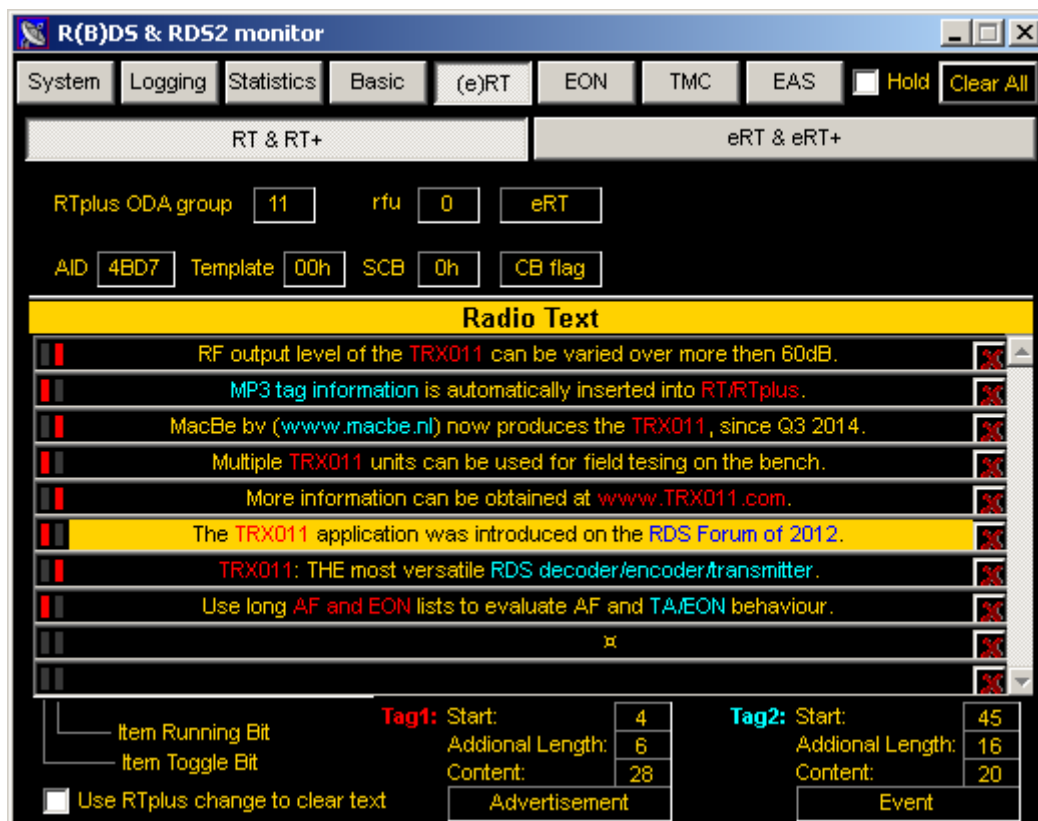
In each line of text 2 items may be "tagged". In the RX014 GUI these tagged items are shown by different colors (red and blue). When you select one of the text lines, the details on the tags are shown at the bottom of the window. The details of the 3A group (which a.o. gives the group number where RT$^+$ can be found in the transmission) of RT$^+$, are shown on the top of the window.

Use eRTplus change to clear text In some cases operators do not toggle the A/B flag between messages. In the previous chapter a solution was given to simulate this A/B flag, but activating this checkbox will also force a "clear text" command in case of a change of (e)RT$^+$ data.

The RX014 GUI will store up to 250 different RT and eRT messages, which can also be individually removed from the list by clicking on the cross at the right side of the text line.

For an eRT message 128 bytes may be used. The number of characters to show depends on the language being used as coding is done using the UTF-8 coding scheme. In UTF-8 a single character may need between 1 and 6 bytes, depending on the language being used.

