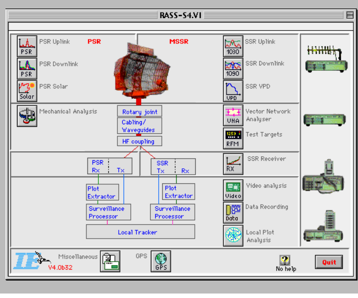

Poems Test Equipment

User Manual Volume 7

TTT User Manual

intersoft electronics

PTE-P2A Product - March 2000
Version 4.1.1

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Organisation of This Manual

The TTT user manual is volume 7 of the complete RASS-S/PTE user manual describing how to use the hardware and software of the RASS-S & PTE Radar Analysis Support System.

The RASS-S User manual is divided into seven Volumes.

Volume 1	Introduction / Technical Specifications
Volume 2	Antenna Diagram Measurements
Volume 3	Reply Recording & Analysis
Volume 4	Data Recording & Analysis
Volume 5	Radar Environment Simulation & Target Injection
Volume 6	RF Test Set & Special Tools
Volume 7	TTT user Manual

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Documentation Comments

If you have any comments or constructive remarks on this manual, please fill in the document that you can find in Appendix G. Do not hesitate to send us this form. We will welcome all information.

MODIFICATIONS CHANGE

Revision	Date	Description	Responsible

Chapter I : Introduction

1.0. Introduction

The Transmitter Test Tool (TTT) is designed as a part of the POEMS Test Equipment (PTE). The TTT is the result of PTE phase 2A (PTE-P2A). The TTT concentrates on testing the POEMS transmitter (eg. duty cycle performance). Two setups were designed for the tests. One which separates the POEMS transmitter from the radar drive signals, and supplies the radar with its own drive signals in order to verify the transmitter output. And one which is slaved on the azimuth (ACP and ARP) of the radar, and records the transmitter output. Both setups are discussed in the following 2 chapters

1.1. Scenario Generating and Recording

To test the duty cycle performance of the radar, the drive signals of the radar are isolated from the radar, and connected to the TTT. The output of the radar is also connected to the TTT, in order to compare its output to its input. The TTT consists of different components: the computer, the RVR, the RTI, and 2 PDM's. The computer and RVR are part of the standard RASS-S (SASS-S) configuration. The computer and RVR will generate commands to the RTI in order to drive the transmitter, read the transmitter-BITE-messages coming out of the RTI (only for Supplier 2), and record the 2 analog video of the 2 PDM modules, which corresponds to the Rf signals of the transmitter (Sum and Control lines). Channel 3 of the RVR is used to trigger for example an external oscilloscope, which can be used as external reference for verification.The RTI output is compatible with both the Supplier 1 (Raytheon) transmitter, and the Supplier 2 (Airsys ATM) transmitter. The Output1 of the RTI can also be used to test the system (for S1 and S2), by connecting the RTI Output1 (normally for S1) directly to the RVR (thus bypassing the transmitter and PDM's). The outputs (sum and control lines) of the transmitter are connected via couplers and attenuators to the PDM modules. These convert the Rf input to video with compatible signal levels for the RVR. Both PDM modules have two outputs, one with 20dB range, one with >70dB range. The one with 20dB range is for accurate TTT measurement, the output with >70dB range is for general purpose use (less critical attenuator selection because of wider input range). Below you will find a drawing giving an overview of the connections.

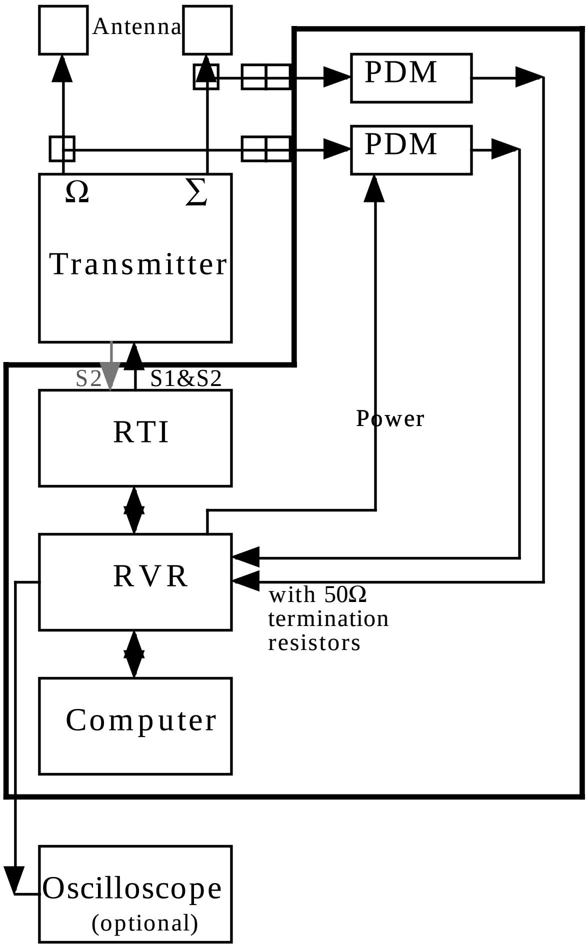


Figure 1.1.1: Overview of the TTT (bold frame) in generation & recording mode

The TTT connects on one side to the RVR, and on the other side to the transmitter. The transmitters of both S1 (supplier1) and S2 (supplier2) are supported. Output 1 is intended for supplier 1 and testing, output 2 is intended for supplier 2. For supplier 2, BITE messages have to be read back, these are passed to the RVR via its digital input. The RTI also has a on/off switch, which can be used to immediately interrupt the transmission signals (hardware protection). The position of this switch can also be read out by the RVR via its digital input. The output of S1 is modulated digitally for supplier 1, but analog in RTI-BITE mode (self test of the RTI). In this mode the output of the RTI is directly connected to the RVR, bypassing the transmitter and PDM's. The RTI-BITE works the same, both for S1 (digital modulated) and S2 (analog modulated) scenario's. The drawing below gives an overview of the internal diagram of the RTI.

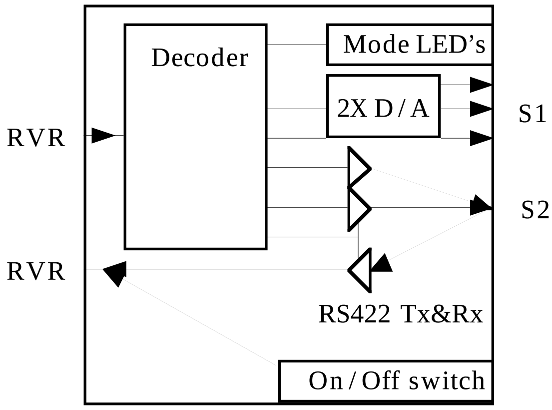


Figure 1.1.2: overview of the internal diagram of the RTI

As explained, Output 1 has a double function:
- The Output1 can be used for the S1 transmitter: Sum amplitude, and Omega amplitude are modulated on or off, Sum phase is always digital in the RTI.

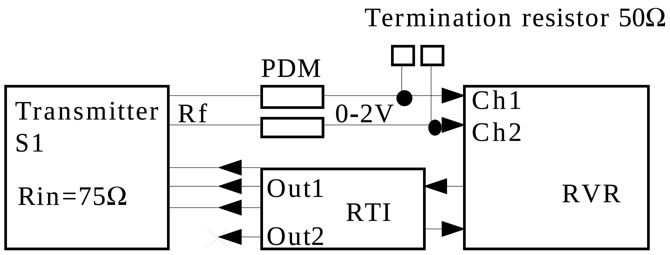


Figure 1.1.3: RTI Connections for S1

- The Output1 can also be used for the RTI-BITE function (RTI self test): This function is used to test the TTT output patterns.
Sum amplitude and Omega amplitude are looped back to Ch1 and Ch2 of the RVR (instead of using the PDM modules in combination with a transmitter). This allows to check to output pattern to both suppliers.
For non-modulated transmissions (S1) this output will have one discrete on level, for modulated transmissions (S2) this output will be analog (Sum and control amplitude are scalable for S2).

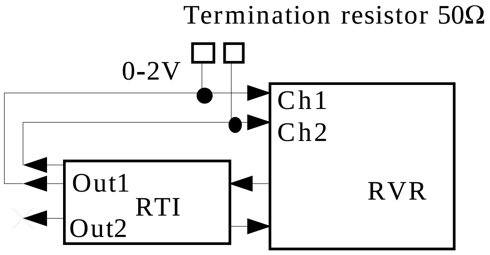


Figure 1.1.4 : RTI Connections for BITE function

Warning: Because of the double use of Output1 (modulated or unmodulated), make sure to select the correct mode in software (TTTmain, check box override attenuation command).

It is possible to generate 18 different interrogations in one scenario: Mode 1, 2, A, C, ALP4, ASP4, CLP4, CSP4, 10 long/short Mode S. Each interrogation has it's own attenuation setting (fixed per interrogations). A total of 18 interrogations (and thus 18 attenuation settings) can be generated. The picture below gives an overview of the timing of the possible modes.

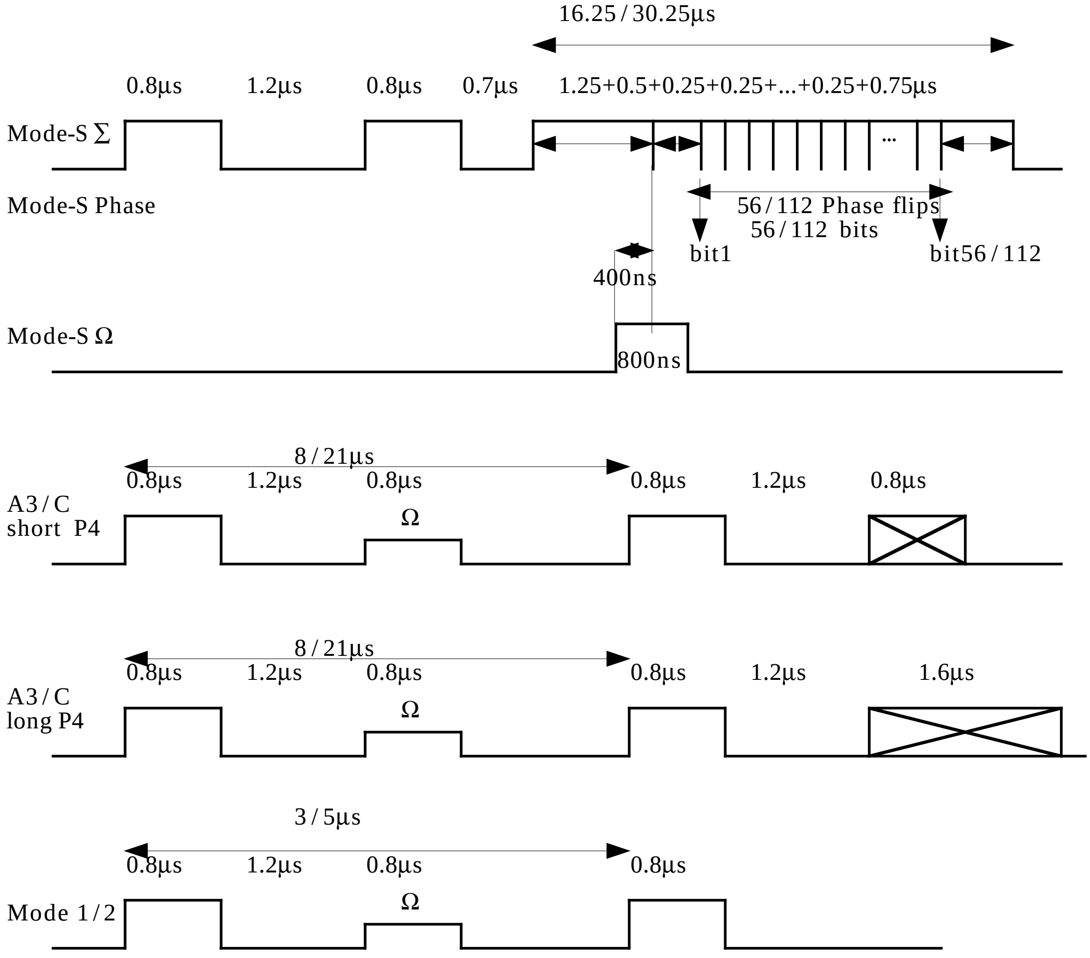


Figure 1.1.5: Timing of the possible interrogation modes.

The detailed connections are discussed in this chapter, under '2.1. Connecting for Scenario Generation and Recording' . About how to use the system, more information can be found in Chapter II, III, and IV.

For a general introduction on the PDM module, see section 1.2.

1.2. Azimuth Slaved Recording

In order to be able to make duty cycle recordings in function of azimuth, the TTT is connected to the azimuth lines (ACP and ARP), and to the Rf output of the transmitter. For this setup, the TTT needs following components: computer, RVR, RVI, and 2 PDM's. The computer, RVR and RVI are part of the standard RASS-S (SASS-S) configuration. The RVI conditions the ACP and ARP to acceptable levels for the RVR digital input. The

RVI does not only output these 2 lines to the RVR, but also other control signals for reply window based recording, and reply pulse recording. For this reason, a ‘ACP-ARP isolation wire is used. This wire isolates the ACP and ARP lines to the RVR. The RVI has to be put in normal mode (for more detail see Chapter V of this volume, and Volume 3).The analog input of the RVR is connected to the sum and control video from the transmitter. This enables the RVR with computer to make recordings of the transmitter power in function of azimuth. Two PDM modules are used to convert the Rf of the transmitter (via a coupler and attenuators) to video. The PDM has 2 video outputs: one with a 20dB range, and one with >70dB range.

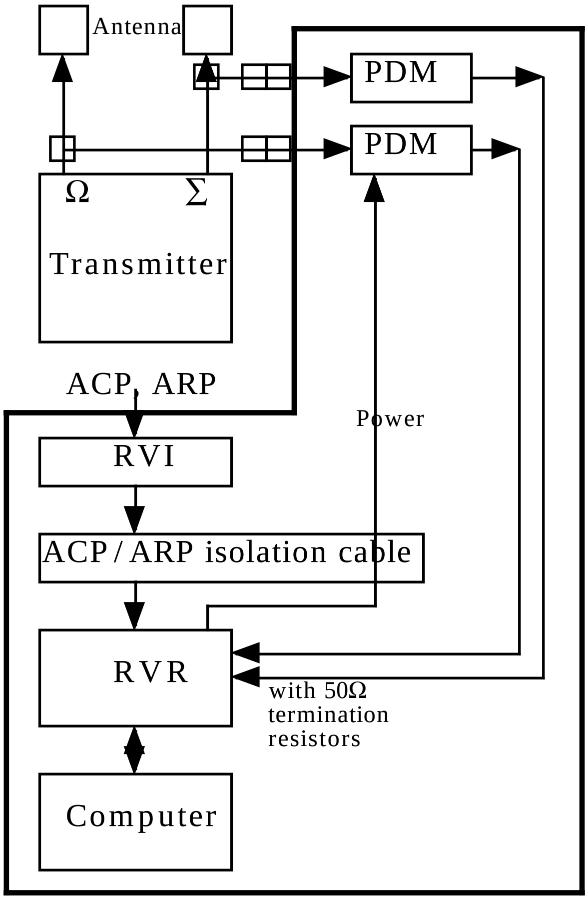


Figure 1.2.1.: Overview of connections for TTT (bold frame) in azimuth slaved recording

The PDM module requires some more explanation. The hart of the PDM module is build around the logarithmic receiver (AD8313), all Rf specifications of the PDM are derived from this component. Internally a 20dB attenuator is placed in front of this component, in order to improve the VSWR.
Furthermore, a BITE facility (build in test) is available in the PDM . This BITE generates pulses, which contain the serial number, and enable the system to calibrate.
A common connector is used for the transmitter video and BITE pulses, this enables the BITE to check the full wiring used by the PDM. However this requires a function to enable the BITE’s. There are 2 conditions on which BITE pulses are generated: about 20 seconds after power-up, and when the ‘Calibration Dongle’ is plugged in the PDM.
Below the internal diagram of the PDM is printed.

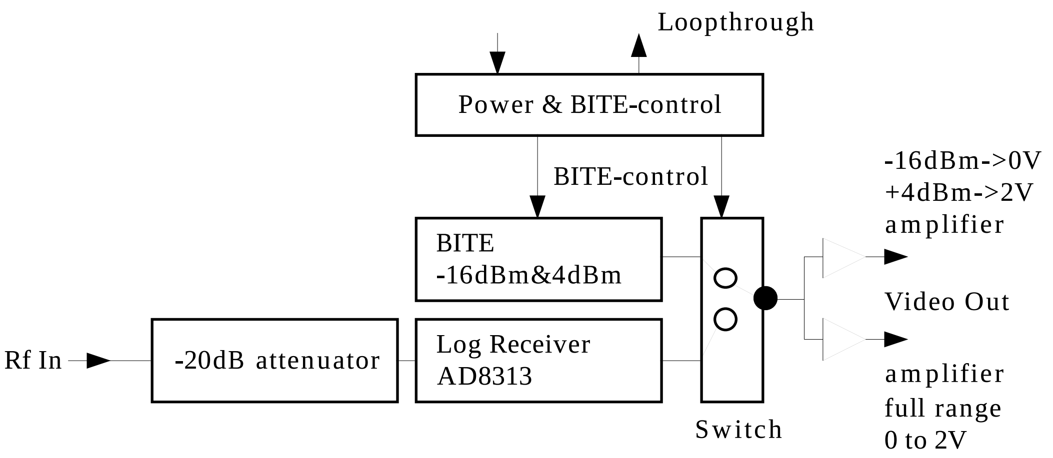


Figure 1.2.2.: PDM Internal Diagram

The PDM BITE pulses start with a test patern that is 20µs high, and 20µs low. This is done intentionally to verify the drop of the PDM-RVR system over 20µs. In the software tool this 20µs can be zoomed into. The signal level of the PDM BITE pulses correspond to the -16dBm and +4dBm levels. The serial number of the PDM module is also included.

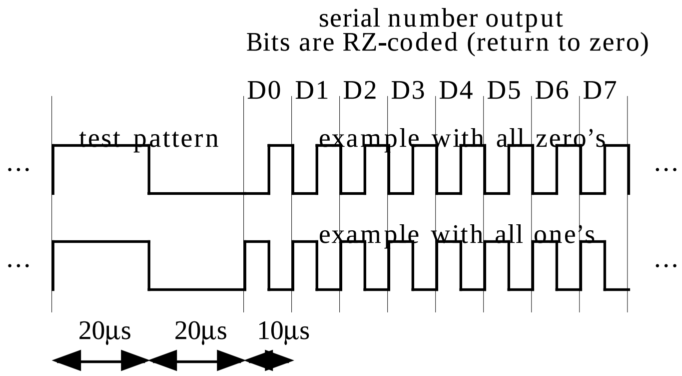
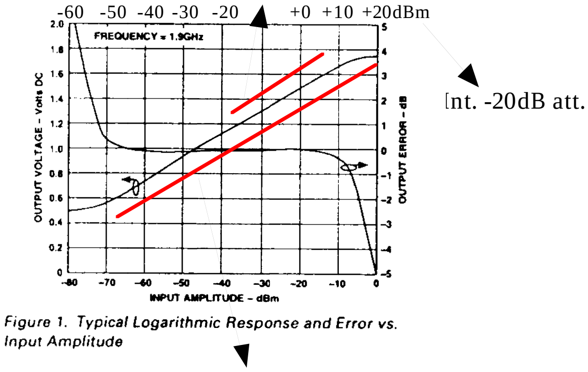


Figure 1.2.3.: Testpulses generated by the PDM-BITE function.

The PDM has a measurement resolution of 0.1dB, using the RVR 8 bit ADC in the -0.2V to 2.2V range (=107 steps per volt). This results in a range of 20dB for a corresponding PDM output voltage of 0 to 2 volt (gives 213 steps or ±0.1 dB/step). The Log receiver has more than 70dB range. To reach this output range the PDM output is zoomed in from the total 70dB range to a 20 dB range by using opamps. This detailed output still allows to monitor the complete modulation range of the transmitter. The graph below shows the relation between the zoomed range and the full range.

Range used on the -16dBm to +6dBm output



Range used on the >70dB output:-50 to +20dBm

Figure 1.2.4.: Ranges used for both outputs of the PDM

The detailed connections are discussed in this chapter V . About how to use the system, more information can also be found in Chapter V.

2.0. Connections

2.1. Connecting for Scenario Generation and Recording

2.1.1. General

Following components are used for the setup.

1. The Radar Video Recorder and its accessories:

- Radar Video Recorder RVR183.
- mains power cable.
- SCSI 50p-50p cable.
- SCSI terminator.
- 2x 2m RG223 cables.
- 1x 5m RG223 cable.
- 2x 270 MB or 1 GB cartridges.

2. The Radar Transmitter Interface (RTI-376)

2.1. The RTI unit

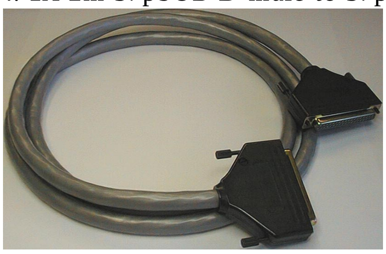
2.2. 2x 1m 15pSUB-D male to 15pSUB-D female

Connection cables between the RVR digital in and out and the RTI.

2.3. 1X DB15HD to 5x BNC

Connection cable between Output1 and the transmitter of S1 or RVR analog input.

2.4. 1X 2m 37pSUB-D male to 37pSUB-D female

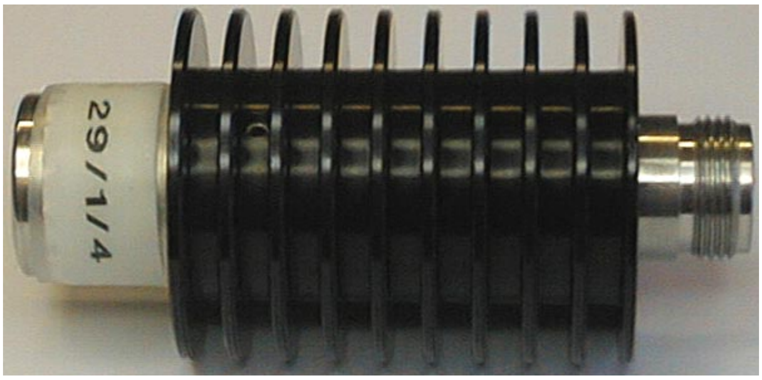


Connection cable between Output2 and the transmitter of S2.

3. Two PDM modules with additional accessories

3.1. 2 x Power Detection Module Serial number: 29/1/. . .

3.2. 2 x Attenuator Narda 766-20: 29 / 1 / . . .



A 20dB medium power attenuator. Power Average: 20W Max., Power Peak: 1kW Max., DC-4GHz, 20±0.25dB (DC-3GHz), VSWR: 1.1 (DC-1GHz), 1.15 (1GHz-4GHz). Two attenuators are supplied, one for each PDM. Use the one with the same serial number as the PDM for highest precision.

3.3. 2x Attenuator Mini-Circuits NAT-10-60: 29 / 1 / . . .

Note that this component has the same package as the NAT-20-21 (of the next paragraph).

A 10dB low power attenuator. DC-6GHz, 10±0.2dB, 0.225W. Two attenuators are supplied, one for each PDM. Use the one with the same serial number as the PDM for highest precision. This attenuator should always be used in combination with the Narda 766-20. *This attenuator is meant for low power radars.*

3.4. 2x Attenuator Mini-Circuits NAT-20-21: 29 / 1 / . .

A 20dB low power attenuator. DC-2.1GHz, 20±0.3dB, 0.2W. Two attenuators are supplied, one for each PDM. Use the one with the same serial number as the PDM for highest precision. This attenuator should always be used in combination with the Narda *766-20. This attenuator is meant for high power radars.*

3.5. 2X BNC T-adapter

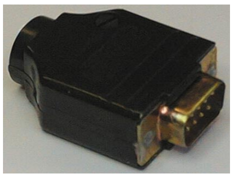
3.6. 2X BNC Terminator 50Ω

3.7. 1X BNC cable 3m red

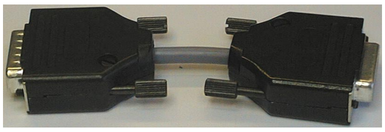
3.8. 1X BNC cable 3m green

3.9. 2X DB9male-DB9Female 3m Power Supply Cable

3.10. 1X DB9male Calibration Dongle



3.11. 1X DB15male-DB15female 15cm ACP-ARP isolation cable



This cable is not used in this setup for scenario generation. It is only necessary for azimuth slaved interrogation recording.

4. Macintosh computer and a printer:
   - PowerPC-based Macintosh Powerbook or other Macintosh PowerPC.
   - Powerbook power supply + power cord.
   - HDI-30 Powerbook SCSI System Cable.
   - HDI-30 Powerbook Disk Adapter Cable.
   - Carrying case.
   - Colour Inkjet printer.