With the introduction of eRT, text in virtually all languages can be sent and displayed as is shown in the next picture. Where the top (English) line was translated in several other languages.
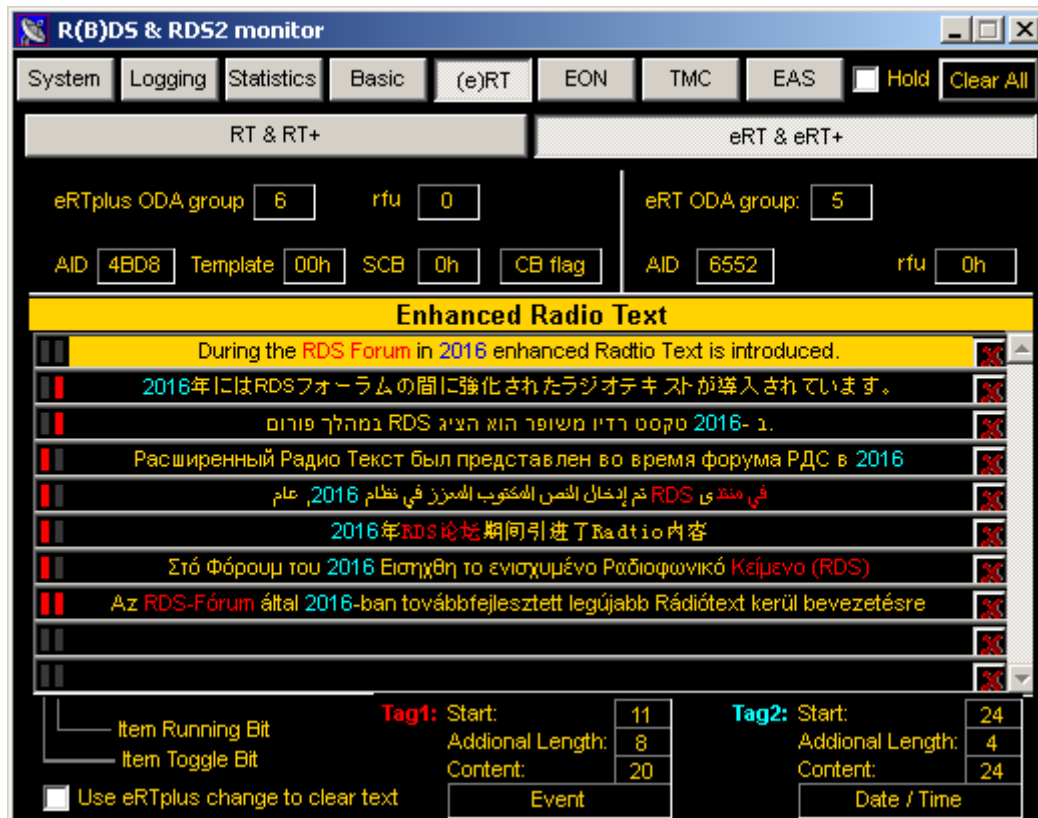
The top section of the pictures shows the details of the 2 ODA's which are used to transmit eRT and eRT⁺.

BTW: the messages were received over air and created and sent by the TRX011 (www.TRX011.com). With this device you can easily create eRT messages by using "copy and paste" from "Goggle translate" for instance.

5.5.   EON

Enhanced **O**ther **N**etworks (EON) is an extremely powerful feature of the R(B)DS system. As the name already implies it is only used in cases of networks which are in some way linked together, like for instance in the UK by Radio1, BBC2, BBC3, etc. Also most of the other European countries employ this kind of network usage.

One of the listener benefits is that while listening to one of the programs of the network, information is received about the other programs in the network.

Figure 17. *The EON Window*

In the example in the figure above, there are 6 other stations (or programmes) available in the network. When using this type of network, most transmitting towers are actually transmitting multiple programs (networks) at the same time.