Description of the setup. The drawing below gives a view of the connections that need to be made for scenario generation. The video recorder is connected to the computer via the SCSI interface on the back. The RTI is connected to the RVR via the digital in and out connectors. And the PDM's are connected from their 20dB range outputs to Ch1 and Ch2 of the RVR. The PDM's get their power supply via the SPORT connector on the back of the RVR, this power is looped through from one PDM to the other via the same DB9male to

DB9female cables. The radar transmitter is connected to the PDM module via a coupler and 2 attenuators. Depending on the power of the radar, other attenuators have to be chosen. For details on Rf connection, please refer to the chapter on Rf connections: ‘2.1.2 Rf Power’ in this volume. The drive input of the radar transmitter, is connected to to the output 1 connector for supplier 1, and the output 2 connector for supplier 2.

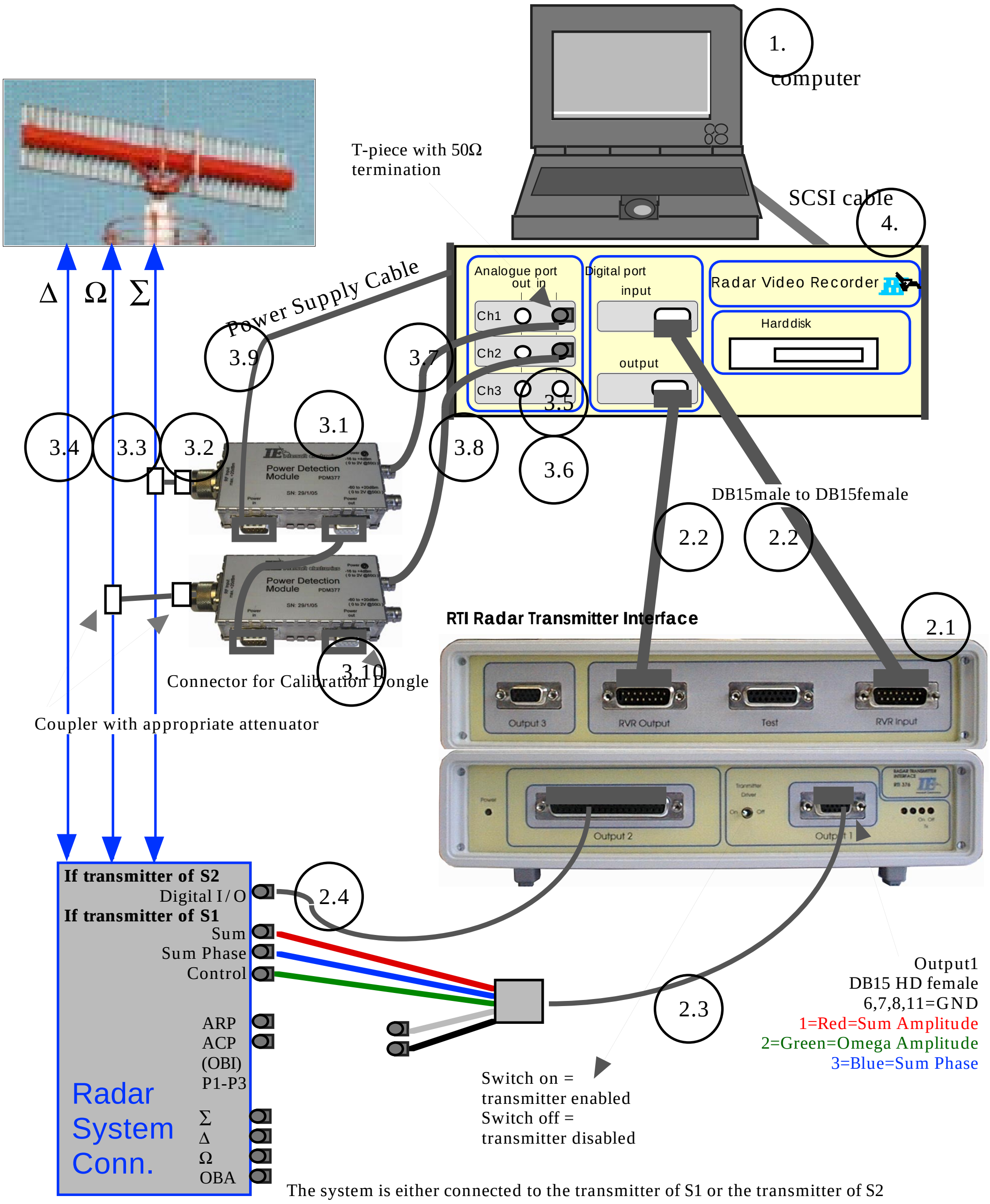


Figure 2.1.1.1.: Shows the connection diagram for scenario generation. The numbers refer to the components number as on page I.9.

For the build in test of the PDM module, the ‘calibration dongle’ needs to be connected to the free connector on the second PDM in the setup above. This will enable the test pulses, which the software will evaluate.

For the build in test of the RTI, the setup has to change somewhat. The transmitter and

PDM modules are bypassed, as can be noticed in the drawing below. This setup enables to use the same software routines as for the full setup above. This allows easy testing of the system and training. **Note that the connections for testing are the same for both suppliers.**

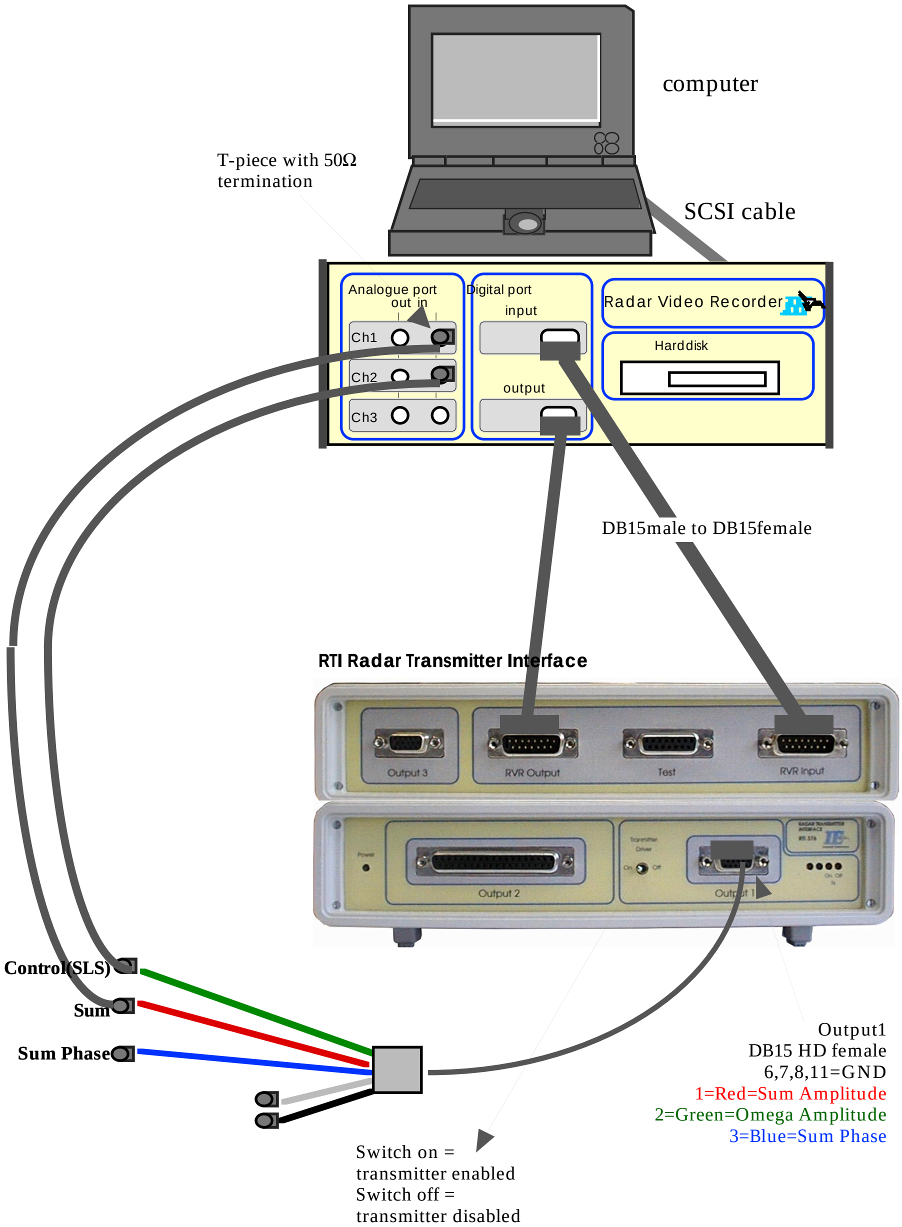


Figure 2.1.1.2.: Shows the connection diagram for the test of the BITE

Next the order of work will be discussed.

STEP 1 : SCSI Connections - Connecting the host computer to the RVR

When setting up the Radar Video Recorder , first connect the SCSI port of the RVR to the host computer. A SCSI cable to connect to the 50p SCSI connector of the RVR is included in the standard configuration.

The Radar Video Recorder is foreseen with two 50p SCSI connectors placed at the back panel. It has no internal termination for SCSI.
One connector is needed to connect the Radar Video Recorder to the host computer. The second one can be used to connect a second device.
Since the RVR is not internally terminated, an external SCSI terminator (shown in the picture below) must be connected in all cases where no further devices are connected.

Please note that the following SCSI addresses are used by default by the RVR:

3: Internal fixed harddisk (2GB)
4: Built-in Iomega JAZ drive
5: RVR DSP controller

Since the addresses of the RVR devices are fixed, make sure that in case more devices are connected to the SCSI bus, they are not conflicting with these addresses.

STEP 2 : Connecting the RTI and PDM's to the RVR

Basically this is building the setup discussed in figure 2.1.1.1.
When all is connected, power up the Radar Video Recorder. Both RVR, PDM's and RTI have a power led indicator. After 30 seconds (to allow the RVR internal harddisk to spin up) also the host computer may be booted.

STEP 3 : Connect the radar signals to the PDM module :

The PDM modules must be connected to the coupler outputs of the Radar under test.
The input power of the PDM must lie between -16 and +4 dBm, so the powers must be attenuated until a match is reached.

A POEMS radar with +51 to + 63 dBm output power is coupled using a 20 dB coupler. Use the 20 dB power attenuator (NARDA) and the 20 dB N type attenuator, to reduce the power to -9 to +3 dBm, which in turn can be measured by the PDM modules.

Please take grate care when working with Rf powers. Mistakes may cause damage. Make sure that the transmitter is terminated properly (50Ω), with an appropriate terminator (enough power).
Section 2.1.2 of this chapter discusses the Rf interface.

Also the input lines of the transmitter are connected as described in figure 2.1.1.1.

2.1.2. Rf Interface - Warning

Warning: when wrong connections are made, damage might occur to the Rf section of the TTT system. Please calculate your power budget carefully. Make sure that the transmitter is terminated properly (50Ω), with an appropriate terminator (enough power).

Below 2 budget calculation are given, one for a radar with a power between 2 to 4kW, and one for a radar with a power between 200 to 400W.

1. With a power of 2 to 4 kW(<4kW), we need to insert two 20dB attenuators after the 20dB directional coupler before connection to the PDM.

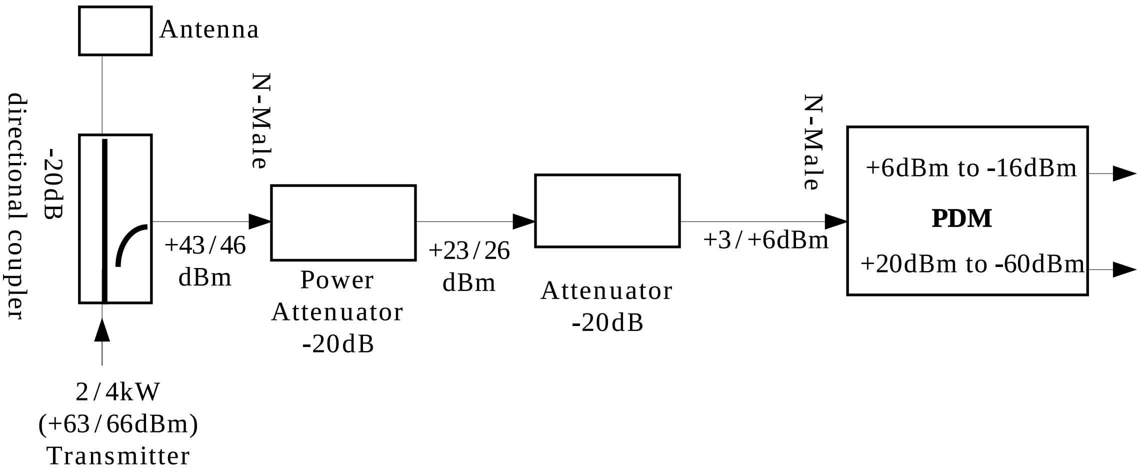


Figure 2.1.2.1 : Connection of PDM to High Power (POEMS) Radar

Because we will use the PDM module in its “high precision “ range (20dB) for the TTT, care has to be taken to the input range (12dB modulation) and to the fact that interrogation modulation (on -off switching) can be monitored with sufficient precision (max 10dB left). With 66dBm input power, a on/off modulation of 10dB can be observed; with 63dBm output power, the visible on/off modulation is 7dB.
Note that the PDM module is specified to go from +4dBm input power to -16dBm, but actually goes from +6dBm to -18dBm.

The modulation in this setup can be represented in a graph, which is shown in figure 2.1.2.2. This shows that in this setup 10dB of on/off modulation is in the dynamic range limits of the PDM.

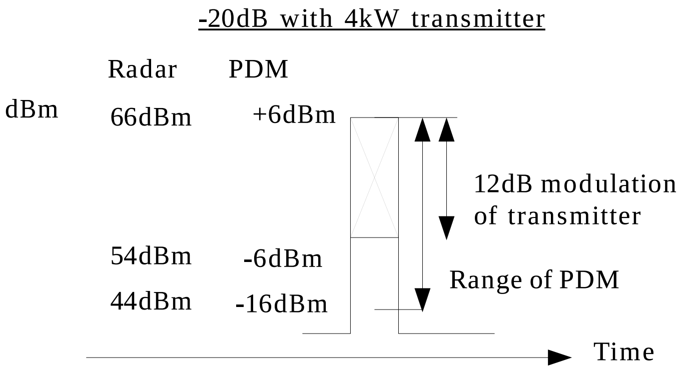


Figure 2.1.2.2. : Dynamic range of PDM versus High power modulation input

A 4kW transmitter with 12dB power switching applied, an on/off modulation of 10 dB is visible within PDM output range. For a 2kW transmitter with 12 dB modulation, an on/off modulation of 8dB is visible within PDM output range, which is sufficient.
The high-range output of the PDM will output a higher span and will show unexpected spurious responses if any are present.

2. The same calculations can be made for a lower power low power radar (<400W). This setup uses a 10dB as second attenuator, instead of a 20dB.

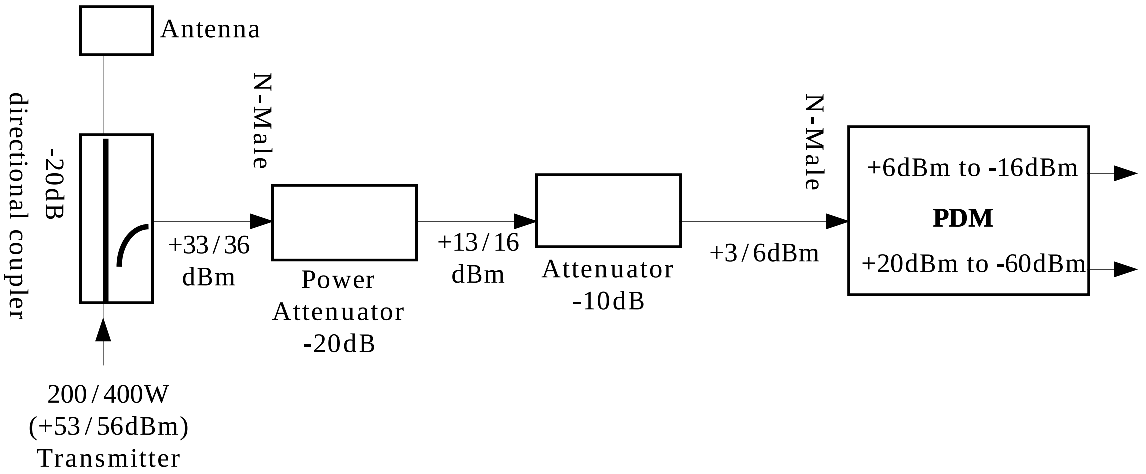


Figure 2.1.2.3. : Connection of PDM to Low Power Radar

-10dB with 400W transmitter

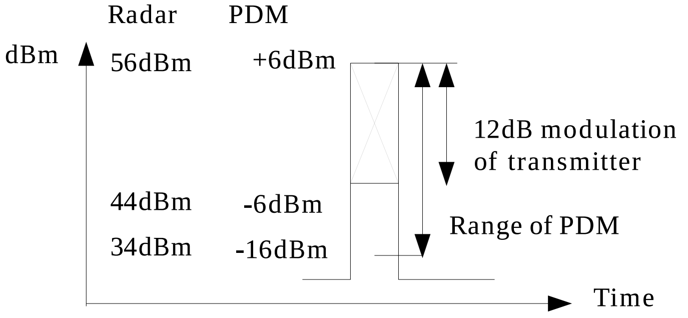


Figure 2.1.2.4. : Dynamic range of PDM versus Low power modulation input

2.1.3. S1 interface

Details on this connector can be found in the ICD of TTT: 'IE_O184_ICD_PTE-P2A v1.2'.

Connections are made using a DB15HD to 5X BNC. The Red cable (BNC) should be connected to Sum amplitude, the green one to Control amplitude, and the blue one to sum phase. The Cable is connected to output 1.

2.1.4. S2 interface

Details on this connector can be found in the ICD of TTT: 'IE_O184_ICD_PTE-P2A v1.2'.

Connections are made using a DB37 pin twisted pair, shielded cable. This cable is supplied with the system, and is 2 metre long. The Cable is connected to output 2.

2.2. Connecting for Azimuth Slaved Recording

Please see Chapter V for details on this setup.

3.0. Software Version Description

The TTT has been designed to work in the PTE environment. The version of the installed RASS-S4/PTE software (toolbox) should be version 4.43 or higher.

The version number of the TTT is printed on the CD. For question on the latest version feel free to ask Intersoft Electronics (via: info@intersoft.be).

4.0. Reference Documents from Intersoft Electronics

During design and evaluation several documents were created. These documents are available via Eurocontrol. Below a list is presented of the documents and their version numbers:

IE_0192 Proj. Plan P2A v1.2
IE_0188_ADD_PTE_P2A v1.6
IE_0187 System Spec. v1.4
IE_0184_ICD_PTE-P2A v1.2
IE_0193 Test Plan v1.3
Test specification: for production: 29.1. PDM377 test report
Test specification: for production: 30.1. RTI376 test report
Test report: IE_0196 Test Report PDM v1.0
Test report: IE_0197 Test Report TTT v1.0
Test report: IE_0206 Test Report RTI v1.1
Test report: IE_0207 Prod. Tests PDM v1.1
Test report: IE_0208 FAT PTE-P2A v1.3
VCRI PTE-P2A v1.1
USER MANUAL v4.1
Progress reports:

- PROG REP 9901 - 9902 v1.0
- PROG REP 9903 v1.0
- PROG REP 9904 v1.1
- PROG REP 9905 v1.0

Chapter II: Interrogation Scenario Generator

1.0. Introduction

The Interrogation Scenario Generator tool was created to allow the user to enter different scenarios for the Transmitter Test Tool.
By defining interrogations , periods , patterns and runs, the user can define a wide range of interrogation scenarios.

It is possible to generate 18 different interrogations in one scenario: Mode 1, 2, A, C, ALP4, ASP4, CLP4, CSP4 plus 10 long/short Mode S. Each interrogation has it's own attenuation setting (fixed per interrogations). A total of 18 interrogations (and thus 18 attenuation settings) can be generated.

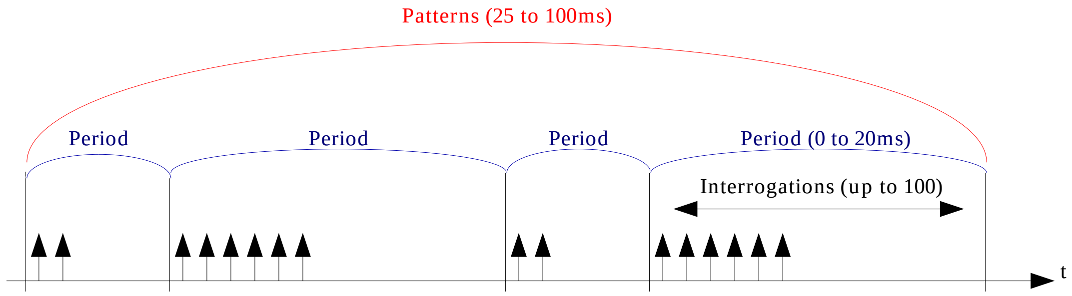
General Structure of a Scenario

A hierarchical structure is defined for the scenario:

- The lower and first level is **Interrogation** which is a set of pulses (P1, P2; P3, P4, P5 and P6) depending on the type of the Interrogation. Each pulse has to be transmitted either on the sum and/or the control channel. The user can chose between different types of Interrogation : SSR; Intermode 3A, C, 1, 2; short and long Mode S. The duration of an Interrogation depends on its type. For Mode S Interrogations the user can chose between 10 different P6 data contents which are themselves user defined. A user friendly user interface is present for inputting the data.
- The second level is **Period** which is a period of time (less than 20 ms) during which up to 100 Interrogations can be requested. The timing of these Interrogations can be either user defined or random. The user can define a list of interrogations plus their timing or can enter a definition of the sort of random period.
- The third level is **Pattern** which consists of a timeframe between 25 and 100 ms representing a beam time and during which up to 20 different Periods can be scheduled.
- The fourth level is **Run** which is a timeframe during which several patterns can be scheduled. Each Pattern can be repeated a number of times. The user can enter multiple patterns in one Run.
- The higher level is **Scenario** which is a period of time during which the same Run or Pattern can be repeated .

Every time a random period is scheduled within a Pattern it will correspond to a new randomly selected timing and power level of Interrogations.
When defined a scenario is then completely predictable.

The first three levels of a scenario are illustrated on the diagram below.



For example the TTT will allow to generate Model A scenarios:

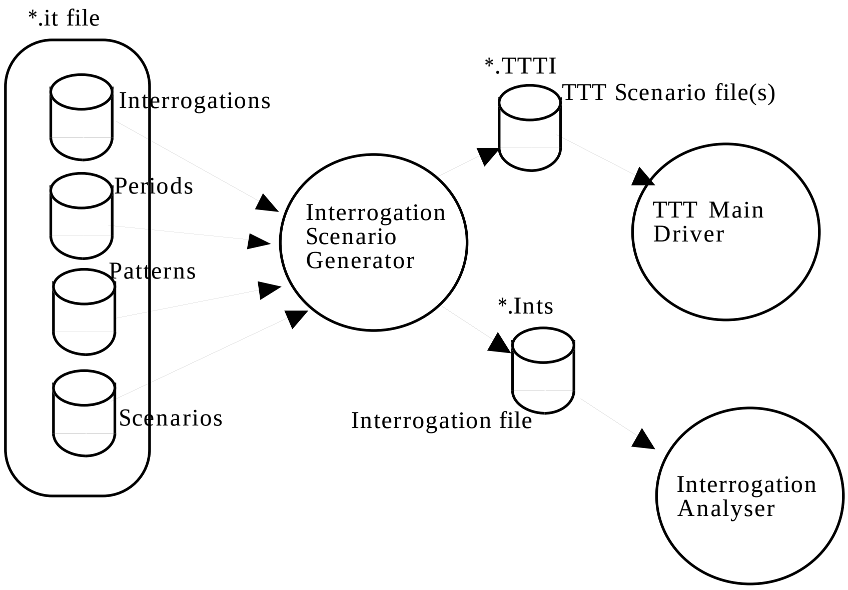
Model A Scenario

A Model A scenario will include one Pattern containing 5 random Periods of 5 ms.
A Model A scenario corresponds to 12 aircraft which are to be serviced by 5 Mode S scheduling periods in a 40 ms beamwidth (or Pattern). Each schedule is allocated a 5 ms period. The data link transactions which occur are as follows :

- Period 1 : 12 short interrogations (i.e. an UELM reservation is transmitted to each aircraft and assume that the reply from each aircraft includes the DELM announcement).
- Period 2 : 48 Comm Cs are transmitted (i.e. 4 Comm-Cs to each aircraft).
- Period 3 : 12 short interrogations (i.e. a combined DELM reservation and surveillance to each aircraft).
- Period 4 : 12 Comm C (i.e. Extract a single DELM from each aircraft).
- Period 5 : 12 short interrogations are transmitted (i.e.; an interrogation combining Comm C and Comm D close-out functions for each aircraft).

Principle of TTT Generation and Recording

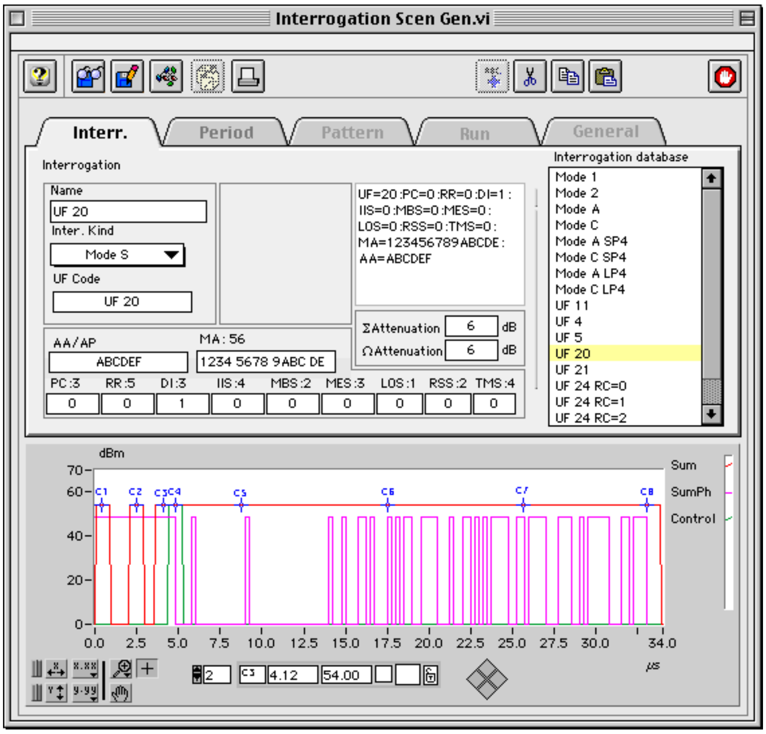
The interrogation scenario generator tool is used to create and define the interrogation scenario. The tool allows the user to define the five levels of the scenario.
The tool displays the defined scenario in a graphical representation, allowing the user to verify the scenario at any time.
All scenario information is stored in a single “Scenario” folder, which can contain several files. The most important file is the “xxx.TTTI” file, which is directly read by the scenario driver. The *.it contains the uncompiled scenario, and the *.Ints contains the expected scenario.



2.0. Interrogation Scenario Generator Tool

2.1 User Interface Overview

The user interface of the Interrogation Scenario Generator tool is constructed using five "levels" of user input, each corresponding to the different levels of the scenario as defined above.

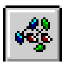


Several buttons control the operation of the tool:

 Toggle "Help" window on/off

 Load an interrogation scenario

 Save an interrogation scenario

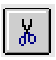
 Compile the scenario

 Randomise a period

 Print the scenario

 Edit a list (Interrogation or period)

 Enter a new record

 Cut a record (and copy to clipboard)

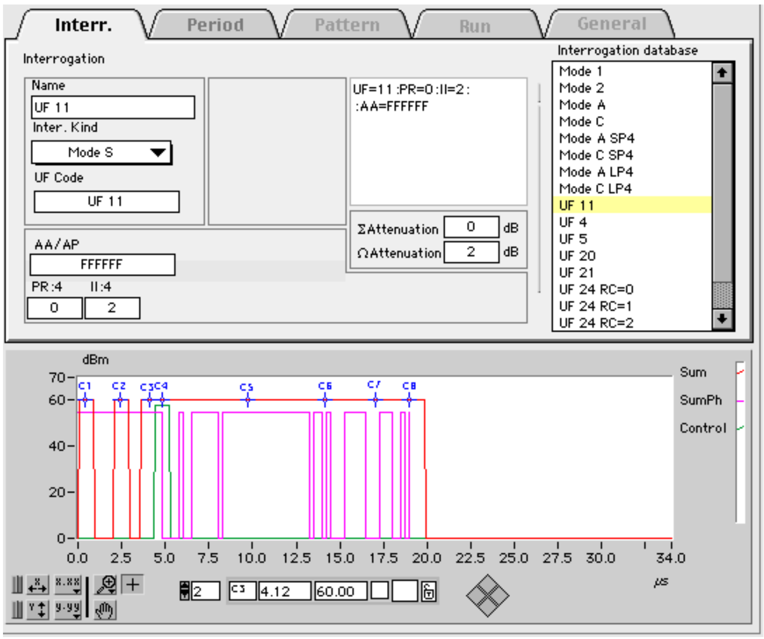
 Copy a record to the clipboard

Paste the record from the clipboard to the current index. Data is inserted

Stop the Interrogation Generator tool

2.1.1.Interrogation level

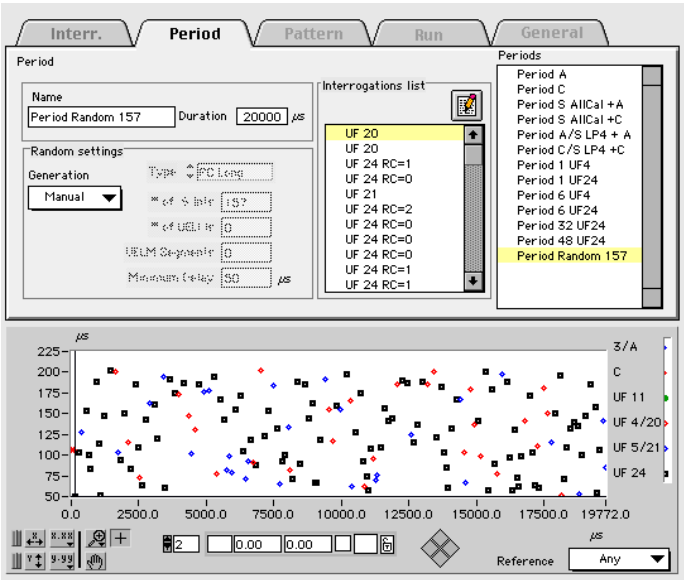
This allows the user to define or edit up to 8 different SSR or inter mode interrogations and 10 different Mode S interrogations. Furthermore, the data contents of the 10 predefined Mode S interrogations can be freely programmed using an input cluster of all the Annex 10 defined sub fields in the interrogations. The user can first define the UF code, and depending on this, he is presented with a selection of the applicable sub fields (including MA or MD data). An online help is foreseen to describe the meaning of the sub fields.Each interrogation must also be attributed an amplitude or attenuation.
Each selected interrogation is drawn in a graph, representing the P1,P2,P3,P4,P5 and P6 pulses (where applicable), and allowing for the input of the sampling position (using 8 cursors) of the amplitude of pulses where applicable.
The set of 18 interrogations can be loaded or saved separately as a template.

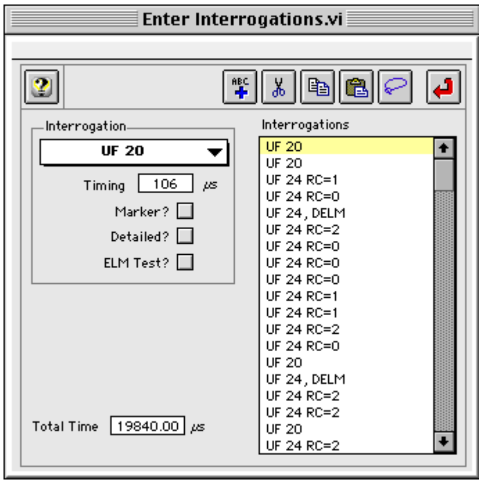


2.1.2.Period level

This level allows the user to create a number of "periods" or sequences of interrogations within a predefined time frame. The generation can be manual or random. In a manual generation, the user can create the period by selecting an interrogation template from a menu and putting it in the list of interrogations at a predefined time. In random mode, the user defines how many Mode S short or Mode S long sequences of interrogations are to be generated within the period.
The random period is generated at compilation time and can not be changed, since it is required for each random period to be unique.
A Pseudo-random period can also be generated, using the randomising button. This implies that the period is generated according to the random rules , but is filled immediately in the period, and as such it is fixed.

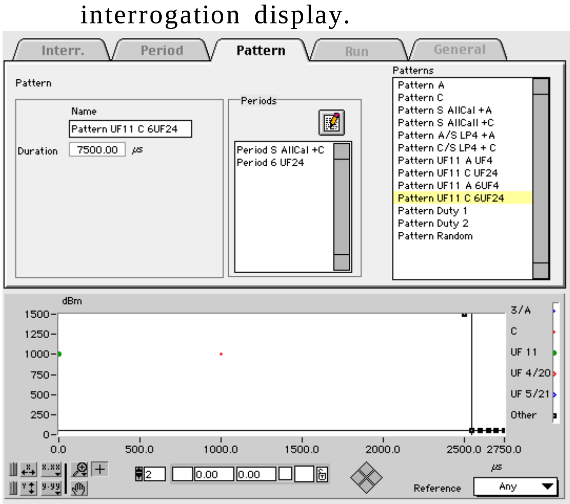
The result of the manual or pseudo-random period editing can be viewed in an interrogation graph, showing type of interrogation and inter-arrival time versus time. The period generation allows the user to select, edit, cut, copy and paste interrogations in the period until the period is according to the required specifications.
Each period is given a unique name by the user and can be saved or loaded from file as a template if required.

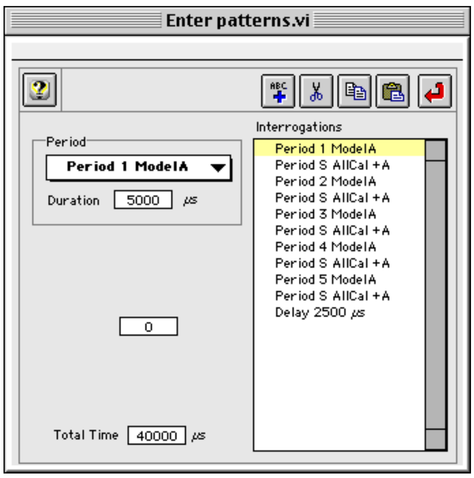




2.1.3 Pattern level

This level allows the user to create a number of “patterns” or sequences of periods within a predefined time frame. The user can select any of the previously defined periods (see above) from a menu and place them in a sequence in a list.
The user can define the start time of each period, obviously limited by the length of the selected periods.
The pattern generation allows the user to select, edit, cut, copy and paste periods in the pattern until the pattern is according to the required specifications.
Each pattern is given a unique name by the user .
The pattern is also drawn in a graph on the scenario generation window as an interrogation display.





2.1.4.Run/ Scenario level

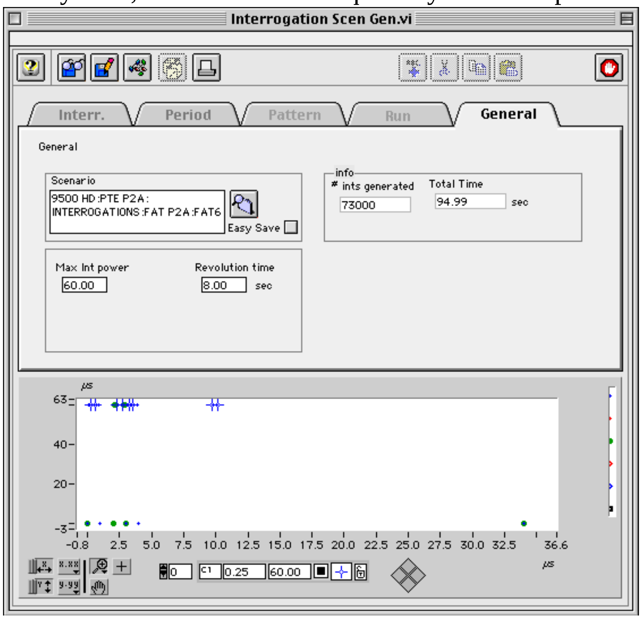
At this level the user can define several different patterns and their respective repetition rates. Typical patterns will be “background” or “ exceptional”.
The run is not drawn in a graph on the scenario generation window since the high load may result in a crowded display.
The last level , Scenario, is in fact nothing more than a run combined with a repetition factor and therefore it is combined with the Run level in the user interface.

Each scenario is given a unique name by the user and can be saved or loaded from file.

2.1.5.General

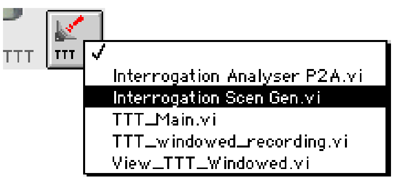
A last “bullet” on the Scenario Generators user interface is “General”. This allows the user to enter the scenario folder plus some additional parameters, such as simulation power and revolution speed etc..
The tool will furthermore allow the user to print a list of interrogations or scenarios.
After scenario definition, the tool will compile the data to the scenario file. The scenario file will be read by the Interrogation driver (TTT Main.vi) . Furthermore, the tool will create an interrogation file, with the same file format as the RES interrogation recording (From PTE P1, see PTE P1/P2 ICD v 2.2) .

This file can be used directly by the interrogation analyser (See Chapter IV) to calculate different interrogation load parameters and duty cycle .
This function must be used as checkup of the generated scenario Before proceeding with the playback of the generated scenario.
This analysis can result in the observation of a too high load or too high duty cycle of the system, which in turn requires you to adapt the scenario.

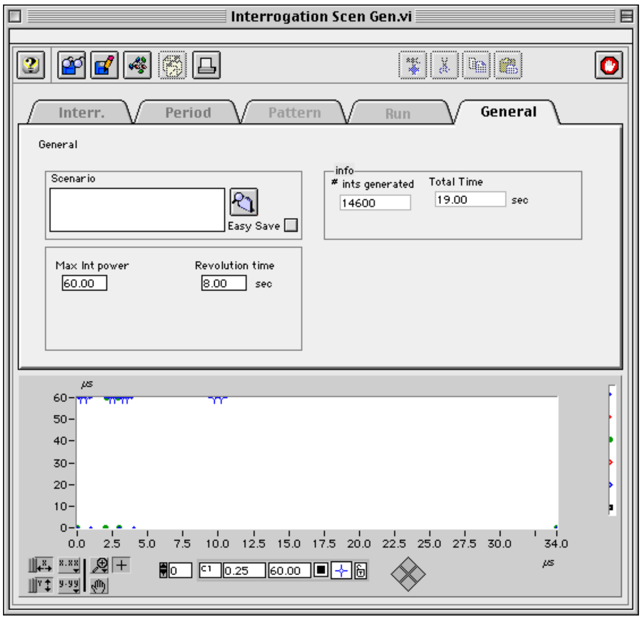


2.2 Starting the Tool

1. Load the Interrogation Scenario Generator tool from the RASS-S/PTE toolbox.

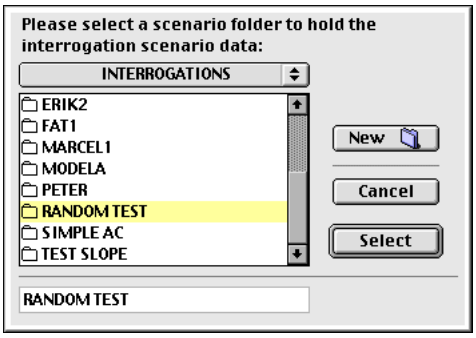


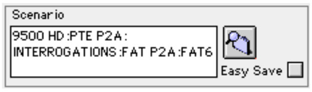
2. Run the Interrogation Scenario Tool tool using the  button in the upper left corner of the window.



3. Select the General option ('interr.' is the default opening option)

Select an interrogation Scenario folder by clicking the **Browse**  button or by entering a folder path name. Interrogation recording files are stored in the *P2A:INTERROGATION:...* folder.

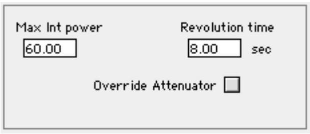




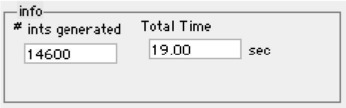
The  option allows you to save or load the scenario automatically under the correct name (*Scenariofoldername*.it) from the selected scenario folder. This can be done by using the  Load and  Save buttons.

If the option is <u>not</u> selected, the user is prompted with a file dialog each time a file is loaded or saved using the  Load and  Save buttons.

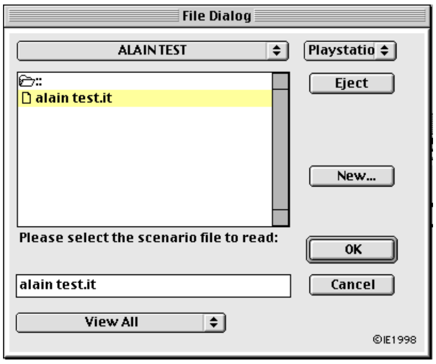
Enter an <u>estimated</u> output power of the transmitter .This value will be used for displaying purposes of the interrogation graph.
Also enter an <u>estimated</u> revolution time of the radar. This value is used to allow the generator to enter ACP values (azimuthal data) in the generated Interrogation data file, which is required for the interrogation analyser function.



Each time you change the scenario definition, the total number of interrogations and the duration of the scenario is calculated and shown in the “Info” field of the General option.



4. If you want to start editing with an existing scenario, now is the time to load that scenario. This can be done by clicking the  Load button.
If Easy Save is off, a file dialog will prompt you to enter a filename: (else *Scenariofoldername*.it is automatically loaded).

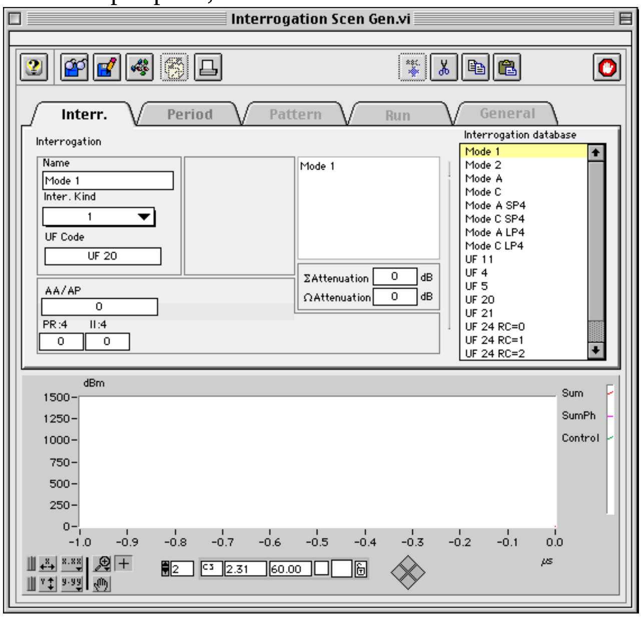


Click OK to load the scenario.

Note: To create a scenario from scratch. First create a folder using the new button in the file selector of the general tab. Then set the desired parameters in interrogations, period,... Then save the scenario and compile it using the buttons above the tab selectors.

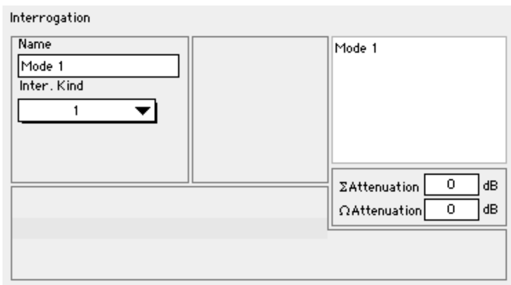
2.3 Entering Interrogations

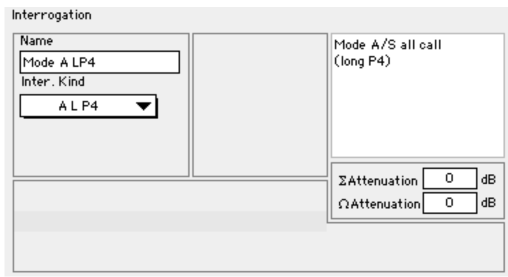
5. Now start by editing the interrogations.
For this purpose, clock the “Interr.” tab on the tab - bar.



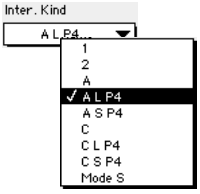
The interrogation list , shown on the right hand side of the window, always contains 18 interrogations.
A default set of interrogations is preprogrammed to accommodate the demonstration scenarios created by EC for the TTT Acceptance.
The first 8 are reserved for SSR and Intermode interrogations, the last 10 are reserved for Mode S. (The user can not change this reservation)
The user is free to program the 18 interrogations to his own imagination, except for the limitation that at least 2 short Mode S interrogations must be present in the list and only the last 10 can be used for Mode S interrogations.
First select an interrogation from the list. The corresponding data is shown on the right hand side.

• Mode 1,2,3 / A,C,A-SP4,A-LP4,C-SP4,C-LP4:

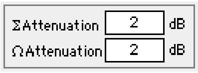




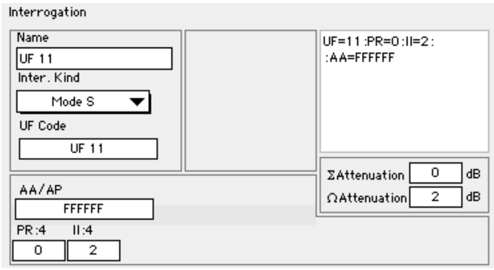
Select the Interrogation Kind using the corresponding menu selection. The selected type will be shown in the text display in the middle of the window.

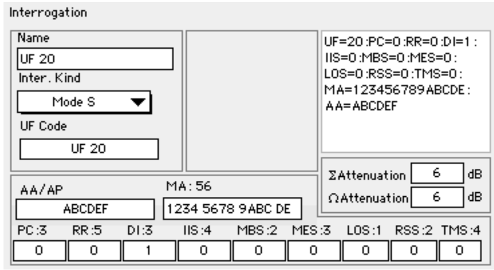


Now enter the attenuation values for the Sum and SLS channel. (Only valid for S2, Airsys) . They can contain values between 0 and 12 dB, step 2 dB. For S1 these modulations will be ignored when the override attenuation check box is crossed in ‘TTTmain.vi’.

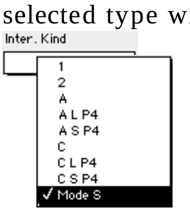


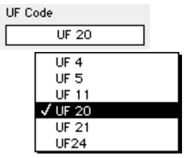
- Mode S:

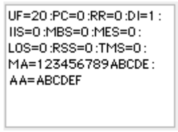




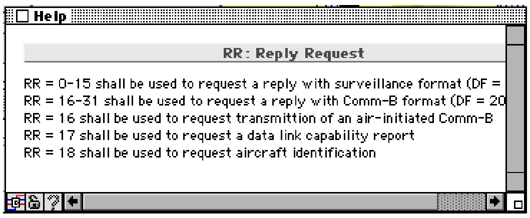
Set the Interrogation Kind to Mode S and the UF Code to the desired UF mode. The selected type will be shown in the text display in the middle of the window.





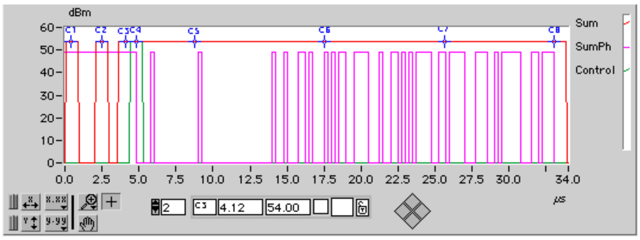


Depending on the type of UF code, the data input will change.
For UF 11, only AA, PR and II must be entered.
UF 4 and 5 require AP,PC,RR,DI plus if DI<>0 IIS,MBS,LOS,MES,RSS and TMS additionally, UF 20 and 21 require MA data
UF 24 require RC,NC,IIS and MC data
Detailed help is foreseen for each of these Interrogation Fields and Subfields:



Data input can be confirmed by selecting an other interrogation in the list.

The selected interrogation can be viewed in the graph in the bottom section of the window:



Depending on the type of interrogation, Sum, SLS and Mode S data signals are drawn as they should look upon transmission.
An important feature of this graph is the definition of the sampling points of the analog data. The TTT main tool always samples the measured power on 8 discrete positions. The exact positions of these cursors can be defined by positioning the eight cursors in this graph.

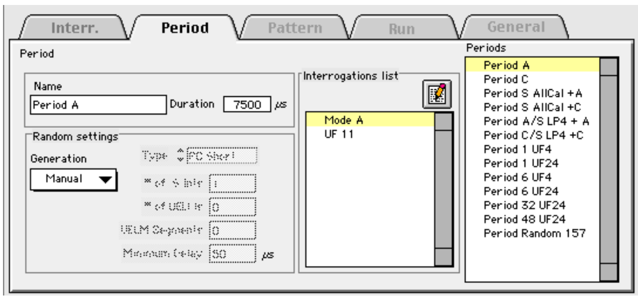
The user can “drag” each cursor over the sum or SLS curve of the interrogation. The X position has only discrete positions (every 62.5ns), while the Y value of the cursors is linked to the power entered in the general parameters minus the set attenuation values.

The user must specify the cursor positions of all interrogations before proceeding.

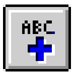
Remember that this data can eventually still be altered in the “TTT main” tool, once the system is really connected to the radar.