When you are listening, for instance, to a program on the frequency of 93.2 MHz and you would like to switch over to the program "TRX 5" you can immediately tune to 90.6 MHz (check lower table) as you will then tune to the same transmitting tower; these frequencies are called "mapped" as they originate from the same or nearby tower. Sometimes more than one Alternative Frequency is available, which has to do with transmitting power of the various towers.
Naturally this system as just described makes little sense to a "standard" user. The power of the system comes from the receiver itself; when multiple presets are stored belonging to the same network, the receiver can keep track (in the background) which frequency to tune to when the user wants to switch between programs avaiulable in the same network..

Another extremely useful and widely used feature is called "Traffic over EON" or "EON-TA". In the top table you can see there is one station which has the TP flag set and all others have their TA flag set. This means that the station which has the TP flag set will transmit traffic information when it becomes available or is urgent. As a listener you can receive the traffic information without having to listen to the station on which it originates.

In the setup shown, your consumer receiver will receive a message from the programme you are listening to that a traffic message is about to go on air on the programme "TRX One". Your receiver will then temporarily switch over to "TRX One" for the duration of the message and then switch back to the

programme you were listening to. Even when you were listening to another source (CD, MP3 or so), your radio would mute that source, switch to the "Traffic program" when you activated this function and would revert back to the original program when the message is done. Quite often you, as a regular user, can also set a different volume level or offset to the current volume for these types of messages to make sure you do not miss them.
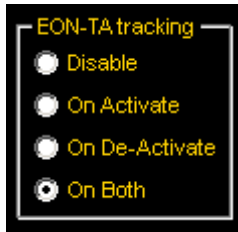
When performing read tests targeted on EON-TA is may be very convenient that the GUI immediately switches view and highlights the line which has been made active by the 14B burst (as described on the System page).

With selector box shown on the left you may chose how the GUI needs to respond to EON-TA messages.

Alongside the "mapped frequency" method, a *Method A* AF list may be send in the EON group. This requires the receiver to check all frequencies first, before switching over to the best alternative.

You can select either group in the top table and scroll to the entire list in the bottom table to see all links.

5.6.   TMC

TMC is short for Traffic Message Channel and should not be mixed up with the traffic information provided by the TP and TA flags.

The traffic information provided by the TP and TA flags is audio information and is being broadcast as spoken text, whilst the TMC information is a coded signal mainly intended for navigation systems. This system provides specific information on hazards, road blocks, traffic jams, etc. and also provides the exact location where the "problem" is. To accomplish this, the navigation systems are provided with special maps (Location Tables) for matching the data.
Usually these TMC services are subscriptions provided by the navigation system provider. When a station does broadcast TMC using the table that was subscribed, the information may be used by the system.
As the TMC system is proprietary, exact details may not be provided in this manual.
For more information, go to www.TISA.org (Traveler Information Services Association).

5.6.1. SYSTEM INFORMATION

TMC is not part of the R(B)DS standards (although it originated there) and is thus implemented as an ODA (Open Data Application) which in general uses group 8A to code the information.

Figure 18. *The TMC System Information Window*

In the group 3A where the ODA is made known to the receiver by its AID (Application IDentification) and the application group, some other details are provided also, such as geographical scope, bandwidth (gap), location table numbers, service identifier, country and extended codes and a flag to indicate if information is available for service following . In the picture above the given gap value is 5, but in real time shown at the bottom of the screen, most of the time the gap appears to be 5. So, if an organization pays the operator for a certain bandwidth, he can see here if he gets what is paying for (in this case he is not).

The gap value indicated how many other groups are send between TMC messages (BTW. Each TMC message is send at least twice directly following each other).

In the **ODA group** itself (8 in the figure above) the **Service Provider Name** (SPN) is made known for user information and several details which only are of concern to the navigation system.

5.6.2. TUNING FORMATION

Similar to the programme following feature using the AF list and PI code, also the TMC system provides information where the same information is being broadcast. This is very useful for navigation systems which have an own "TMC receiver" (as most systems do).