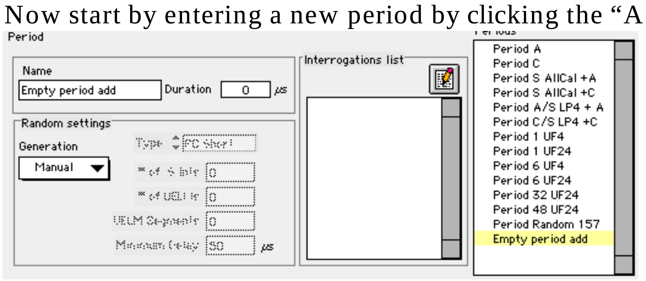
2.4 Entering Periods

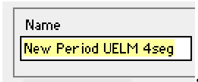
6. Once all interrogations are defined, we can start defining periods.
For this purpose, click the “Period” tab on the tab - bar.



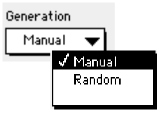
By default, the period list is filled with some example periods. The user is free to edit these or to add additional periods to the list. They can also be removed if you feel the need to do so. The size of the list of periods does not influence the scenario in any way, since only those periods selected in patterns contained in the run will be compiled. Other periods simply “reside” in the scenario file without being used.

Now start by entering a new period by clicking the “Add” button. 

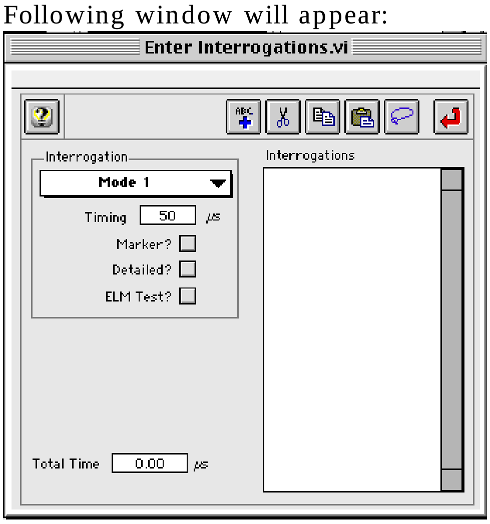


An empty period is added at the end of the list. Now enter a name for this period by over typing the name : 

. Now decide whether the period will be manually entered or randomly constructed during compilation.
This can be done by setting the “Generation” menu:



• Manual:
In manual mode, you must enter the selected interrogations in the interrogation list. This can be done by double clicking the list or by clicking the “Edit list” button: .
Following window will appear:



This window is controlled by the following buttons:

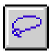
 **Toggle** “Help” window on / off

 **Add** a new interrogation in the list

 **Cut** an interrogation from the list (and copy to clipboard)

 **Copy** an interrogation from the list to the clipboard

 **Paste** an interrogation from the clipboard to the current index in the list. Data is inserted

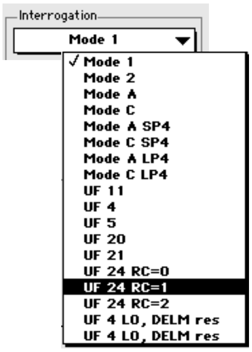


Select All interrogations in the list (so they can be e.g. cut from the list)

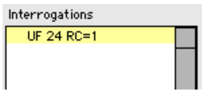
Return to the Interrogation Generator tool

Select an interrogation using the Interrogation menu and click the “Add” 

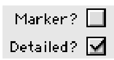
button. Also enter a timing value. This value is the delay between the current selected interrogation and the next interrogation in the period. (between the P1 pulses).
Beware: The resolution of the delay is limited to 1 µs, but some delay values can not be generated(such as 51µs, 53µs,63µs,73µs, etc..). These values will be coerced to the nearest lower value. 51 µs will be coerced to 50µs, 53 becomes 52, etc.. Note that this also applies to random and pseudo random periods.



The selected interrogation will appear in the list:

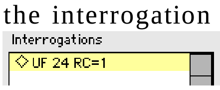


Now you can enter a “Detailed” check box, which will cause the TTT main driver to record a detailed interrogation every time an interrogation of this type is scheduled.



Beware! the number of detailed recordings is limited to ±100 per second. The software does NOT warn the user for mistakes in the scheduling of detailed data. In case too many detailed interrogations are scheduled, a number of them will not be recorded.

The “detailed” interrogations are indicated using a special icon in front of their name in the interrogation list:



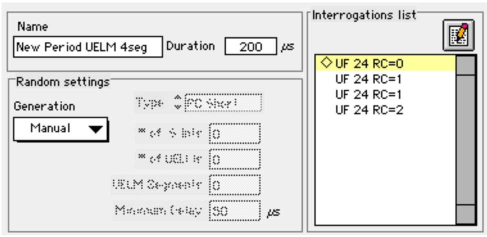
The “Marker” option is reserved for future expansion of the tool.

The ELM test must be enabled for periods containing an UELM. (Manually entered, Random generated UELMs are automatically marked). This allows the analysis of the Power drop along several UELMs. (See Chapter IV).

Add further interrogations using the method described above.
Remove unwanted interrogations using the Cut function, or copy and paste interrogations to build up your period.
The total duration of the period is always shown in the lower left corner of the window:

Once all interrogations are entered, return to the main window by clicking the **Return** button.

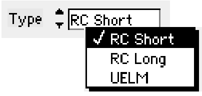
The interrogation list as well as the total duration of the period is copied into the main window:



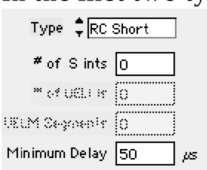
•Random: 

For random generated Periods, the user must enter a number of parameters, which in turn depend on the type of interrogations used for random generation:
First determine the total duration of the random period by entering a “Duration” value manually. 

Next select the Random type:

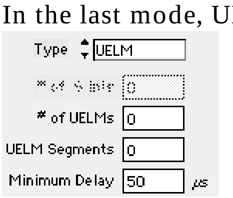


In the first two types, RC short and RC Long, the user can enter two parameters:



# of S ints: Number of S interrogations generated in the period [1..200,1]
Minimum delay : Minimum delay between two consecutive interrogations [50...20000µs,50µs]

In the last mode, UELM, the user can enter three parameters:



# of UELMs : Number of UELM messages generated in the period [1..200,1] (This is NOT the number of interrogations)
UELM segments : Number of UELM interrogations generated in one message [2..16,2]
Minimum delay : Minimum delay between two consecutive UELM segments (delay between P1 of last Interrogation of 1st ELM and P1 of first interrogation of next ELM. [50...20000µs,50µs]
In UELM mode, the ELM flag for the ELM analysis is automatically set.

Depending on these settings, the compiler will generate a sequence of random interrogations each time the random period is encountered in the scenario. So one random period is randomised several times in one scenario.

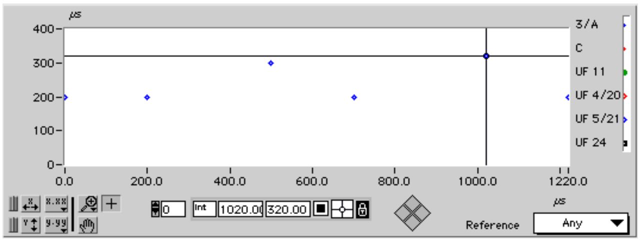
The interrogations used for this randomising are determined in two ways:
1) If no interrogations are entered in the interrogation list of the period, the selected interrogations depend on the Random type selector.
In RC short mode, only UF4 and 5 are retained.
In RC Long mode , only UF 20,UF21 and UF 24 with RC=3 are retained.
In UELM mode, only UF 24s with RC <3 are retained

2) If the user entered some interrogations in the list, a random selection from this list is made for the generation of the random period.
Special attention must be given for the case of UELM data. For correct Annex 10 like interrogations, the first UF 24 must be of the type RC=0, the next must be RC=1 and the last must be RC=2. If the user enters these three types of interrogations in the interrogation list, the random function will automatically create such sequences.

•Pseudo Random: 

For pseudo random generated Periods, the program uses the parameters entered in the random section to create a fixed set of interrogations. All the parameters mentioned under random generation are used, but the pattern is generated on the spot, by clicking the **randomise**  button.

The period data can be visualised in the graph in the lower side of the window using the “stagger display” representation. This methods shows each type of interrogation in a different colour or symbol , with the X scale representing time in µs and the Y scale representing Time between two consecutive interrogations.



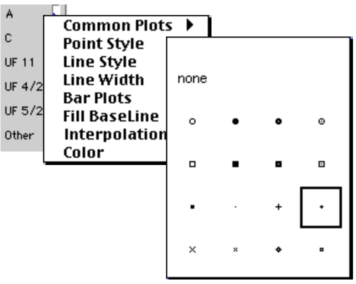
The Y-axis zero reference can be selected form the following list.

√ A/C
All Call
Roll Call
Any
None

This means that each time the selected interrogation type is encountered, the Y-axis value (time) is reset to zero. This results in a specific “stagger” patterns.
•in **AC**, the Y scale time is reset each time an A or C interrogation is encountered, showing the SSR interrogation schedule.
•in **All Call**, the Y scale time is reset each time an Mode S or intermode All call interrogation is encountered, showing the All Call interrogation schedule.
•in **Roll Call**, the Y scale time is reset each time an Mode S Roll call interrogation is encountered, showing the Mode S Roll Call interrogation schedule. This option has less importance.
•in **Any**, the Y scale time is reset each time an interrogation is encountered, showing the

time periods between any interrogation.
•in **None**, the Y scale time is never reset, showing the interrogation timing in the Y scale. This option allows the viewing of interrogation time versus azimuth.

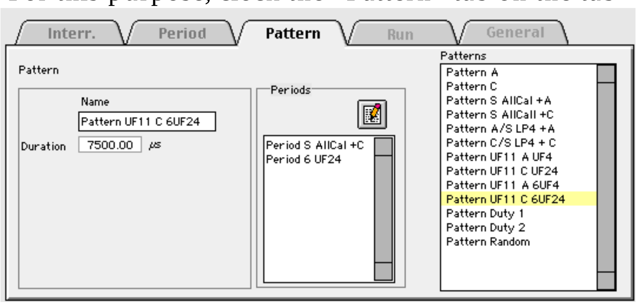
The different interrogation types are displayed according to the legend.



This legend can easily be adapted to the preference of the user.

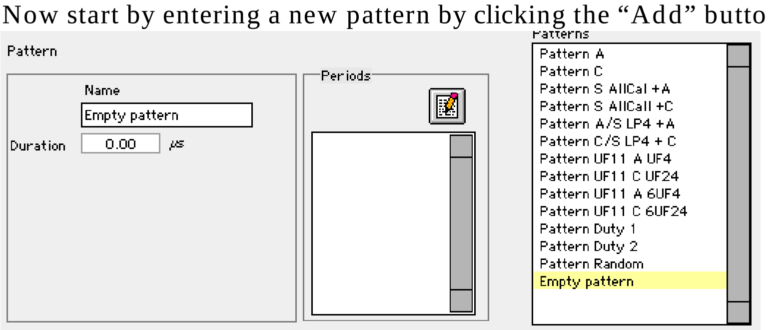
2.5 Entering Patterns

7. Now we need to define the patterns :
For this purpose, clock the "Pattern" tab on the tab - bar.



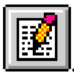
By default, the pattern list is filled with some example patterns. The user is free to edit these or to add additional patterns to the list. They can also be removed. The size of the list of patterns does not influence the scenario in any way, since only those patterns contained in the run will be compiled. Other patterns simply "reside" in the scenario file without being used.

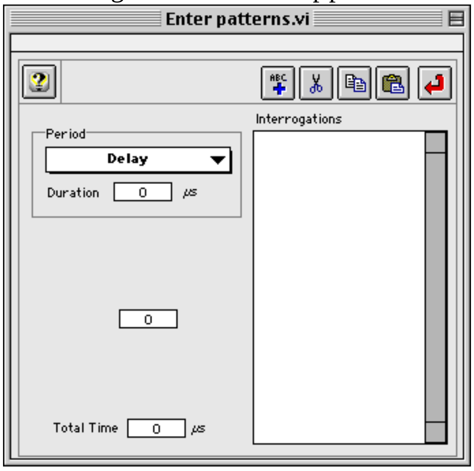
Now start by entering a new pattern by clicking the "Add" button. 



An empty pattern is added at the end of the list. Now enter a name for this pattern by over typing the name : 

.

Now you must enter the selected periods in the **Periods** list. This can be done by double clicking the list or by clicking the "Edit list" button: .
Following window will appear:



This window is controlled by the following buttons:

 **Toggle** "Help" window on/off

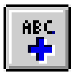
 **Add** a new periods in the list

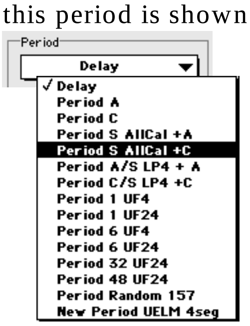
 **Cut** a period from the list (and copy to clipboard)

 **Copy** a period from the list to the clipboard

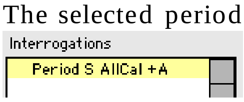
 **Paste** a period from the clipboard to the current index in the list. Data is inserted

 **Return** to the Interrogation Generator tool

Select a period using the period menu and click the "Add"  button. The duration of this period is shown in the "Duration" indicator.

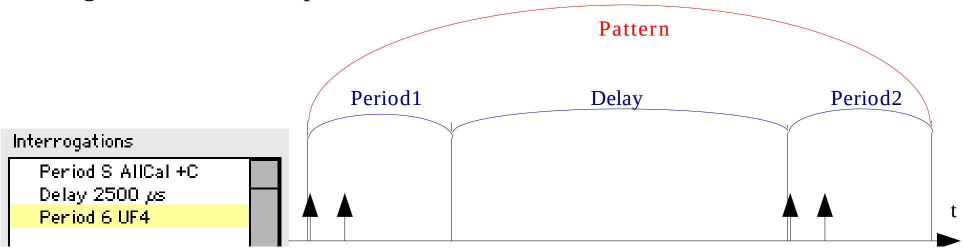


The selected period will appear in the list:



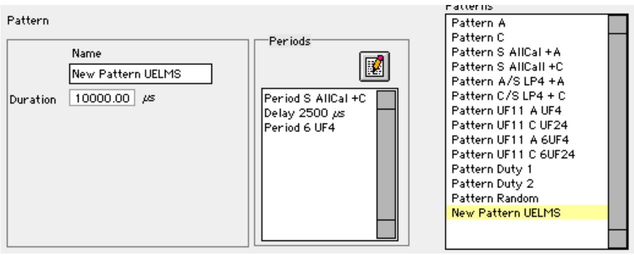
Add further periods using the method described above.
Remove unwanted periods using the Cut function, or copy and paste periods to build up your pattern.
The total duration of the pattern is always shown in the lower left corner of the window:

On top of the predefined periods, you can enter a “delay”. This is a delay between two consecutive periods, or between the end of the first period and the P1 pulse of the first interrogation in the next period.

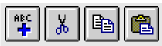


Once all periods are entered, return to the main window by clicking the **Return**  button.

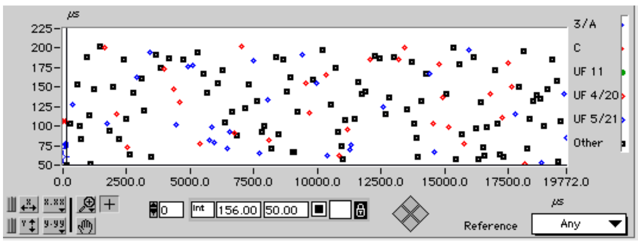
The period list as well as the total duration of the pattern is copied into the main window:



Continue editing other patterns until you have sufficient “Building blocks” to create your scenario.
Patterns can be cut , copied or pasted from and to the the list using the **Cut** , **Copy** and **Paste** buttons in the main toolbar:



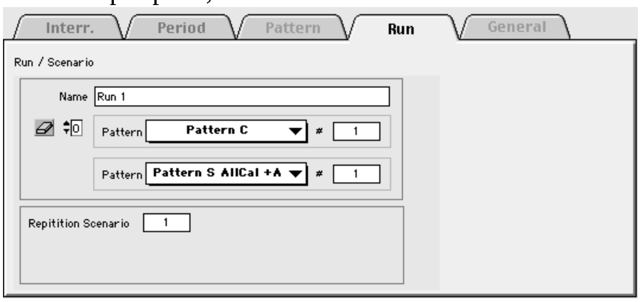
The pattern data can be visualised in the graph in the lower side of the window using the “stagger display” representation. This methods shows each type of interrogation in a different colour or symbol , with the X scale representing time in µs and the Y scale representing Time between two consecutive interrogations.



For details see **§2.4. Entering Periods**.

2.6 Entering The Run and Scenario

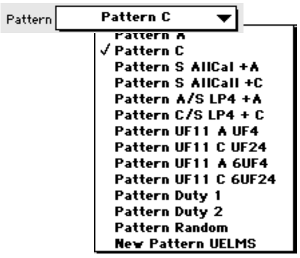
8. Finally we need to define the Run and scenario repetition parameters :
For this purpose, click the “Run” tab on the tab - bar:



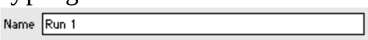
Two main items can be seen in the Run field:
1) The list with patterns in the Run
2) The scenario repetition factor.

The first item is the list with patterns. By default, two patterns are defined in the scenario.
Both patterns are shown using the “Pattern” menu selections. Each Pattern has its own repetition factor.

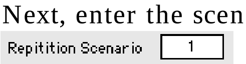
The user can select any pattern previously defined from the menu under the pattern selection:



Once the two patterns are defined, the run is defined. You can enter a name for the run by typing it in the “name” field.



Next, enter the scenario repetition factor:



Now all data for the scenario is defined.

As previously mentioned, basically a run consists of two patters (defined by a Background and a foreground pattern.)
IE added additional functionality to this by allowing the user to enter multiple patterns in a run.
This can be done by paging through the list of patterns using the “Pattern index” control:

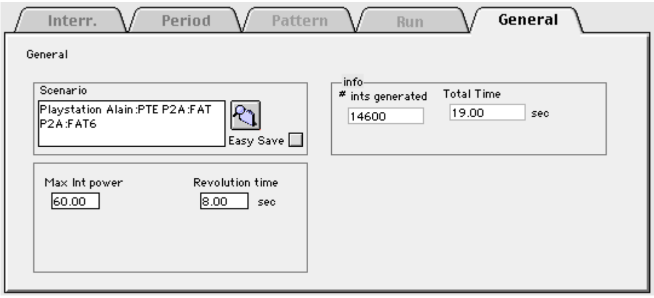
To enter multiple patterns, simply increment the index by 1 . Now you will see that the bottom pattern scrolls up one position and the bottom position becomes available.

Click on the Greyed menu and select a pattern plus repetition factor.
Now the run consists of 3 patterns. The same procedure can be repeated (in principle indefinitely) to add additional patterns to the run.

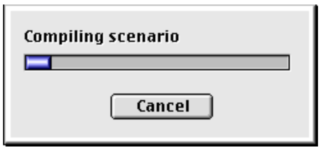
A selected entry can be eliminated by clicking the **Clear**  button or by entering 0 as the repetition factor.

2.7 Compiling

9. Once the scenario is constructed, you can compile it. This compilation is performed by clicking the **Compile**  button.

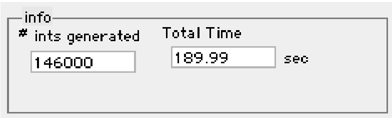


Make sure a scenario folder is selected in the General area of the Window.
The compilation can take a while to complete, depending on the number of interrogations that need to be generated. (e.g. A Model A scenario with ±150.000 interrogations lasting 190 seconds takes 48 seconds to compile.)
Following window will be shown:



By hitting the **Cancel** button the compilation process is interrupted. This interruption does not corrupt the section of the file that is already created!

After compilation, you can verify the number of generated interrogations in the “# ints generated “ indicator, plus verify the total time for the generation.:



Now, you should verify the generated data using the interrogation analyser. See Chapter IV for details.

Duty cycle and load verification are the two main analysis which should be performed before proceeding with transmission of the scenario.

After generation, 2 files are created (*.TTTI and *.Ints). The first (*.TTTI) is used for generating and recording the scenario (TTTmain.vi). The second one is used for analysis, in order to compare the recorded scenario with the expected recording (*.Ints), the type format is ‘interrogation log file’ such as used in PTE-P1 (see chapter IV, paragraph 2).

3.0. Example Scenarios

During FAT several scenarios were defined to test the capabilities of the TTT. These scenario's are included in 'PTE P2A / INTERROGATIONS / FAT P2A'.
Below you will find a description of these scenario's.

FAT 1. One scenario constituted by the alternated repetition of two patterns (1 & 2). Pattern 1 is 7.5 ms duration and contains one Mode A interrogation. Pattern 2 is 7.5 ms duration and contains one Mode C interrogation.

FAT2. One scenario constituted by the alternated repetition of two patterns (1 & 2). Pattern 1 is 7.5 ms duration and contains one Mode S All Call only (UF11) interrogation followed ~~1 ms~~ 122µs later by one Mode A interrogation. Pattern 2 is 7.5 ms duration and contains one Mode S All Call only (UF11) interrogation followed ~~1 ms~~ 109µs later by one Mode C interrogation.

FAT3. One scenario constituted by the alternated repetition of two patterns (1 & 2). Pattern 1 is 7.5 ms duration and contains one combined Mode S All Call (long P4) interrogation followed ~~1 ms~~ 122µs later by one Mode A interrogation. Pattern 2 is 7.5 ms duration and contains one combined Mode S All Call (long P4) followed ~~1 ms~~ 109µs later by one Mode C interrogation.

FAT4. One scenario constituted by the alternated repetition of two patterns (1 & 2). Pattern 1 is 7.5 ms duration and contains one period of 2.5 ms containing one Mode S All Call only (UF11) interrogation followed ~~1 ms~~ 122µs later by one Mode A interrogation and one period of 5 ms containing one UF4 Mode S interrogation. Pattern 2 is 7.5 ms duration and contains one period of 2.5 ms containing one Mode S All Call only (UF11) interrogation followed ~~1 ms~~ 109µs later by one Mode C interrogation and one period of 5 ms containing one UF24 Mode S interrogation.

FAT5. One scenario constituted by the alternated repetition of two patterns (1 & 2). Pattern 1 is 7.5 ms duration and contains one period of 2.5 ms containing one Mode S All Call only (UF11) interrogation followed ~~1 ms~~ 122µs later by one Mode A interrogation and one period of 5 ms containing 6 UF4 Mode S interrogations spaced of 50 microsec. Pattern 2 is 7.5 ms duration and contains one period of 2.5 ms containing one Mode S All Call only (UF11) interrogation followed ~~1 ms~~ 109µs later by one Mode C interrogation and one period of 5 ms containing 6 UF24 Mode S interrogations spaced of 50 microsec.

FAT6. One model A type scenario.

FAT7. One scenario (named duty cycle1) constituted by the repetition of one pattern of 16 ms containing one fixed (non-random) period (1.6 ms duration) of 32 long mode S interrogations repeated every 50 microsec.

FAT8. One scenario (named duty cycle2) constituted by the repetition of one pattern of 24 ms containing one fixed (non-random) period (2.4 ms duration) of 48 long mode S interrogations repeated every 50 microsec.

FAT9. One scenario (named duty cycle3) constituted by the repetition of one pattern of ~~100~~ 200ms containing ~~one~~ 4 random periods of 25ms duration containing 78 (2 periods) long Mode S interrogations (minimum delay between interrogations 50µs) repeated every 50ms ~~of 157 long mode S interrogations~~. This scenario is representive of 5% duty cycle on a long term.

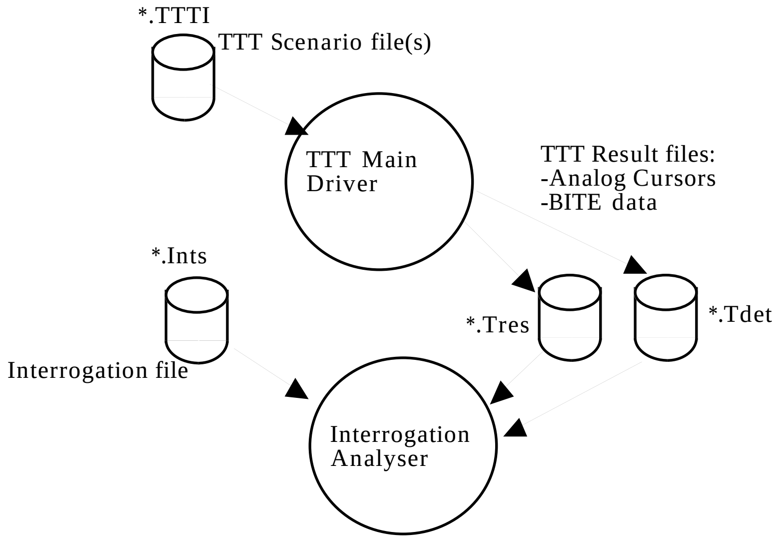
Chapter III: Transmitter Test Tool Main Driver

1.0. Introduction

The Interrogation Scenario Generator tool was created to allow the user to enter different scenarios for the Transmitter Test Tool.
By defining interrogations , periods , patterns and runs, the user can define a complete scenario of interrogations.
The TTT Main tool was developed to feed the hardware developed to interface with the POEMS station under test with the necessary data. Furthermore, the tool reads the recorded data from the TTT tool (or the Radar Video Recorder to be more specific) and writes this data to a file for further analysis.
The TTT main tool has a number of safety features incorporated, which protects the transmitter against possible malfunction of the hardware .
It also provides the user with a Built in test facility of the TTT hardware, plus the possibility of reading and decoding the BITE messages send by the POEMS S2 (Airsys) supplier .
The tool allows the user to halt generation after a certain preset number of erroneous BITE returns.