Figure 19. *The TMC Tuning Information Window*

If this type of information is present the AFI (Alternative Frequency Indicator) will light up in the group 3A data stream.

The information may be provided in various ways as can be seen on the **Tuning Information** window.

The programme you are listening to may provide a separate AF or Mapped AF list or even just a list of PI codes to look for. All details were assembled in this example, which is usually not the case.

Figure 20. *The TMC Tuning Information Window with Mapped AFs*

By clicking one of the loaded items a table will appear with the details. In Figure 20 the PI code is

selected to show its details, and the mapped AFs are displayed.

5.6.3. MESSAGE INFORMATION

In this window, the contents of the actual messages are shown.

Figure 21. *The TMC Message Information Window.*

The TMC message source is a message carousel from which entries disappear and to which message are added.

If you prefer the messages to come in continuously, then check the **Allow duplicates** checkbox. Entries that are duplicates are marked with a "*" in the right-most column.
To remove the duplicates, click the **Remove duplicates** button.
You can clear the window by pressing the **Clear** button.

The entries will always scroll in a way that the last entry is visible at the bottom of the window provided the **Auto scroll** box is checked. When unchecked, you can scroll through the list manually by using the scrollbar at the right of with the mouse wheel. The **Buffer:** value indicates the number of messages received.

Column headers and their descriptions from left to right:

Message number	Number generated by the GUI
S|M	Indication whether the message consists of just one message or is part of the type "multi message"
D, P	Duration or Persistence: Gives an indication of how long the situation/problem is expected to last.
Ci	Continuity index: Helps distinguish between different multi-group messages. All groups within any particular multi-group message contain the same value of this continuity index.

D|G	Diversion | Group number. Diversion: indicates whether drivers are advised to find and follow an alternate route. Group number: the message number in a "multi-message" message.
Dir and Extent	Direction and Extent: Indicates the number of segments, adjacent to the location, affected by the situation, and where appropriate, the direction concerned.
Event	Gives details of the traffic situation, or other factor (e.g. weather) affecting or potentially affecting traffic. An eleven-bit number represents the event description, A common table is used by all service providers; the list of numbers and associated descriptions are in EN ISO 14819-2.
Location	Indicates the area, highway segment or point of the source of the traffic situation. The location is indicated by a sixteen-bit code. Obviously, the table of locations is country specific and possibly service provider specific as well. In order for a terminal to be able to use the location information, it requires a copy of the location table used by the service provider. Each Location Table is referred to by a Location Table Number.
L/R	Local (PC) or RDS time
Date	Date of reception
Time	Time of reception
Dup	Duplicate entry (marked with a "*").

In case of a "multi message" entry with a group number higher than "1", the **Dir**, **Extent** and **Event** are combined to a free format data field whilst the **Location** entry is field of hexadecimal data.

5.7   EAS

The Emergency Alert Tab is fully dedicated to the system that has been used in demonstration projects in the U.S. Gulf Coast area in 2014. This demonstration project was been initiated by the U.S. Department of Homeland Security and was designed for an at-risk population who are hard-of-hearing and profoundly deaf.

The specification is based on Annex Q of the 1994 RBDS specification, but has been substantially improved by NPR Labs, Jump2Go, Inc. and Catena Radio Design in the Netherlands (specifically: by me...when I was still working for Catena).

5.7.1 SYSTEM

The EAS has an AID of 0xE911 which is shown to the receiver in a group 3A message, where also the application group is assigned which is group 9A by default.