Principle of TTT Generation and Recording

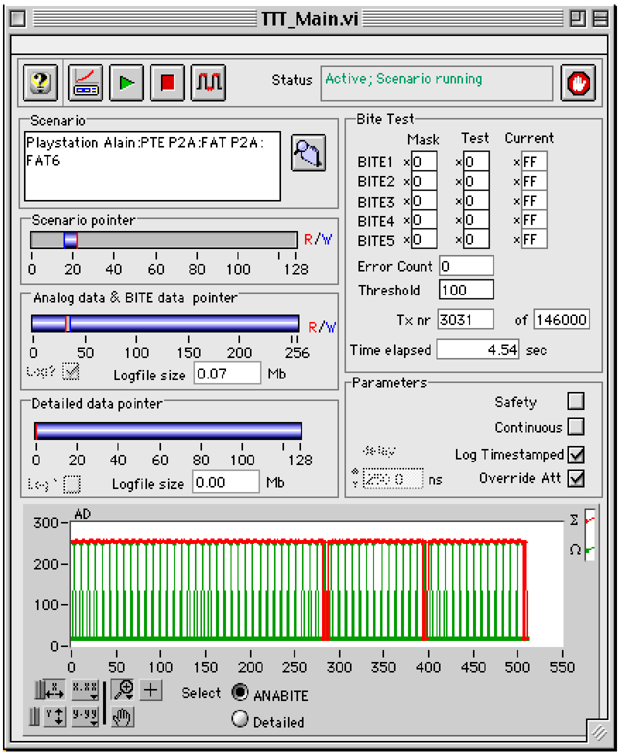
The interrogation scenario generator tool is used to create and define the interrogation scenario. The TTT Main tool drives the TTT hardware and reads back the recorded data.
It saves this data into two separate files:
-One "Analog Cursor and BITE data " file (AnaBITE) : x.TRes
-One " Detailed sampled " data file x.TDet
, where x stands for the scenario folder name.
All scenario files s are stored in a single "Scenario" folder, which can contain several files. Inside this scenario folder, multiple "Result" folders are created.
In these folders, the two result files are put.
Depending on the selection of the "Log Time stamped" checkbox (see paragraph 2.1 below), the result folder is named TTT_RSLT (untimestamped) or TTT_RSLT_yyyyMMdd_hhmmss, where
yyyy is the year, MM is the month, dd is the date, hh the hour, mm the minutes and ss the seconds.



2.0. TTT Main Tool

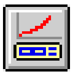
2.1 User Interface Overview

The user interface of the TTT Main tool consist of several important fields, each divided according to their function.

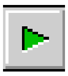


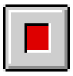
Several buttons control the operation of the tool:

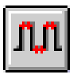
 Toggle “Help” window on / off

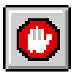
 Calibrate the PDM modules

 Specify a folder containing an interrogation scenario

 Start the generation of the scenario

 Halt generation of the scenario

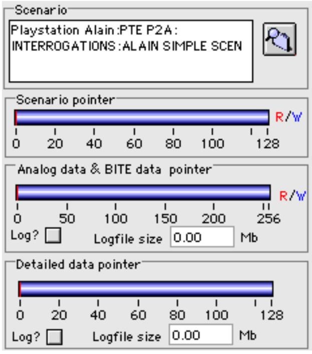
 Single step generation of interrogations, adjustment of cursors

 Stop TTT Main tool

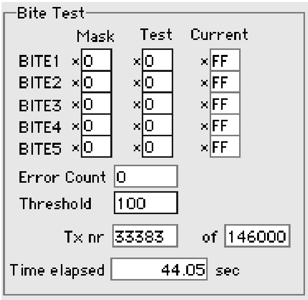
The first important section is the input fields for the scenario file plus the progress indicators for the different data streams. In fact, the tool handles three different data streams:

1) Scenario data from Computer to RVR

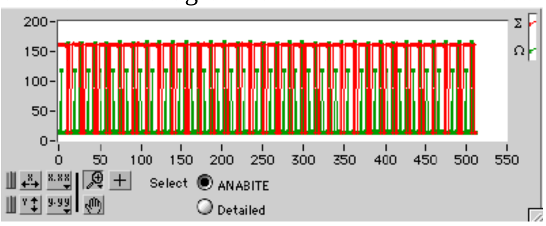
2) AnaBITE data from RVR to Computer
3) Detailed data from RVR to Computer



Next, the right hand side of the window shows the BITE message handling and the different status indicators of the TTT main tool:



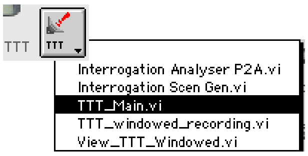
In the lower half of the window, the user can select between a monitor display of the last 512 read Analog cursor data or the last recorded Detailed data.



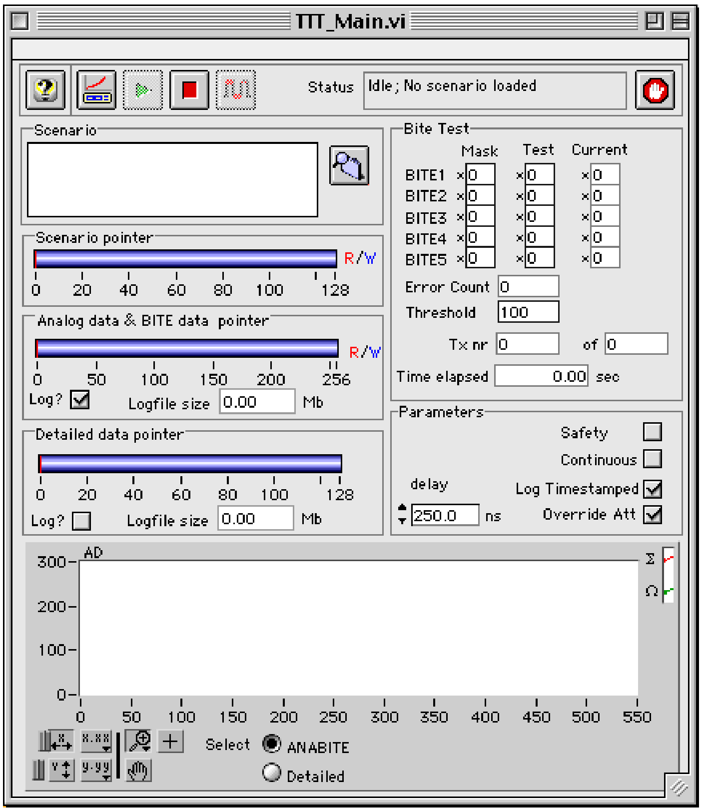
Furthermore, the tool shows the status of the hardware in the status field:

2.2 Starting the Tool

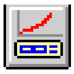
1. Load the TTT Main tool from the RASS-S / PTE toolbox:



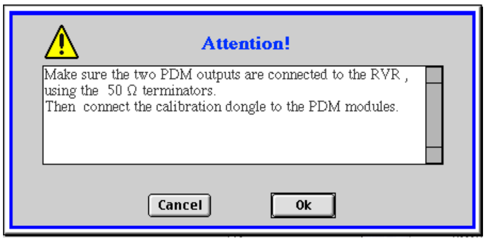
2. Run the TTT Main tool using the  button in the upper left corner of the window.



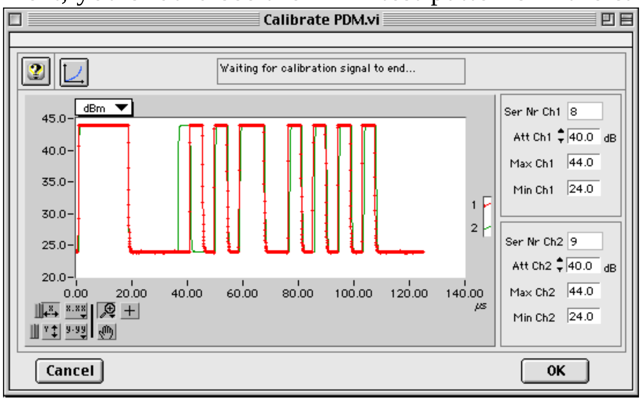
2.3 Calibrating the PDM modules

3. If you use the PDM for the first time that day, the PDM calibration window will pop up automatically: Else, this function can be recalled by clicking the  **Calibrate** button.

A dialog box will ask you to connect the Calibration dongle to the two PDM modules. Perform this action before proceeding.



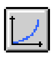
When ready, Click Ok. Cancel halts the calibration procedure and continues with scenario generation.
Next, you should see the PDM test patterns in the calibration window:



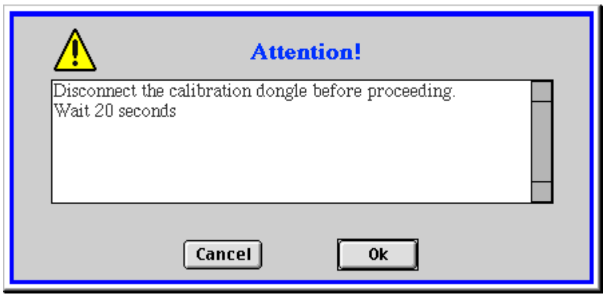
You can select the Y scale of this picture in two modes: ADs or dBms using the Y scale selector: 

Once put in dBms, the minimum and maximum signal strength should read +4 and -16 dBm, plus the attenuation values of both channels.
The principle behind this calibration is that internally, the amplitude of the two levels in the test pulses are matched with the video amplitudes of a Mode S interrogation sampled at +4 or -16 dBm. In fact this procedure eliminates external influence such as cabling, termination, AD convertor of RVR etc.
The two AD values for the two levels are sampled and referenced towards the two power levels.

Make sure to enter the proper attenuator values for the input of the PDM modules .
Default this should be 60 dB, namely 40 dB of external attenuator values plus 20 dB of the POEMS coupler.

Once this is done, click the **Calibrate**  button, which copies the sampled AD values and equalises the sampled data values towards the preset power values.

Once calibrated, click the OK button and reply to the following dialog:

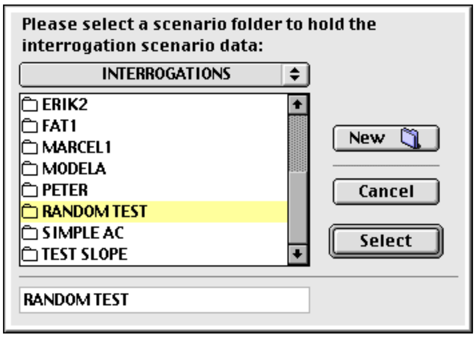


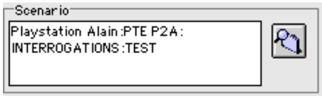
Now you **Must** disconnect the calibration dongle and wait for ±20 seconds for the signal to disappear. The calibration window remains open as long as the signal is present and warns you with this message in the status bar:

Once the calibration window is closed, it is safe to connect the PDM modules to the radar.

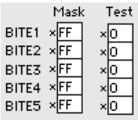
2.4 Starting a scenario

4. Select an interrogation Scenario folder by clicking the **Browse**  button or by entering a folder path name.

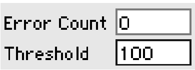


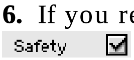


5. Enter the BITE conditions if the tool is connected to an S2 transmitter.
If the transmitter is of type S1 or no BITE checking must be performed, enter all zeros in the Mask fields.



The BITE check masks all incoming BITE messages with the **Mask** bytes (logical AND) and compares them individually with the **Test** bytes. Each time a message is unequal, an error is counted.
Once the **Error Count** is higher than **Threshold** the generation is halted.
Beware! this has one limitation: BITE data is always read in blocks of 64 messages, so the granulity of the **Threshold** value is 64!.

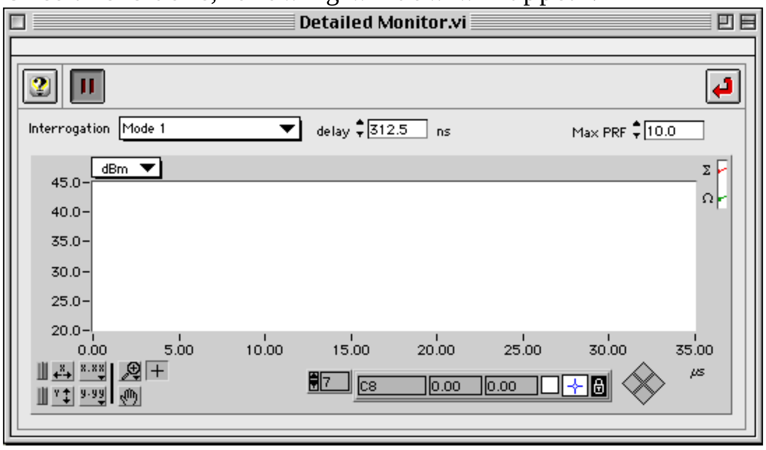


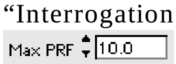
6. If you require the safety function to be operational at all times, make sure the “safety”  feature is enabled.

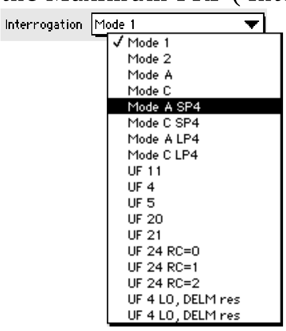
If this is the case, the user will be warned each time he starts the scenario to put the safety switch on or off.

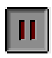
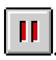
7. Now make sure the cursors are set correctly for all transmissions. This can be done by clicking the  **Single Step** button. If the safety feature is enabled , following window will warn you that this action causes life transmission and that the safety switch must be set to On:

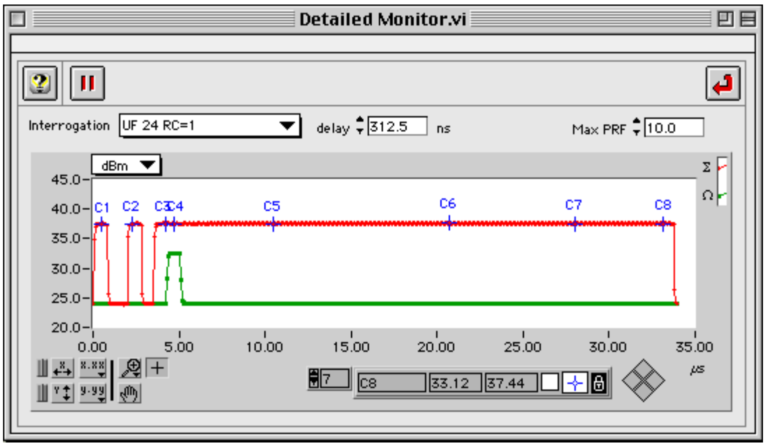
Cancel will skip the transaction.
The only correct way to proceed is setting the switch on the TTT interface to “On”.
Once this is done, following window will appear:



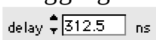
Select the type of transmission you want to send using the “Interrogation” selector, plus the Maximum PRF (Interrogations per Second transmitted). 



Once selected, enable the transmissions using the **pause** button  => .
The graph will show the sampled transmissions, if all connections are properly made . (See chapter I) .



It is now the intention to correctly position all the cursors on the different transmissions pulses. In general, all cursors (for all transmissions) can be shifted back and forth using the **delay** control , and individual cursors can be manipulated using the mouse (by dragging the cursors to other positions.



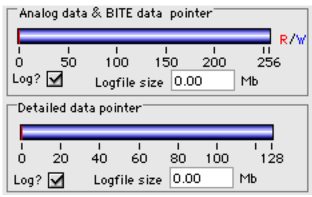
Later, all interrogations will be sampled on the positions given by the different cursors in this window.

Now select every interrogation used in your scenario at least once to make sure the cursor settings are correct.(especially if the delay value is changed, verify all interrogations).

After setting all cursors, close the window by clicking the **return**  button.

If the safety feature was enabled, following dialog will warn you to put the TTT back in a “Safe” mode:

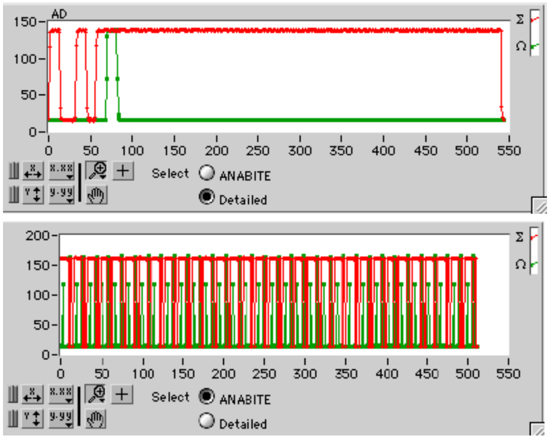
8. Now you are ready to start the scenario. First decide whetter you want to log the result data. If this is the case, check the **log** buttons on the AnaBITE data or the Detailed data side.



Next, start generation by clicking the **Start**  button.

If safety feature is enabled, you will be warned to set the safety switch to “On” .
Generation will not start before you set the switch correctly!

Now observe the monitor display at the bottom side of the TTT main window.
It will show you the AnaBITE data or the detailed data (if present) .
Select between the two using the selector switch:



The AnaBITE data is in fact a block of the last 64 recorded interrogations (times 8 cursors per interrogation makes 512 samples).

The data is shown in AD values.

9. The result data is saved in two files, named *Scaneriofoldername* . TRes and *Scaneriofoldername* . TDet.
if the “**Log Time stamped**” option is enabled each new scenario run creates a log file inside a folder named “TTT_RSLT_YYYYMMDD-hhmmss”, where YYYYMMDD is the date and hhmmss is the time.
If the **option is not selected**, the result is simply saved inside a folder named TTT_RSLT inside the scenario folder. In this case , each rerun of **the scenario will overwrite the previous result.**

The two files are automatically read when using the interrogation analyser.

10. The scenario generation automatically halts at the end of the scenario, unless the “**continuous**” check box Continuous is enabled. **Beware, when in continuous mode** , the AnaBITE and detailed data files are overwritten each time the scenario is restarted if the “**Log Time stamped**” option is not enabled. **This will fill up your harddisk and possibly crash your system .**

11. The scenarios can be created with different attenuation values for each interrogation. This results in the output of interrogations with different powers (only for Airsys type). If a scenario needs to be generated without attenuation instructions (so full power) , this can be selected using the “**Override Att**” command.

12. The scenario replay can also be halted at any time by clicking the **halt** button.
The result data can be analysed using the “Interrogation analyser”. See chapter IV.

Chapter IV: Interrogation Analysis

1.0. Introduction

The Interrogation Analyser tool allows the user to do an in depth investigation of recorded interrogations. These interrogations can be recorded in several ways, namely by the RES during a scenario generation, by the Reference extractor during opportunity traffic recording of from the TTT Interrogation Scenario generator. Extensive filtering and zooming tools make it possible to pinpoint a specific problem. Multiple statistical functions result in an easy analysis of the interrogations.
An difference must be made between the “standard” version interrogation analyser and the P2A version, which adds a number of Transmitter Test Tool specific analysis functions to the palette of this tool. The user interface of both tools are similar and can be described in general.

2.0. Making an interrogation analysis source file

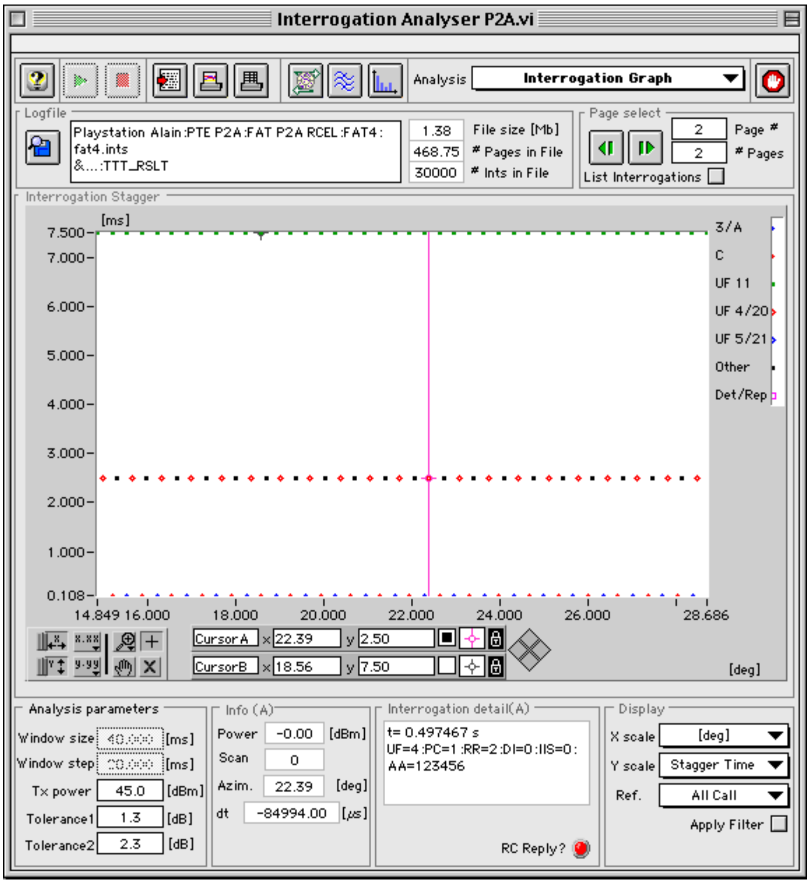
The starting point of an Interrogation Analysis is an interrogation recording file. This is the result of an TTT interrogation Generator session. Note that this file-type (interrogation log file) can also be created with a multi level analysis (Reference extractor) or can be created with the RES Main Controller tool.

More details about making an interrogation log file with the RES Main Controller tool can be found in the RASS-S / PTE User Manual Vol 5 Radar Environment Simulation. More details on making an interrogation log file using a multi level analysis can be found the RASS-S / PTE User Manual Vol 3 Reply Recording and Analysis.
More details on creating an interrogation log file using the TTT interrogation generator can be found in chapter II of this volume.

3.0. Interrogation Analyser P2A tool

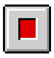
3.1 User Interface Overview

The user interface of the Interrogation Analyser tool is divided into several functional panels. At the top there is a set of buttons and controls to operate the tool.



 Toggle “Help” window on / off

 Start the analysis

 Stop the analysis

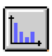
 Export data to spreadsheet

 Print graph

 Print Table

 Link with multi level analysis

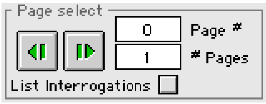
 Edit filter

 Call the histogram function

 Stop the Interrogation Analyser tool

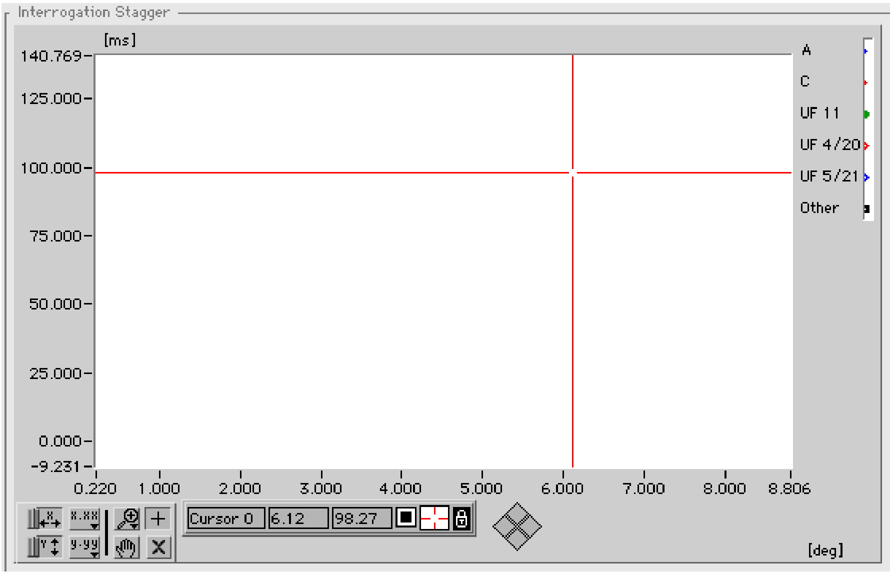
Select analysis type

Select interrogation file

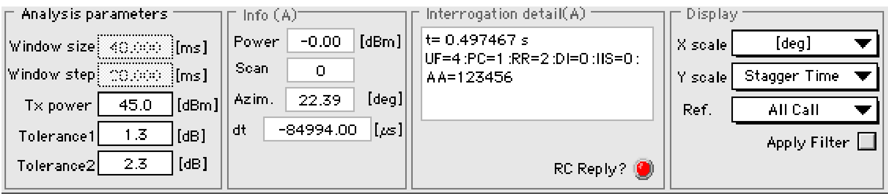


Select interrogations to be displayed

The middle part of the tool displays s a graph/table which presents the results of the analysis.

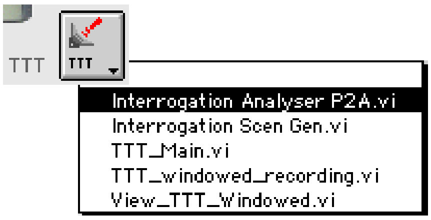


At the bottom of the window there are some analysis and display settings which become available upon selection of a specific analysis type.



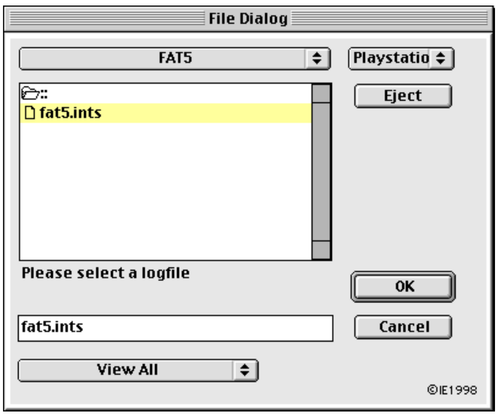
3.2 Starting the Tool

1. Load the Interrogation Analyser tool from the RASS-S / PTE toolbox.
The P2A version allows additional analysis and use of TTT session result files. For this option, the P2A software must be installed on your computer.



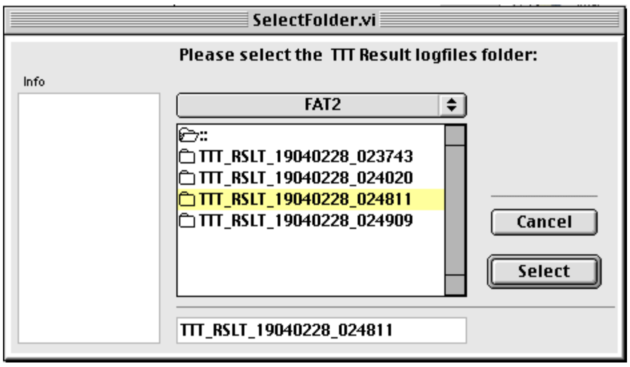
2. Run the Interrogation Analyser tool using the  button in the upper left corner of the window.

3. Select an interrogation log file by clicking the **Browse**  button or by entering a file path name. Interrogation recording files are stored in the *P2A:INTERROGATION:...* folder.



The file size will be displayed in MBytes and in # Pages. The tool also shows the number of interrogations in the File. A page consists of 64 interrogations.

If the interrogation file was recorded during a TTT session, some result files of this session should be available. (RES recorded files will not perform this action)
If this is the case, the interrogation analyser will detect this and ask the user which result folder he wants to be linked to the interrogation recording:
Select the time stamped (or none-time stamped) result folder of your choice:



Once the folder is selected, the special P2A and TTT related features become available. (TTT power check and TTT Power drop vs duty cycle)

3.3 General Tool Functions

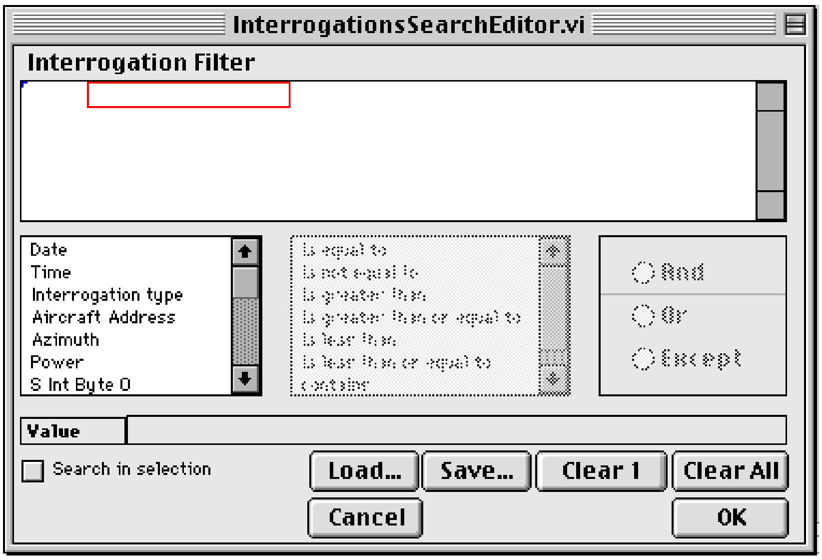
4. A filter can be applied to all data being processed in the the interrogation analyser. For the filtering function, two actions must be taken:

-The filter must be defined (or loaded from disk)

-The filter must be activated.

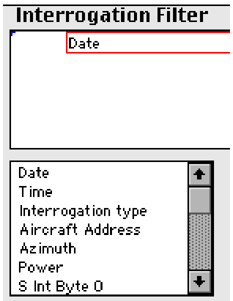
To define the filter, click the **Edit Filter**  button.

The following window will appear.

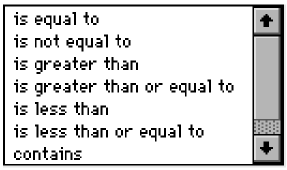


Enter the specific search criteria for the filter.

A filter consists of four functional blocks. The first block is the object of filtering. Choose an object in the list. Use the scroll bars to page through the list and click the wanted item.

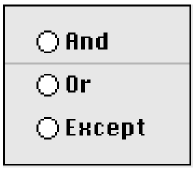


The chosen item is automatically transferred to the filter and the next block, the condition, is enabled. In the same way, select a condition from the list.



The chosen item is automatically transferred to the filter and the next block, the value , is enabled. Type in the desired value and hit the return key.

The chosen value is automatically transferred to the filter and the next block, the logical connection, is enabled. Select a logical operator from the list.



The chosen value is automatically transferred to the filter. This process is repeated until the filter setting is complete.

A filter setting can saved to disk with the Save... button or recalled from disk by clicking the Load... button.
This function is important to allow certain analysis functions to be repeated under certain conditions. Therefore we advise that all filters used for a certain analysis are saved along with the result data.

Clicking the Clear One button will clear the selected line from the filter setting, Clicking the Clear All button will clear the complete filter setting. The Cancel button will close the window and ignore all changes.
Click the OK button accept the filter and close the filter editing window.

Beware: the "Power" filter only works on RES recorded files, recorded with version 4.0.44 or later , since TTT recorded files store the power in a separate result file!

Once defined, the filter must be activated: Check the apply filter check box Apply Filter in the main window to activate the filter.

When paging through the data or making analysis, only the interrogations which comply with the search criteria are be displayed or processed.

Following fields can be used as filter criteria:

Date	MES
Time	LOS
Interrogation type	RSS
Aircraft Address	TMS(b30..32)
Azimuth[0..360]	TCS
Linear Azimuth*	RCS
Scan nr	SAS
Power	SIS
S Interrogation	LSS
UF	RRS
RL	PR
AQ	II
PC	MA
RR	NC
DI	RC
SD	MC
IIS	
MBS	

For the field “S Interrogation” , a hexadecimal representation of the interrogation can be used as filter criteria. The filter supports * and ? wild cards. (* selects all that follows, ? replaces a specific half byte.

Beware for Azimuth data : e.g.:
“Azimuth[0..360] > 45 AND Azimuth[0..360] < 90” uses the wrapped azimuth: all ints with azimuth between 45 and 90 degrees for any scan are selected.

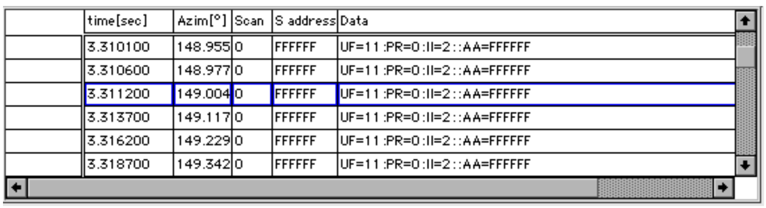
“Linear Azimuth > 45 AND Linear Azimuth< 90” uses the unwrapped azimuth: all ints with azimuth between 45 and 90 degrees for the first scan are selected.

“Scan nr >2 AND Scan nr <3” select all interrogations of scan 2.
“Scan nr >2.1 AND Scan nr >2.2” selects all interrogations of scan 2 between 36 and 72 degrees.

Once defined, the filter must be activated: Check the apply filter check box Apply Filter in the main window to activate the filter.

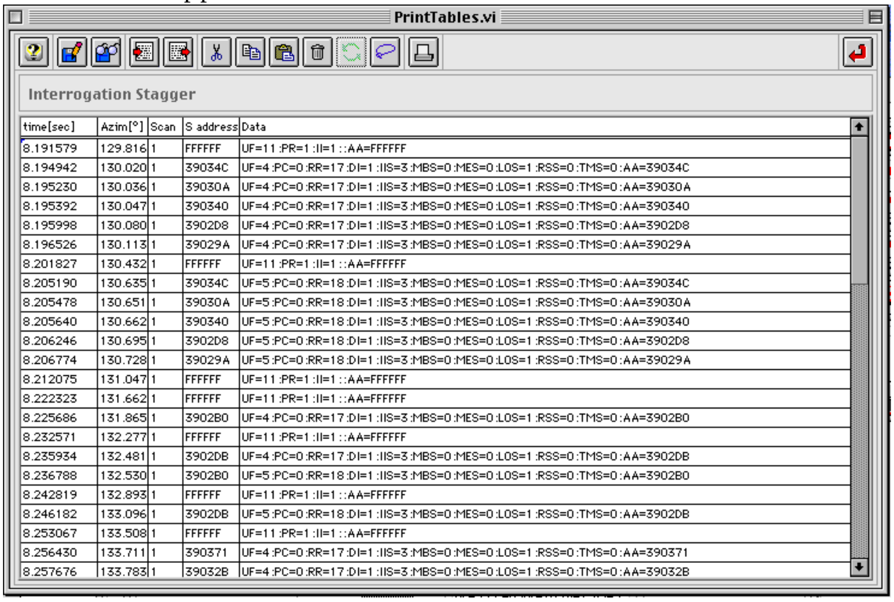
When paging through the data or making analysis, only the interrogations which comply with the search criteria are be displayed or processed.

5. Throughout the tool, data is presented in a table:



	time[sec]	Azim[°]	Scan	S address	Data
	3.310100	148.955	0	FFFFFF	UF=11 :PR=0:II=2::AA=FFFFFF
	3.310600	148.977	0	FFFFFF	UF=11 :PR=0:II=2::AA=FFFFFF
	3.311200	149.004	0	FFFFFF	UF=11 :PR=0:II=2::AA=FFFFFF
	3.313700	149.117	0	FFFFFF	UF=11 :PR=0:II=2::AA=FFFFFF
	3.316200	149.229	0	FFFFFF	UF=11 :PR=0:II=2::AA=FFFFFF
	3.318700	149.342	0	FFFFFF	UF=11 :PR=0:II=2::AA=FFFFFF

This table can be scrolled using the scroll bars to the right of the table. Its contents can also be printed or exported by clicking the **print table** button. The following window will appear.


PrintTables.vi

Interrogation Stagger

time[sec]	Azim[°]	Scan	S address	Data
8.191579	129.816	1	FFFFFF	UF=11 :PR=1 :II=1 ::AA=FFFFFF
8.194942	130.020	1	39034C	UF=4 :PC=0 :RR=17 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=39034C
8.195230	130.036	1	39030A	UF=4 :PC=0 :RR=17 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=39030A
8.195392	130.047	1	390340	UF=4 :PC=0 :RR=17 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=390340
8.195998	130.080	1	3902D8	UF=4 :PC=0 :RR=17 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=3902D8
8.196526	130.113	1	39029A	UF=4 :PC=0 :RR=17 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=39029A
8.201827	130.432	1	FFFFFF	UF=11 :PR=1 :II=1 ::AA=FFFFFF
8.205190	130.635	1	39034C	UF=5 :PC=0 :RR=18 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=39034C
8.205478	130.651	1	39030A	UF=5 :PC=0 :RR=18 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=39030A
8.205640	130.662	1	390340	UF=5 :PC=0 :RR=18 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=390340
8.206246	130.695	1	3902D8	UF=5 :PC=0 :RR=18 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=3902D8
8.206774	130.728	1	39029A	UF=5 :PC=0 :RR=18 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=39029A
8.212075	131.047	1	FFFFFF	UF=11 :PR=1 :II=1 ::AA=FFFFFF
8.222323	131.662	1	FFFFFF	UF=11 :PR=1 :II=1 ::AA=FFFFFF
8.225686	131.865	1	3902B0	UF=4 :PC=0 :RR=17 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=3902B0
8.232571	132.277	1	FFFFFF	UF=11 :PR=1 :II=1 ::AA=FFFFFF
8.235934	132.481	1	3902DB	UF=4 :PC=0 :RR=17 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=3902DB
8.236788	132.530	1	3902B0	UF=5 :PC=0 :RR=18 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=3902B0
8.242819	132.893	1	FFFFFF	UF=11 :PR=1 :II=1 ::AA=FFFFFF
8.246182	133.096	1	3902DB	UF=5 :PC=0 :RR=18 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=3902DB
8.253067	133.508	1	FFFFFF	UF=11 :PR=1 :II=1 ::AA=FFFFFF
8.256430	133.711	1	390371	UF=4 :PC=0 :RR=17 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=390371
8.257676	133.783	1	39032B	UF=4 :PC=0 :RR=17 :DI=1 :IIS=3 :MBS=0 :MES=0 :LOS=1 :RSS=0 :TMS=0 :AA=39032B

This window allows the user to load and save the listed data, export to and import from spreadsheet, cut, copy and paste the data and to print the table.

To export the data, the user can click the Export button . This creates a Tab separated text file, which can be imported into any spreadsheet application (e.g. MS Excel).

The top row buttons operate the window.

Toggle “Help” window On/Off

Save list to disk

Load list from disk

Import list from spreadsheet (text based file)

Export list to spreadsheet (text based file)

Cut item from list

Copy item from list

paste item in list

Empty list

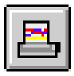
Undo last delete

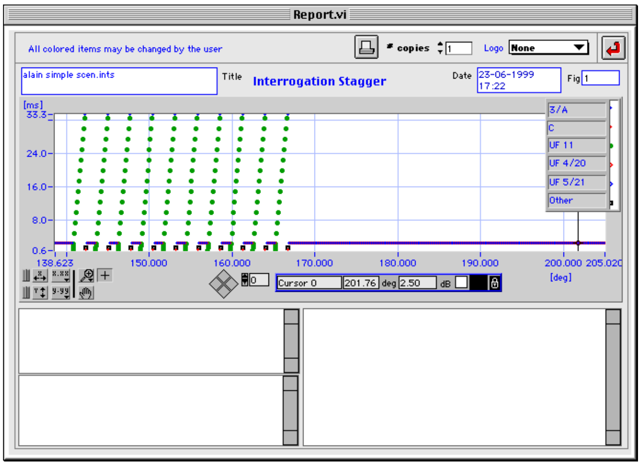
Select all

Print list

Close list window and return to the Interrogation analyser

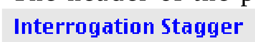
6. Throughout the tool, data is presented in a graph. This graph can be zoomed, panned or scaled using the LabVIEW tool set for Graphs:

Its contents can also be printed or exported by clicking the **print Graph**  button. The following window will appear:



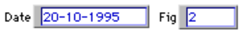
In the report window, all the blue items can be changed to fit the user. This applies for the following items:

-The header of the page:

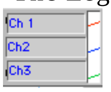


-The title of the page:

-The date and figure number:



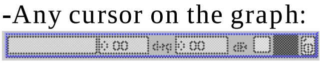
-The Legend for the different graphs:



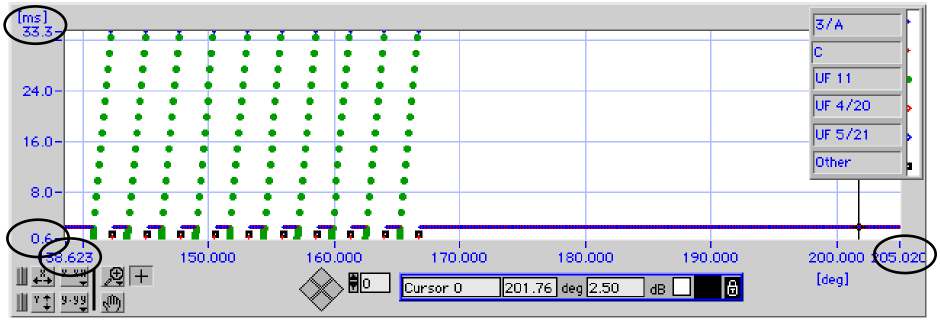
-The number of copies for the page

-The X and Y scale names:

-Any cursor on the graph:

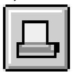


-The X and Y scales and graph positioning.

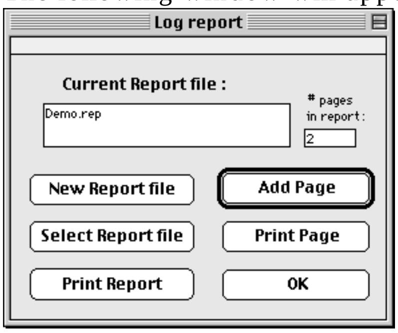


-All 3 comment and OTD parameter fields.

-The Logo

Once the scales, the axis, the plot names , the header etc, is edited to your satisfaction, click the **Print**  button on the report manager.

The following window will appear:



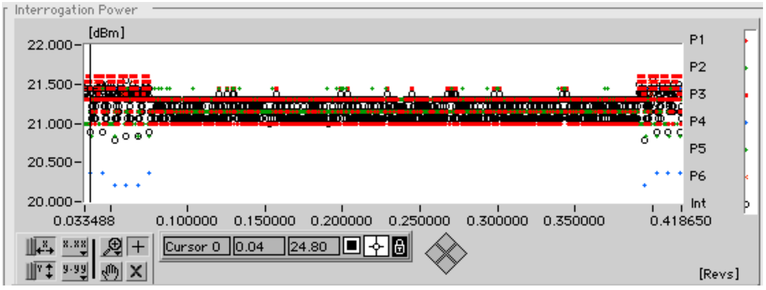
You have the following choices to make:

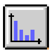
Print Page	-Print the page you were looking at.
New Report File	-Create a new report file
Open Report File	-Open an existing report file
Add Page	-Add this page to the report file
Print Report	-Print the complete report you selected.
Ok	-Leave this window

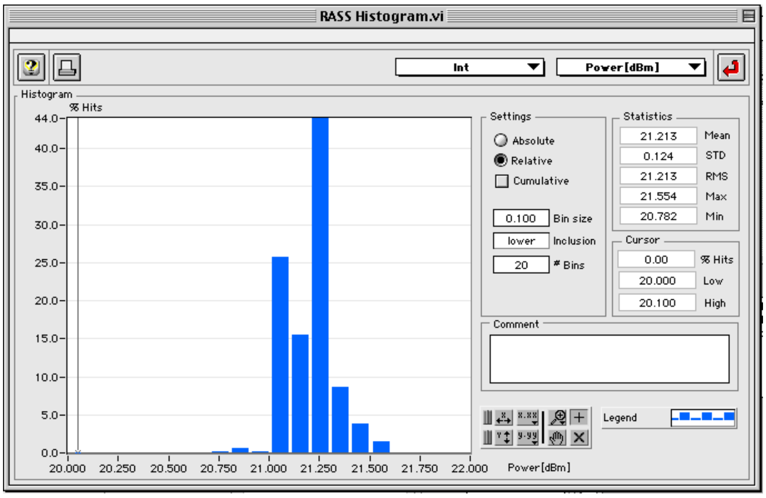
In order to print the current page, use the **Print Page button.**
If you want to save the page (with the complete layout and options) , first open or create a new report file, using the **New Report File** or **Open Report File** , then add the page using the **Add Page** button. A complete report can be printed using the **Print Report** button.
If a report file is opened, or a page is added to a new one, the “# Pages in report” indicator will be updated.
Leave the window using the **OK** button.

The printout will now be printed on the printer or saved to disk.
Printing can be stopped using the Command-point ([,]+[.]) keys.

7. Throughout the tool, data is presented in a graph. The data in the graph can be represented in a histogram if this representation makes since.
An example is the power versus azimuth graph, which can be shown as a power histogram:

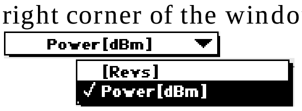


Now click the Histogram button: 
The following window appears:

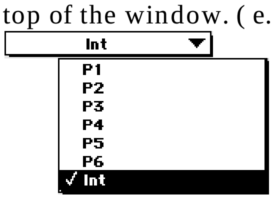


An histogram shows the number of hits (occurrences) of a specific data item in a particular bin. The size of this bin is defined by the user, as well as the number of bins.

Data from one of the two axis (In this case Power versus Azimuth, so a selection between power and azimuth is offered) can be selected using the selector in the top right corner of the window.

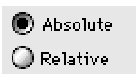


Also the layer of graph (if available) can be selected using the selector in the middle top of the window. (e.g. P1,P2, ... Int power)



The following settings can be done in the histogram function:

Relative or absolute value representation



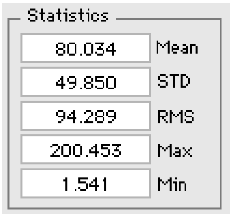
Cumulative value representation

Bin size value. The # Bins indicator is directly coupled with the Bin size value, since the complete range of the data is fixed by the X scale of the histogram(which in turn is copied from the original selected section of the input graph)

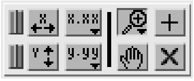
Boundary inclusion

These parameters can be altered at any time and this will result in an immediate recalculation and redisplaying of the histogram.

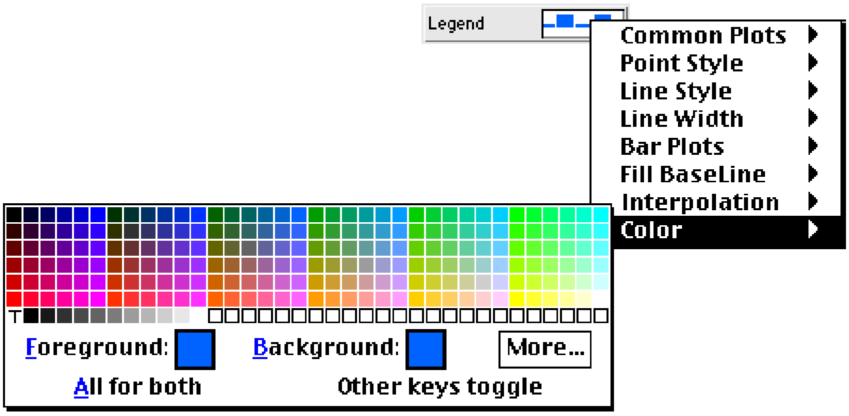
Some statistics are automatically calculated on the selected data set and are displayed at the right hand side of the histogram window.



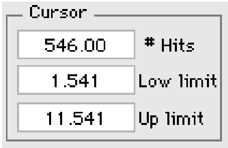
Use the graph palette to zoom and pan in the data, centre and select the cursor.



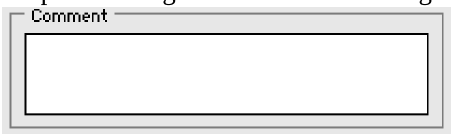
Use the legend palette to change the appearance of the histogram.



The cursor display shows the value, the upper and lower boundary of the selected histogram bin. A bin can be selected by dragging the cross cursor to it. The cursor will automatically be placed in the centre of the bin and the cursor display will be updated at the same time.



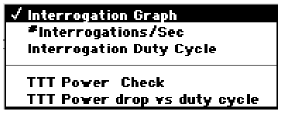
The histogram can be printed by clicking the print button. The RASS-S/PTE reporting function is enabled which allows you to store or print the histogram. Information about the histogram can be entered in the comment field. This field will be printed together with the histogram.



Click the return button to close the histogram function and return to the Interrogation tool

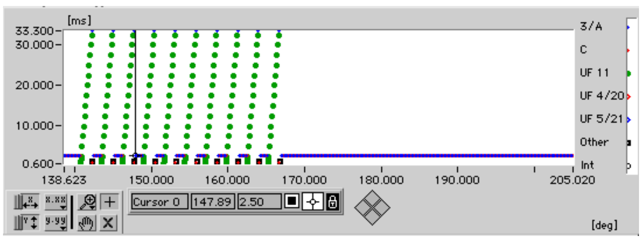
3.4 Timing and Interrogation Contents Analysis

9. A first analysis function of the Interrogator Analyser is to display the recorded interrogations and their contents according to their type and position in time. For this function choose Interrogation graph from the analysis menu. The Interrogation Graph function is the only selection which does not need proceeding before the result can be displayed. This function is available for PTE-P1 and PTE-P2A.

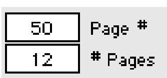


The Y scale should be set to stagger” for this type of graph . (For other possibilities, see further).