Figure 22. *The EAS Group 3A & System Window*
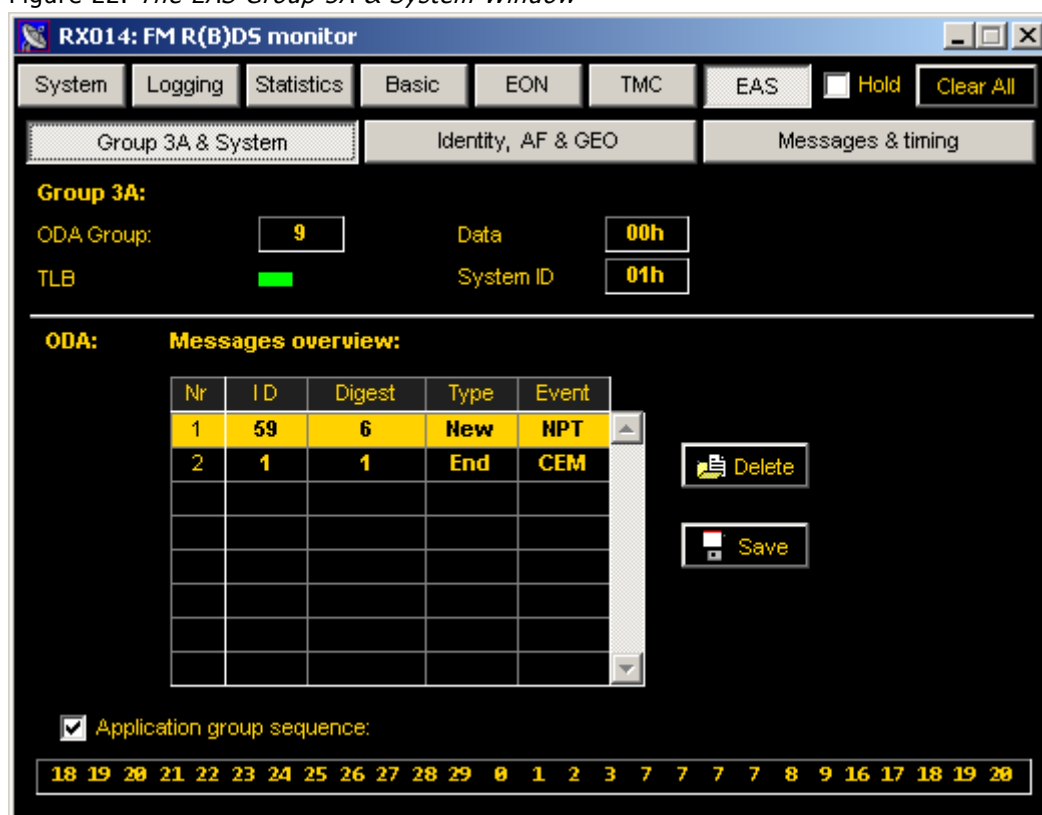
There is one other bit in group 3A which is of importance and that is the TLB or Text Location Bit. This bit indicates whether the alarm text is only shown on special receivers or in the standard RT fields.

The primary identification of a message consists of an ID and Digest number and a flag, indicating whether the message is New, to be Updated or Closed/Deleted. On the system tab also the event type is shown. Messages can be deleted by selecting the appropriate one followed by a click on the "Delete" button or saved to disk by pressing the "Save" button.

☑ Application group sequence: The "sub-group" number (made up of the last 5 bits of the data from a B-block) sequence is shown at the bottom of this tab and can be paused by un-checking the **Application group sequence** checkbox.

5.7.2. IDENTITY, AF & GEO

Each message can be identified by a large number of categories and descriptions as shown below. The details of all the possible codes are described in the specification which can also be found on the installation stick.

Figure 23. *The EAS Indentify, AF & GEO Window*

Similar to the TMC system, the EAS system allows a number of Alternative Frequencies to be transmitted but which *do* need to have EAS content that is related to the station you are listening to.

The GEO codes indicate for which portion of the population the message is intended. The GEO codes define U.S. states and counties within those states. The codes are based on the Federal Information Processing Standard (FIPS).

5.7.3. MESSAGE AND TIMING

In this window the actual message is presented as well as some timing information on when the message was originated and how long it will persist.