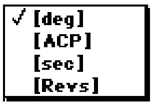
A set of recorded interrogations will be displayed in the graph each time a new page is selected:



This set can be controlled using the Page Up or Page Down button. Alternatively, a specific start page and the number of pages to be displayed can be entered directly in the respective controls. The graph will be update immediately.

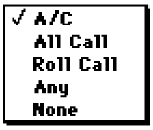


The X-axis scale unit can be selected from the following list, and may show time or azimuthal data . (Azimuth, ACP, Time or Scan numbers)



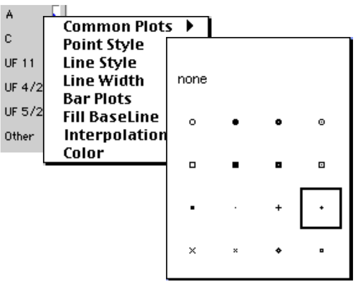
The Y scale is set to “stagger” for this type of graph . (For other possibilities, see further).

The Y-axis zero reference can be selected form the following list.



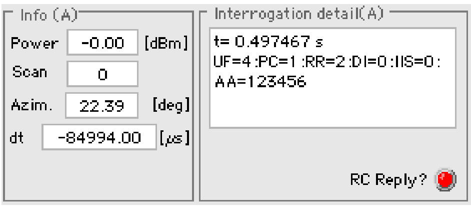
This means that each time the selected interrogation type is encountered, the Y-axis value (time) is reset to zero. This results in a specific “stagger” patterns.
•in **AC**, the Y scale time is reset each time an A or C interrogation is encountered, showing the SSR interrogation schedule.
•in **All Call**, the Y scale time is reset each time an Mode S All call interrogation is encountered, showing the Mode S All Call interrogation schedule.
•in **Roll Call**, the Y scale time is reset each time an Mode S Roll call interrogation is encountered, showing the Mode S Roll Call interrogation schedule. This option has less importance.
•in **Any**, the Y scale time is reset each time an interrogation is encountered, showing the time periods between any interrogation.
•in **None**, the Y scale time is never reset, showing the interrogation timing in the Y scale. This option allows the viewing of interrogation time versus azimuth.

The different interrogation types are displayed according to the legend.

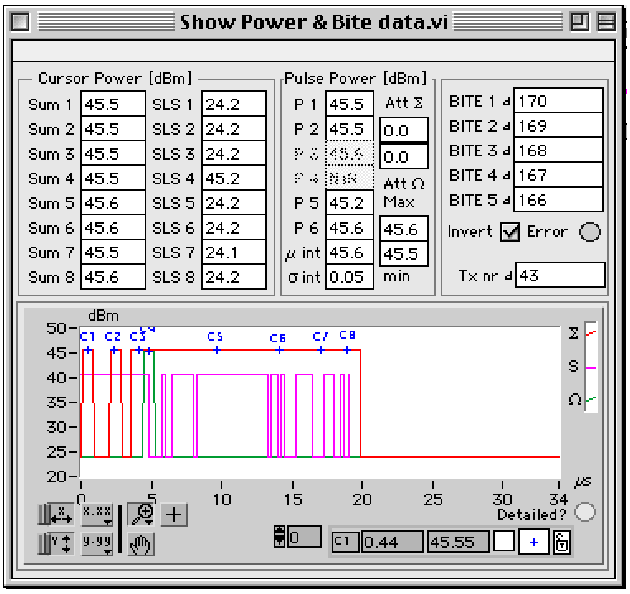


This legend can easily be adapted to the preference of the user.

Details and the contents of the interrogation selected with the first cursor are displayed below the graph. This information data also provides you with reading of power, scan nr and azimuth of the selected interrogation. Using the second cursor, a delta time value (time difference between two selected interrogations can be determined.



The first cursor is also linked to the "Show Power&Bite data.vi" window. This shows the reconstructed interrogation with correct powers plus the values of the eight sampled cursors on both channels.
The window can also be used for display of BITE data. If a specific interrogations was marked "detailed" during scenario definition, the detailed data can be seen in the same window. The contents of the BITE message can be inverted , depending on the setting of the "Invert" checkbox.



A filter can be applied to the interrogation display function. Check the apply filter check box Apply Filter ☑ and click the **Edit Filter** button.
Enter the specific search criteria for the filter. See above for detail.

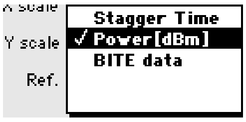
Checking the **List Interrogations** List Interrogations ☑ check box will add a table with details about the interrogations displayed in the graph. The graph will shrink to half its size on the window and the interrogations are shown in a graphical table.
The selected interrogation (using the cursor in the graph) is also highlighted in the table.

	time[sec]	Azim[°]	Scan	S address	Data
	3.310100	148.955	0	FFFFFF	UF=11 :PR=0:II=2::AA=FFFFFF
	3.310600	148.977	0	FFFFFF	UF=11 :PR=0:II=2::AA=FFFFFF
	3.311200	149.004	0	FFFFFF	UF=11 :PR=0:II=2::AA=FFFFFF
	3.313700	149.117	0	FFFFFF	UF=11 :PR=0:II=2::AA=FFFFFF
	3.316200	149.229	0	FFFFFF	UF=11 :PR=0:II=2::AA=FFFFFF
	3.318700	149.342	0	FFFFFF	UF=11 :PR=0:II=2::AA=FFFFFF

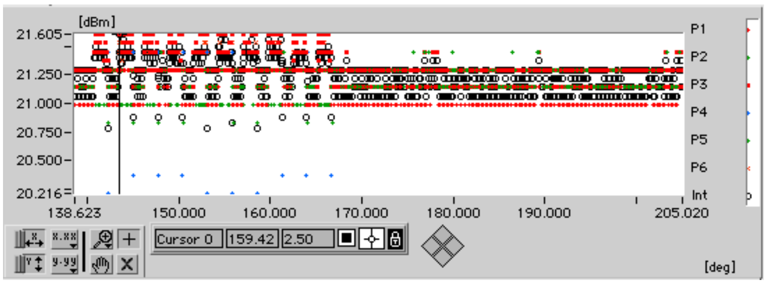
3.5 Interrogation Power Analysis

8. The Interrogator Analyser allows us to display the recorded interrogations power as a function of time or azimuth. For this function choose Interrogation Graph from the analysis menu. This function is available for PTE-P1 and PTE-P2A.

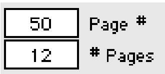
The Y scale should be set to “Power [dBm]” for this type of graph . (For other possibilities, see above).



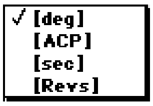
A set of recorded interrogation powers will be displayed in the graph each time a new page is selected:



The pages can be controlled using the Page Up  or Page Down  buttons. Alternatively, a specific start page and the number of pages to be displayed can be entered directly in the respective controls. The graph will be update immediately.

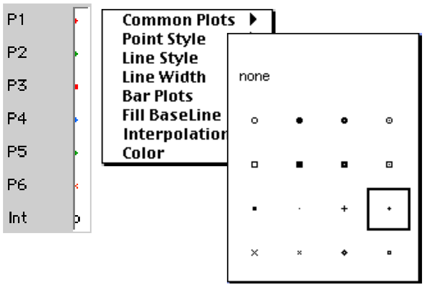


The X-axis scale unit can be selected from the following list, and may show time or azimuthal data . (Azimuth, ACP, Time or Scan numbers)



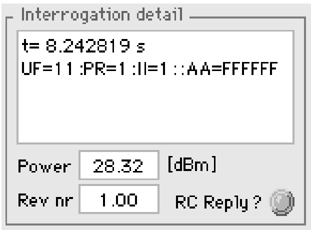
The powers are shown in seven different graphs, each containing the average power of one type of pulse in the interrogation (P1 through P6) plus the average power of the interrogation itself (on Sum channel). The power of each pulse is determined using the preset cursors, as set in the interrogation scenario generator or the TTT Main control.
In case of RES recorded data, only the average interrogation power is shown.

The power of each pulse is the average value of all cursors which fall within the Annex 10 specified timing slots for these pulses. (depending on the type of interrogation.)
P2 and P5 pulses are measured on the SLS channel, P1,P3, P4 and P6 are measured on Sum channel.

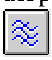


The seven graphs each have a legend which can be adapted accordingly.
This legend can easily be adapted to the preference of the user.

Details and the contents of the interrogation selected with the cursor are displayed below the graph.



A filter can be applied to the interrogation display function. Check the apply filter check box 

and click the **Edit Filter**  button.
Enter the specific search criteria for the filter. See above for detail.

When paging through the data, only the interrogations which comply with the search criteria will be displayed.

Checking the **List Interrogations** 

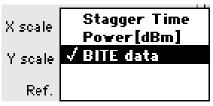
check box will add a table with details about the interrogations displayed in the graph. The graph will shrink to half its size on the window and the interrogations are shown in a graphical table.
The selected interrogation (using the cursor in the graph) is also highlighted in the table.

3.6 BITE Data Analysis

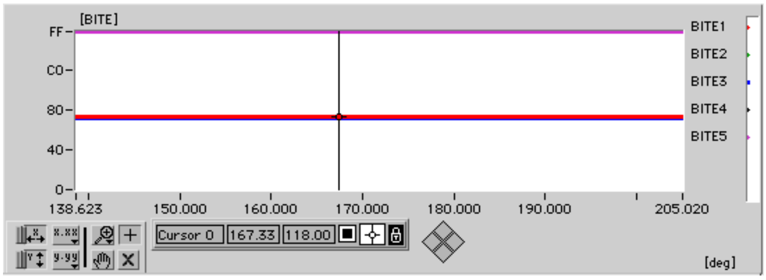
This function only works for TTT generated files on S2 (Airsys) type POEMS radars.

9. The Interrogator Analyser allows us to display the recorded interrogations BITE messages as a function of time or azimuth. For this function choose Interrogation Graph from the analysis menu.

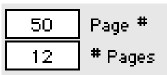
The Y scale should be set to “BITE data” for this type of graph . (For other possibilities, see above).



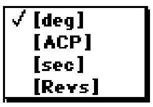
A set of recorded interrogation BITE messages will be displayed in the graph each time a new page is selected:



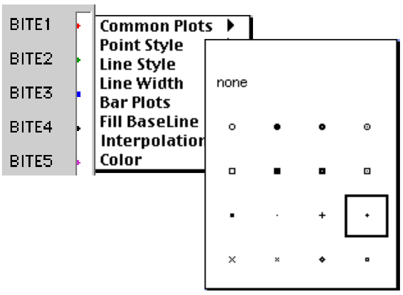
The pages can be controlled using the Page Up  or Page Down  buttons. Alternatively, a specific start page and the number of pages to be displayed can be entered directly in the respective controls. The graph will be update immediately.

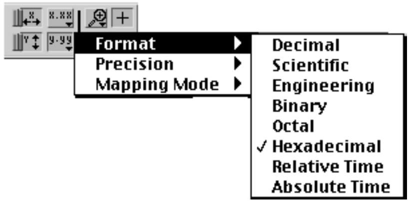


The X-axis scale unit can be selected from the following list, and may show time or azimuthal data . (Azimuth, ACP, Time or Scan numbers)

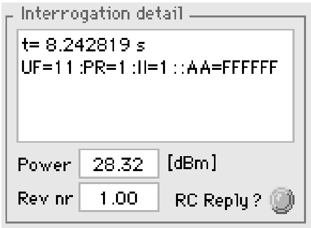


The BITE messages are shown in five different graphs, each containing one BITE message.
The BITE contents is displayed as a 8 bit number (0..255), but the Y scale can be set to Hex or Binary representation if required. The Legend of each graph can also be adjusted.

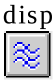




Details and the contents of the interrogation selected with the cursor are displayed below the graph.



A filter can be applied to the interrogation display function. Check the apply filter check box 

and click the **Edit Filter**  button.
Enter the specific search criteria for the filter. See above for detail.

When paging through the data, only the interrogations which comply with the search criteria will be displayed.

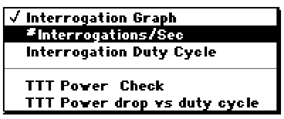
Checking the **List Interrogations** 

check box will add a table with details about the interrogations displayed in the graph. The graph will shrink to half its size on the window and the interrogations are shown in a graphical table.
The selected interrogation (using the cursor in the graph) is also highlighted in the table.

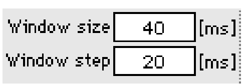
3.7 Transmitter Load Analysis

This Type of analysis calculates the load (# interrogations per second) in a specific sliding window for a complete interrogation file. This function is available for PTE-P1 and PTE-P2A.

10. Select # Interrogations/sec from the analysis selection menu.



This selection requires processing before any results can be displayed. Some extra analysis parameters need to be set before processing the data.

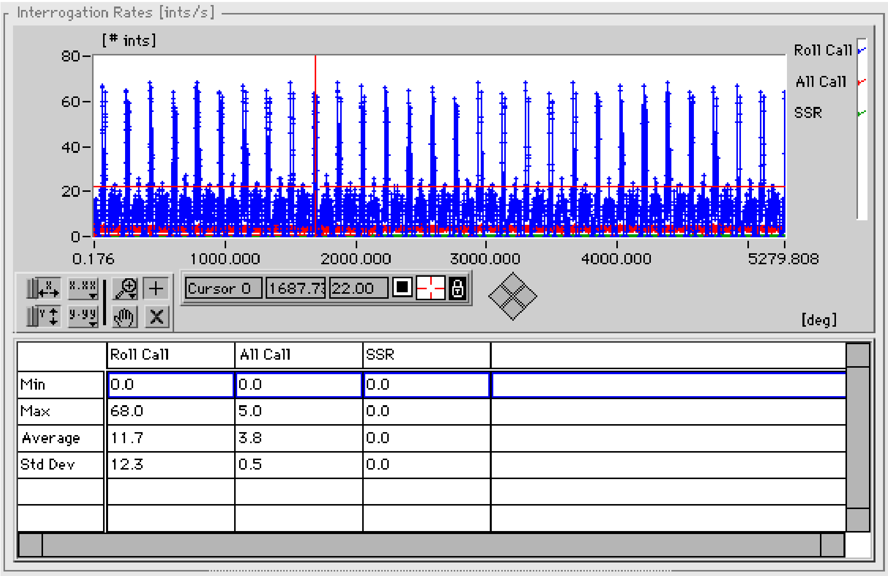


The window size parameter determines the interval in which the processing is done. In

this case, the number of interrogations of a specific type are counted in that interval. The window step parameters defines the step size that the calculation window takes for each calculation.
Window size can vary between 50 µs and 15 seconds. Window step can vary between 50µs and 15 seconds.

Click the **Start**  button to start the processing. A progress indicator will appear to show the processing.

The processing can be stopped at any time by clicking the **Stop**  button. The results of the data already processed will be displayed in the graph and in the table.



The Y-axis scale unit can be selected from the following list.

[# Ints] means the number of interrogations of a specific type counted in an interval defined by the window size .
[# Ints/sec] means the the number of interrogations in the window is recalculated to an interval of 1 second. In the window size is set to 1 second, both results will be the same.

Filtering, printing and exporting the data is available in this analysis mode.

3.8 Transmitter Duty Cycle Analysis

This Type of analysis calculates the duty cycle (Time transmitter is sending power / total time) in a specific sliding window for a complete interrogation file.
Each type of interrogation is given a fixed time "on-time" duration.
Times are shown hereunder:
1,2,A,C : 1.6µs
SSR only All Call : 2.4 µs
Intermode S All Call : 3.2 µs

S Short : 17.85µs
S long: 31.85 µs
This function is available for PTE-P1 and PTE-P2A.

11. Select Interrogation Duty Cycle from the analysis selection menu.

Interrogation Graph
✓ *Interrogations/Sec
Interrogation Duty Cycle

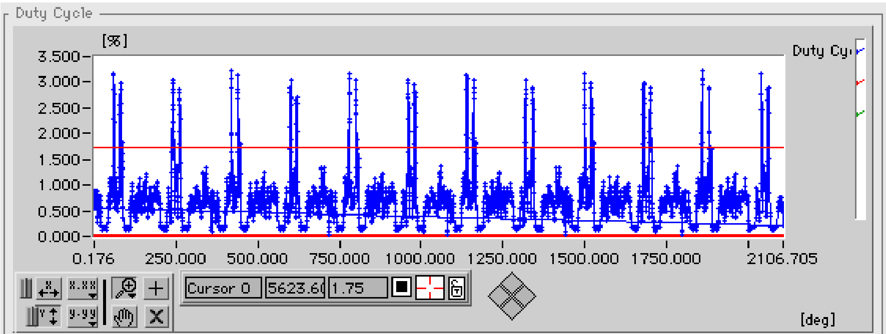
TTT Power Check
TTT Power drop vs duty cycle

This selection requires processing before any results can be displayed. Enter the preferred analysis parameters settings.
Some extra analysis parameters need to be set before processing the data:

Window size	40	[ms]
Window step	20	[ms]

The window size parameter determines the interval in which the processing is done. In this case, the number of interrogations of a specific type are counted in that interval. The window step parameters defines the step size that the calculation window takes for each calculation. Window size can vary between 50 µs and 15 seconds. Window step can vary between 50µs and 15 seconds.

Click the **Start** button to start the processing.
The following window shows the result. Remember that the duty cycle statistics are calculated with the window size as time interval.



	Duty Cycle(%)
Min	0.04
Max	3.21
Average	0.69
Std Dev	0.55

Filtering, printing and exporting the data is available in this analysis mode.

3.9 TTT Result Power and Presence Analysis

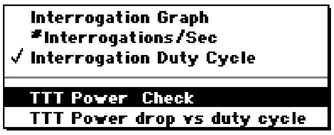
This Type of analysis checks all the interrogations generated by the TTT main tool and recorded in a Tres -file for errors interrogations or patterns . The analysis also calculates the average interrogation power (overall for all interrogations) and min and max power. The analysis does not work on RES recorded data.

1. A Pattern will be declared correct if the following conditions are met for all the Interrogations included in that Pattern :

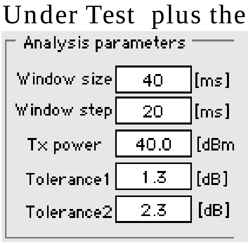
- all the pulses (P1, P2, P3, P4, P5, short or long P6) requested have been actually transmitted on the corresponding channel (sum or control). This condition is included in the next condition:
- The average power of the pulse of an interrogation transmitted on the sum or control channel is within (taking into account the measurement errors) a user selectable value (0.1..10,1.3) dB of the requested power level. In case of 16 consecutive long interrogations, only the first interrogation of the set will be evaluated.
- The amplitude variation during any transmitted P6 pulse is less than 1 dB (=Tolerance 1) (taking into account the measurement errors).
- The amplitude variation along P6 pulses corresponding to a set of consecutive long Mode S Interrogations (UELM transmission) is less than a user selectable value (0.1..10,2.3) dB (=Tolerance 2) (taking into account the measurement errors). Note that in the data preparation phase the checkbox “ELM test” has to be marked, see chapter II, paragraph 2.4.

Note : With a measurement error with a standard deviation of .1 dB on amplitude, the amplitude condition is met (with 97.5% of confidence), when the measured amplitude variation is <1.3 dB (one P6) or < 2.3 dB (16 consecutive long P6).

2 . Select **Power Error Check** from the analysis selection menu:



3. For this type of analysis, you must enter the expected output power of the Radar Under Test plus the allowable tolerances for two types of tests (see above)



4. Click the **Start**  button to start the processing.
The following table will show the results:

P2A power check

Result	% correct	# errors	# ints/patterns
Total/Interrogation	58.0	6130	14600
Total/Pattern	95.2	100	2101
P1	67.5	4745	14600
P2	67.5	4751	14600
P3	100.0	0	2500
P4	-	0	0
P5	100.0	0	12100
P6±Tol dB	71.9	2385	8500
P6 jitter <1dB	95.5	544	12100
ELM jitter <2dB	0.0	1200	1200
Average Pwr[dBm]	42.52		
Max Pwr[dBm]	45.14		
min Pwr[dBm]	36.36		

5. The table shows the % of correct Interrogations, the % of correct patterns (as defined in the interrogation scenario generator), Correct Pulses (P1 trough P6) , correct P6 power drop, correct ELM tolerances, , the average power of all interrogations , the minimum detected power (on Sum) of all interrogations and the maximum detected power on Sum.

Filtering, printing and exporting the data is available in this analysis mode.

3.10.P6 power Drop analysis versus Duty cycle

This Type of analysis calculates the power drop of each P6 pulse (Mode S interrogation) and the power drop along the 16 interrogations of an UELM and displays it versus time, azimuth or duty cycle before the interrogation in a specific sliding window for a complete interrogation file. This analysis does not work for PTE-P1 files.
The calculation of duty cycle is the same as in the above analysis.

1. Select **TTT Power Drop vs duty cycle** from the analysis selection menu:

Interrogation Graph
#Interrogations/Sec
Interrogation Duty Cycle
✓ TTT Power Check
TTT Power drop vs duty cycle

2. This selection requires processing before any results can be displayed. Enter the window size in the analysis parameters: It is the window before a specific interrogation. A measurement is made for each Mode S interrogation.

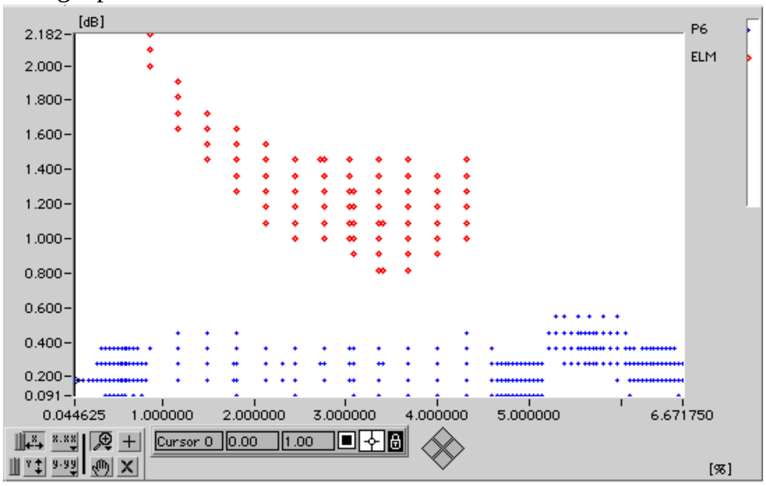
Window size 40 [ms]
Window step 20 [ms]

The window size parameter determines the interval in which the processing is done. In this case, the number of interrogations are counted in that interval and the "on " time is determined. Window size can vary between 50 µs and 15 seconds. (typ 40 ms).

3. Click the **Start** button to start the processing.

A progress bar becomes visible and disappears after certain time.

The graph shows the result:



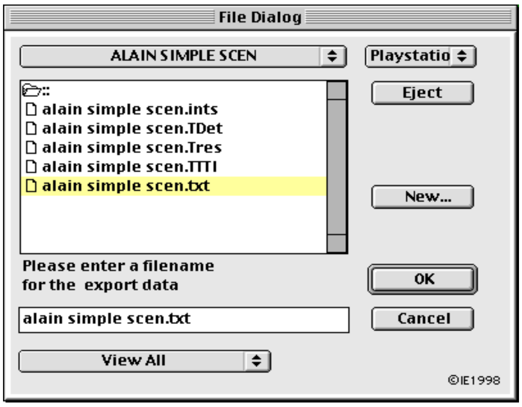
4. The contents of the graph depends on the X axis and Y axis selectors:
The X axis can be Azimuth (Azimuth[deg] selection), ACPs ([16 bit ACP] selection) , time (time [sec] selection), scans (scans [Revs] selection) or Duty cycle (Duty cycle[%] selection).
The Y axis can be power drop (Power drop [dB] selection) or duty cycle (Duty cycle [%] selection) .

Filtering, printing and exporting the data is available in this analysis mode.

3.11 TTT Result Exporting to Spreadsheet Data

The interrogation analyser allows the exporting of interrogation data to a spreadsheet style table which can be imported into Excel or any other type of spreadsheet program.
The tool includes as many data as possible in the exported table.