Figure 24. *The EAS Messages & timing Window*
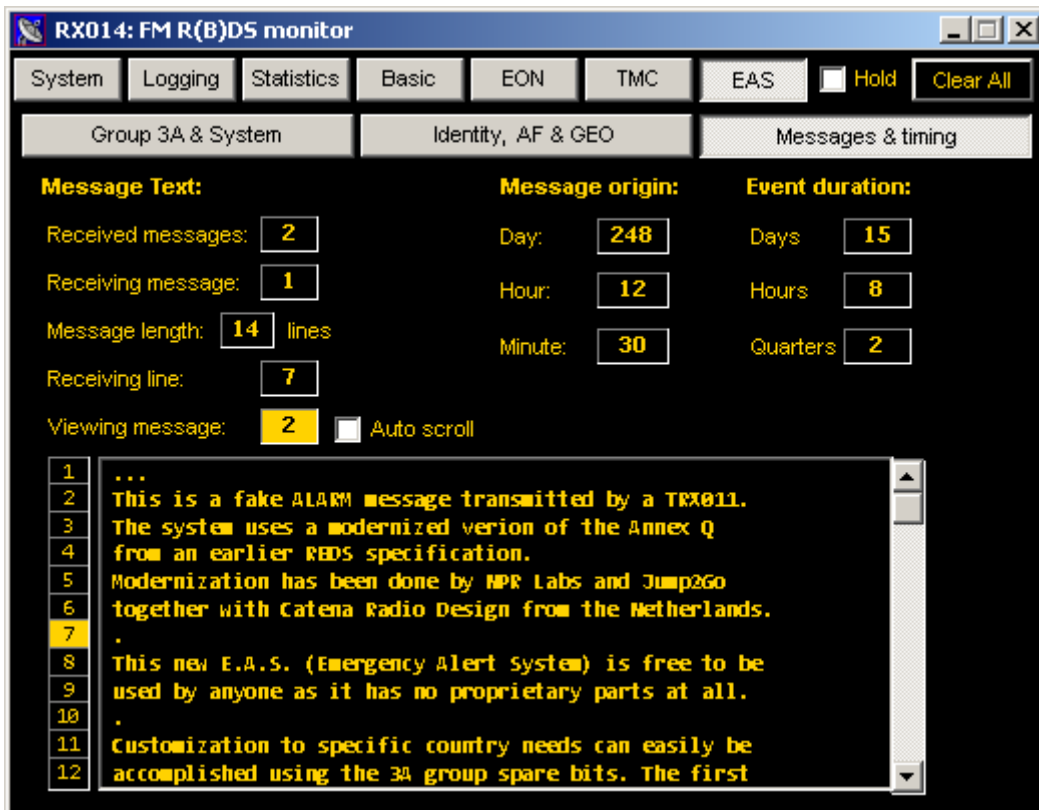
Day indicates the number of days since January 1. **Quarters** indicates which quarter-hour.

On the top left side of this window is shown the number of messages that have been received and which message is currently being processed, the length of the current message, and which line of the current message is being received.

When the **Auto scroll** checkbox is checked the last line of the window will show the last received line of the message. When messages are repeated several times a small indicator left of the line shows which line is being processed.

When the checkbox is un-checked, the user may select which message should be shown and can scroll through the contents either by using the scrollbar at the right or by turning the mouse wheel.

This entire EAS system can be fully evaluated by using my other product the TRX011 (www.TRX011.com) which is an FM R(B)DS transmitter *and* receiver, and incorporates the full implementation of this specific system.

6. ADDITIONAL

The GUI for the RX014 is constantly updated, either because bugs are found (I *am* only human) and because I am continually improving my products. Customer requests for additional features are welcomed.

As usual, all updates are <u>free</u> for the RX014 purchasers, and can always be freely downloaded from the download page of the site www.RX014.com

Should you have remarks | complaints | suggestions, please do write to me at the dedicated e-mail: info@RX014.com

I hope you enjoy using the RX014, and I look forward to hearing from you.