1. Click the **Export** button to start the processing.
Next, enter a filename for the export file:



The file can be imported by excel using the following steps:
File; Open; Using Tab delimited text import function

alain simple scen.txt

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	
1	Int nr	Time[s]	Azimuth	Scan	S address	Int	BITE1	BITE2	BITE3	BITE4	BITE5	Pwr P1	Pwr P2	Pwr P3	Pwr P4	Pwr P5	Pwr P6	Pwr Int	Std dev	Max pwr	Min pwr	Error?	Error P1	Err
2	0	0.002500	0.113	0		3/A	76	75	74	73	FF	21	21.1	21.1				21.1	0.4	21.6	20.7	0	0	
3	1	0.005000	0.225	0		C	76	75	74	73	FF	21.1	21.3	21.3				21.2	0.1	21.3	21	0	0	
4	2	0.007500	0.337	0		3/A	76	75	74	73	FF	21	21.1	21.1				21.1	0.4	21.6	20.7	0	0	
5	3	0.010000	0.45	0		C	76	75	74	73	FF	21.3	21.3	21.3				21.3	0.2	21.6	21	0	0	
6	4	0.012500	0.562	0		3/A	76	75	74	73	FF	21.3	21.1	21.3				21.3	0.3	21.6	21	0	0	
7	5	0.015000	0.675	0		C	76	75	74	73	FF	21.3	21.3	21.3				21.3	0.2	21.6	21	0	0	
8	6	0.017500	0.787	0		3/A	76	75	74	73	FF	21	21.1	21.3				21.1	0.3	21.6	20.7	0	0	
9	7	0.020000	0.9	0		C	76	75	74	73	FF	21.3	21.3	21.3				21.3	0.2	21.6	21	0	0	
10	8	0.022500	1.012	0		3/A	76	75	74	73	FF	21	21.1	21.3				21.1	0.3	21.6	20.7	0	0	
11	9	0.025000	1.125	0		C	76	75	74	73	FF	21.1	21.1	21.3				21.2	0.1	21.3	21	0	0	
12	10	0.025600	1.152	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.6		21.3	21.6	21.5	0.2	21.9	21.3	1	0	
13	11	0.026200	1.179	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.5		21.3	21.5	21.4	0.1	21.6	21.3	1	0	
14	12	0.026700	1.202	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.6	21	21.6		21.3	21.5	21.5	0.3	21.9	21	1	1	
15	13	0.027300	1.229	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.6	21.3	21.6		21.3	21.5	21.5	0.2	21.6	21.3	1	1	
16	14	0.029800	1.341	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.5		21.3	21.5	21.4	0.1	21.6	21.3	1	0	
17	15	0.032300	1.454	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.6		21.3	21.6	21.5	0.2	21.9	21.3	1	0	
18	16	0.034800	1.566	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.5		21.3	21.5	21.4	0.2	21.9	21.3	1	0	
19	17	0.037300	1.679	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.5		21.3	21.5	21.4	0.1	21.6	21.3	1	0	
20	18	0.039800	1.791	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.5		21.3	21.5	21.5	0.2	21.9	21.3	1	0	
21	19	0.042300	1.904	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.5		21.3	21.5	21.4	0.2	21.9	21.3	1	0	
22	20	0.044800	2.016	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.5		21.3	21.5	21.5	0.2	21.9	21.3	1	0	
23	21	0.047300	2.129	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21	21.5		21.3	21.5	21.3	0.2	21.6	21	1	0	
24	22	0.049800	2.241	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.5		21.3	21.5	21.5	0.2	21.9	21.3	1	0	
25	23	0.052300	2.354	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.5		21.3	21.5	21.4	0.2	21.9	21.3	1	0	
26	24	0.054800	2.466	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.6		21.3	21.6	21.5	0.2	21.9	21.3	1	0	
27	25	0.057300	2.579	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.5		21.3	21.5	21.4	0.1	21.6	21.3	1	0	
28	26	0.058300	2.624	0		A Only All Call	76	75	74	73	FF	21	21.1	21.1	20.2			20.8	0.8	21.3	19.1	1	0	
29	27	0.059100	2.66	0		C/S All Call	76	75	74	73	FF	21.3	21.3	21.3	21.5			21.3	0.3	21.6	21	1	0	
30	28	0.060300	2.714	0		2	76	75	74	73	FF	21.3	20.8	21.5				21.4	0.3	21.6	21	1	0	
31	29	0.062800	2.826	0		3/A	76	75	74	73	FF	21	21.3	21.1				21.1	0.4	21.6	20.7	0	0	
32	30	0.065300	2.939	0		C	76	75	74	73	FF	21.1	21.3	21.3				21.2	0.1	21.3	21	0	0	
33	31	0.067800	3.051	0		3/A	76	75	74	73	FF	21	21.1	21.1				21.1	0.4	21.6	20.7	0	0	
34	32	0.070300	3.164	0		C	76	75	74	73	FF	21.3	21.3	21.3				21.3	0.2	21.6	21	0	0	
35	33	0.072800	3.276	0		3/A	76	75	74	73	FF	21	21.1	21.1				21.1	0.4	21.6	20.7	0	0	
36	34	0.075300	3.389	0		C	76	75	74	73	FF	21.3	21.3	21.3				21.3	0.2	21.6	21	0	0	
37	35	0.077800	3.501	0		3/A	76	75	74	73	FF	21	21.1	21.1				21.1	0.4	21.6	20.7	0	0	
38	36	0.080300	3.614	0		C	76	75	74	73	FF	21.3	21.3	21.1				21.2	0.3	21.6	21	0	0	
39	37	0.082800	3.726	0		3/A	76	75	74	73	FF	21	21.1	21.3				21.1	0.3	21.6	20.7	0	0	
40	38	0.085300	3.839	0		C	76	75	74	73	FF	21.3	21.3	21.3				21.3	0.2	21.6	21	0	0	
41	39	0.085900	3.866	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.6	21	21.6		21.3	21.5	21.5	0.3	21.9	21	1	1	
42	40	0.086500	3.893	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21	21.4		21.3	21.4	21.3	0.2	21.6	21	1	0	
43	41	0.087000	3.915	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.5		21.3	21.5	21.4	0.2	21.9	21.3	1	0	
44	42	0.087600	3.942	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21.3	21.5		21.3	21.5	21.5	0.2	21.9	21.3	1	0	
45	43	0.090100	4.055	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.3	21	21.4		21.3	21.4	21.3	0.2	21.6	21	1	0	
46	44	0.092600	4.167	0	FFFFFF	UF=11 :PR=0 :II=2 :	76	75	74	73	FF	21.6	21	21.6		21.3	21.5	21.5	0.3	21.9	21	1	1	

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Chapter V : Window Based Video Recording

1.0. Introduction

The Windowed interrogation recording allows us to visualise the transmitter video data of sum and control beam in great detail. This tool allows the user to record interrogation video on an operational radar using the TTT PDM modules. These modules detect the RF interrogations and transfer the RF power into video level signals. These are recorded in a “windowed” way, meaning that only video is recorded in a specific (Azimuth) slice and during the time transmission is send.

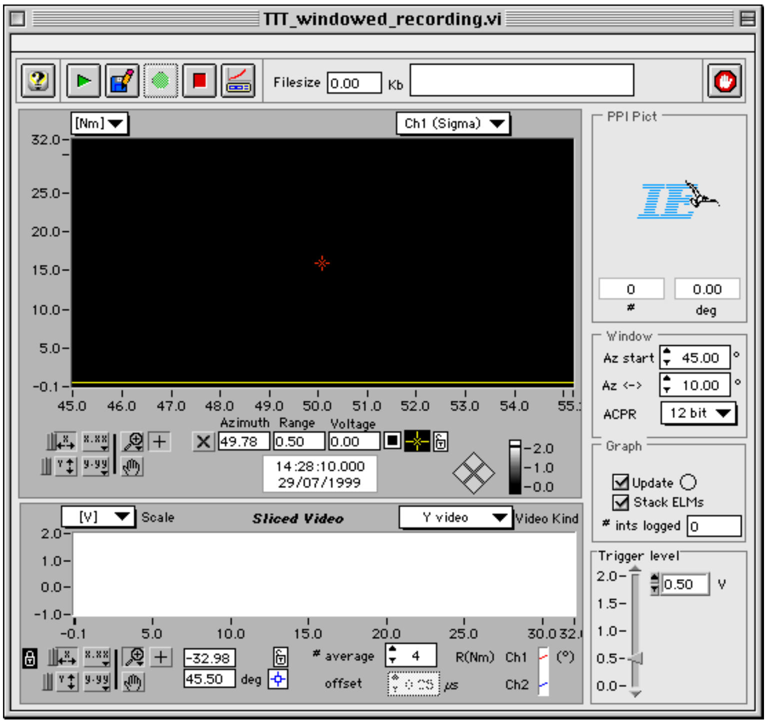
This chapter will explain you how to make a window based recording using the RASS-S/PTE Radar Video Recorder (with the RVI) and two PDM modules.

2.0. Windowed Interrogation Recorder and Related Files

We will start with a short explanation of the functions implemented for window based interrogation recording.

When performing the RVR measurements, you will be confronted with the functions in order as listed below. For each of the functions, the most important program front panels are shown. In case you want detailed information, please select the related paragraphs for each function further on in this chapter.

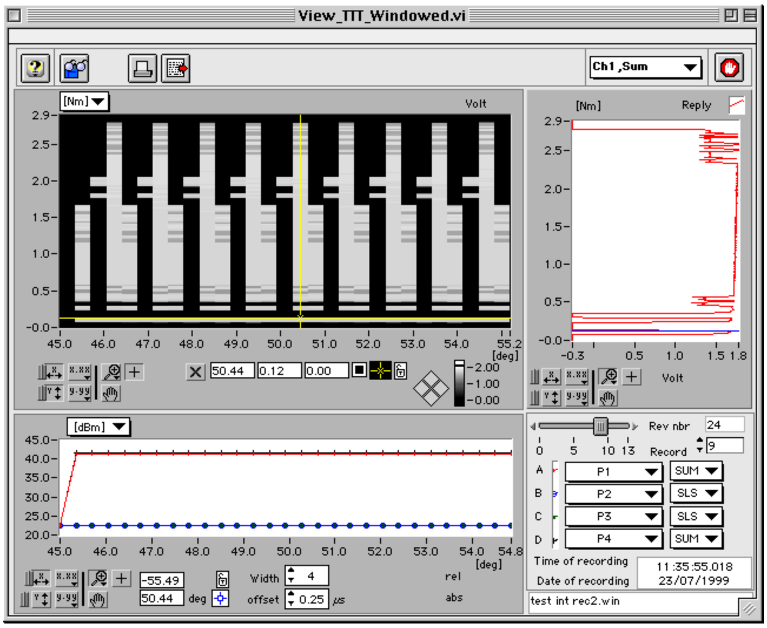
1. The RVR Windowed Interrogation recording can be loaded by selecting **"TTT Windowed Recording"** under the TTT menu. Its main function is to perform the measurement setup and most important, the actual recording of interrogations.
   Indicators visualise the presence of the necessary trigger signals. The azimuth indicator displays the sector selected for recording. The video data is shown in an intensity graph display, showing the recorded video data within the defined window. A cursor is foreseen to slice the data vertically or horizontally to be able to visualise the signals in a simple horizontal graph (at the bottom).



2. A calibration of the PDM modules is needed to rescale the values from measured ADs in the RVR in to dBs for the Radars Transmitter power. By clicking the **"Calibration"** button  a window will appear to sample the calibration data of the PDM modules.

3. After recording, the recorded interrogation windows can be viewed using the 'View TTT Windowed' window. The tool can be loaded by selecting **"View Windowed Video"** under the Video Analysis menu. Its main function is to display the actual recorded video for

analysis.



3.0. Setting up the Windowed Recording Equipment

3.1. Components

A complete configuration contains the following elements:

1. The Radar Video Recorder and its accessories:

- Radar Video Recorder RVR183.
- mains power cable.
- SCSI 50p-50p cable.
- SCSI terminator.
- 2x 2m RG223 cables.
- 1x 5m RG223 cable.
- 2x 270 MB or 1 GB cartridges.

2. The Radar Video Interface and related cables:
   - Radar Video Interface RVI299.

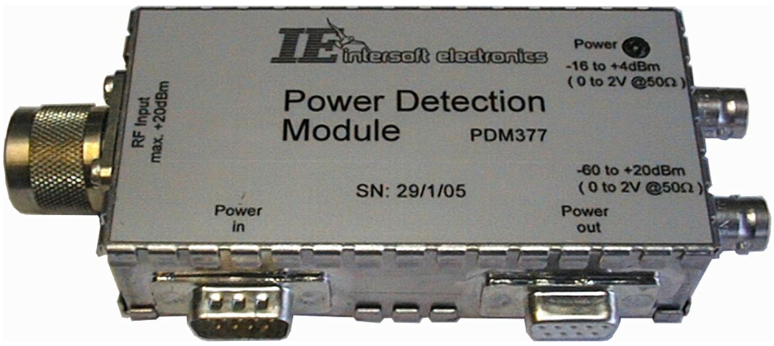
   - 1x 2m 15p interface cable (to connect the digital signals between RVR and RVI)
   - 1x 2m 15pHD to 5x BNC (to connect the analog signals between RVR and RVI)
   - 2x 2m 15pHD to 5x BNC (to connect digital and analog radar signals to RVI inputs)
   - 1x 2m 15pHD to 5x BNC (spare)


Connection cables between RVR and RVI: analog (left) and digital (right).

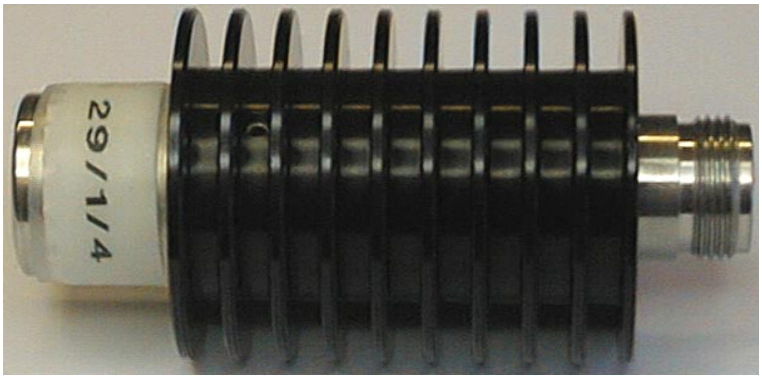
also included, but beyond the scope of the measurement:
- 1x 3m15pHD(m) to 15pHD(m) (RVI - RIU connection)

To distribute timing signals: RVI-RIU /RFT cable.

3. Two PDM modules with additional accessories
   2 x Power Detection Module Serial number: 29/1/. . .



2 x Attenuator Narda 766-20: 29/1/. . .



A 20dB medium power attenuator. Power Average: 20W Max., Power Peak: 1kW Max., DC-4GHz, 20±0.25dB (DC-3GHz), VSWR: 1.1 (DC-1GHz), 1.15 (1GHz-4GHz). Two attenuators are supplied, one for each PDM. Use the one with the same serial number as the PDM for highest precision.

2x Attenuator Mini-Circuits NAT-10-60: 29/1/. . .

Note that this component has the same package as the NAT-20-21 (of the next paragraph).

A 10dB low power attenuator. DC-6GHz, 10±0.2dB, 0.225W. Two attenuators are supplied, one for each PDM. Use the one with the same serial number as the PDM for highest precision. This attenuator should always be used in combination with the Narda 766-20. *This attenuator is meant for low power radars.*

2x Attenuator Mini-Circuits NAT-20-21: 29/1/. .

A 20dB low power attenuator. DC-2.1GHz, 20±0.3dB, 0.2W. Two attenuators are supplied, one for each PDM. Use the one with the same serial number as the PDM for highest precision. This attenuator should always be used in combination with the Narda *766-20. This attenuator is meant for high power radars.*

2X BNC T-adapter

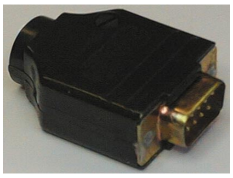
2X BNC Terminator 50Ω

1X BNC cable 3m red

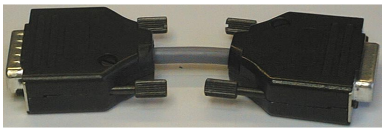
1X BNC cable 3m green

2X DB9male-DB9Female 3m Power Supply Cable

1X DB9male Calibration Dongle



1X DB15male-DB15female 15cm ACP-ARP isolation cable



This cable is used between the digital input of the RVR and the RVI.

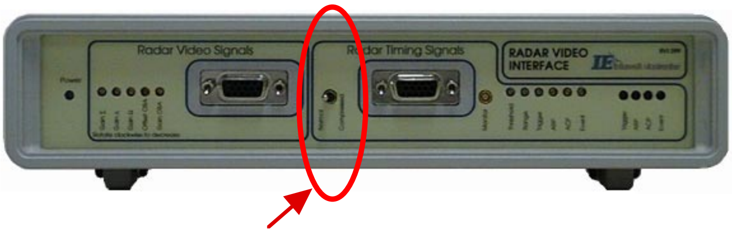
4. Macintosh computer and a printer:
   - PowerPC-based Macintosh Powerbook or other Macintosh PowerPC.
   - Powerbook power supply + power cord.
   - HDI-30 Powerbook SCSI System Cable.
   - HDI-30 Powerbook Disk Adapter Cable.
   - Carrying case.
   - Colour Inktjet printer.

3.2. Connections

This section describes the connections to be made at the radar transmitter side in order to perform a windowed interrogation recording .

For this measurement, the Radar Video Recorder needs to be set up in combination with the Radar Video Interface (RVI). The complete setup is illustrated in fig. 5, showing both front and back panel of the RVI and the PDM connections to the radar system and to the Radar Video Recorder.

The Radar Video Interface has two modes of operation, selectable by a front panel switch. For Windowed Interrogation recording it must be operated in NORMAL mode.



!! Select NORMAL mode for Windowed Recording

Make sure that the switch is set to normal mode, otherwise no useful measurement result can be obtained !

STEP 1 : SCSI Connections - Connecting the host computer to the RVR

When setting up the Radar Video Recorder , first connect the SCSI port of the RVR to the host computer. A SCSI cable to connect to the 50p SCSI connector of the RVR is included in the standard configuration.

The Radar Video Recorder is foreseen with two 50p SCSI connectors placed at the back panel. It has no internal termination for SCSI.
One connector is needed to connect the Radar Video Recorder to the host computer. The second one can be used to connect a second device.
Since the RVR is not internally terminated, an external SCSI terminator (shown in the picture below) must be connected in all cases where no further devices are connected.

Please note that the following SCSI addresses are used by default by the RVR:
- 3: Internal fixed harddisk (2GB)
- 4: Built-in Iomega JAZ drive
- 5: RVR DSP controller

Since the addresses of the RVR devices are fixed, make sure that in case more devices are connected to the SCSI bus, they are not conflicting with these addresses.

STEP 2 : Connecting the RVI to the RVR

The RVI analog and digital output connectors are situated on the back panel:

RVI Back Panel Connections.

For TTT interrogation recording, Only the digital cable is required. It can be recognised since it has a DB15 connector at both sides. It connects the timing outputs of the RVI to the digital input port of the RVR, and also supplies power to the RVI.
Beware! In order to correctly operate, it is required to connect the “ACP-ARP isolation” cable between the digital cable and the RVR digital input.

Connection cables between RVR and RVI: digital cable (right).

The analog inputs of the RVR are connected directly to the outputs of the PDM modules using a BNC T junction and 50 ohm terminators. Make sure to connect to the detailed output of the PDM modules (marked ‘-16 to 4dBm’).
The ‘DB9male-DB9female 3m power supply cables’ give power from the sport connector of the RVR, to the first PDM module; where the second cable is used to go from the first PDM to the second.

For the Windowed recording , following signal connections should be made:

- Σ, SUM (red) = channel 1
- Ω, SLS (Green) = channel 2

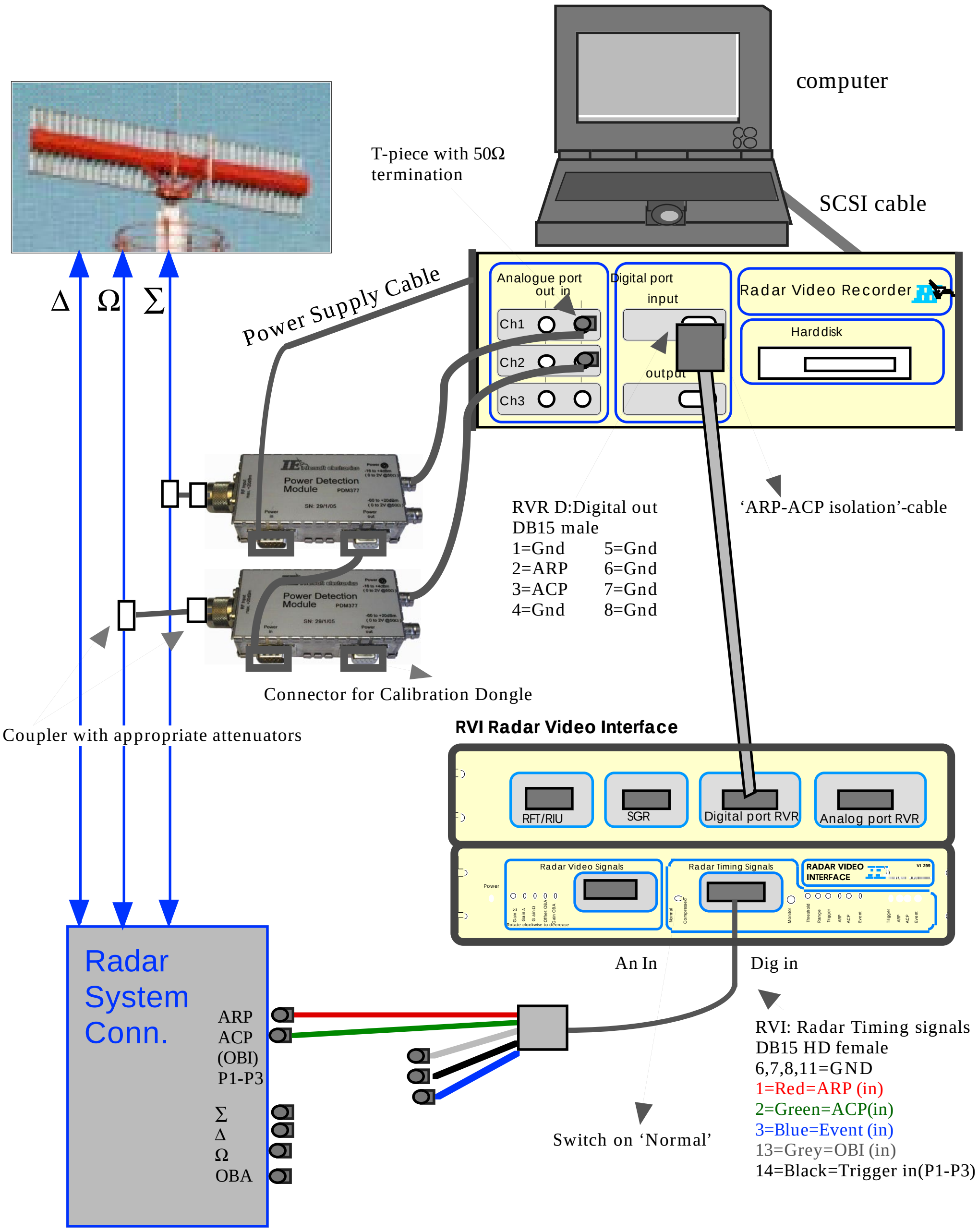


Figure 5: Interrogation Windowed recording using RVR and RVI : setup.

When RVR and RVI are connected, power up the Radar Video Recorder. Both RVR and RVI have a power led indicator. After 30 seconds (to allow the RVR internal harddisk to spin up) also the host computer may be booted.

STEP 3 : Connect the radar signals to the PDM module :

The PDM modules must be connected to the coupler outputs of the Radar under test.
The input power of the PDM must lie between -16 and +4 dBm, so the powers must be attenuated until a match is reached.
e.g.

A POEMS radar with +51 to + 63 dBm output power is coupled using a 20 dB coupler. Use the 20 dB power attenuator (NARDA) and the 20 dB N type attenuator, to reduce the power to -9 to +3 dBm, which in turn can be measured by the PDM modules.

Please take grate care when working with Rf powers. Mistakes may cause damage. Make sure that the transmitter is terminated properly (50Ω), with an appropriate terminator (enough power).

Connecting the radars timing signals

The RVI provides signal conditioning for the digital radar signals needed to perform the measurement. The digital inputs are fed into a comparator circuit with hysteresis. The threshold level is adjustable from 1V up to 20V. Input impedance is determined by the 1 kΩ trimmer of the input circuitry.

Digital signals that need to be connected:
- ACP GREEN Cable
- ARP RED Cable

RVI Connector for digital signals, trimmers and LED indication.

ACP: Use the ACP generator output of the radar. This signal can have different duty cycles, depending on the position where you tap it from the radar or depending on the type of radar. The duty cycle is irrelevant for the video recorder, since only the rising edges are used for analysis. (Green connector on “Radar Timing Signals” of RVI).

ARP: Use the North reference pulse supplied by the interrogators ACP generator. The signal should be a short positive or negative going pulse. The pulse can be offset sometimes (using software or hardware counters in the radar). Be aware of this if you use the software and note this offset. (Red connector on “Radar Timing Signals” of RVI).

Since the threshold level is adjustable between 1V and 20V, the digital input signals should be able to pass a threshold level between 1V and 20V.
For each of the digital inputs a trimmer is foreseen to adjust the threshold level. The corresponding LED’s indicate the detection of the connected signals.

The following paragraph explains the windowed recording and all related actions on software level necessary to perform a correct measurement.

4.0. Making a Window Recording : Checklist

4.1. Procedure

The window based interrogation recording will be made in three steps:

a) Hardware connections
b) Start of video recording
c) Video contents analysis

Corresponding to each step one or more programs (virtual instruments) will be used :

a+ b) TTT windowed recording.vi : This program will setup all the parameters for the video recorder, test the trigger, ACP and ARP signals and log the video signals to the internal hard disk.

c) View TTT Windowed.vi : This program is used to retrieve the logged data from file and make detailed analysis of the data.

4.2. The Windowed Recording Program

4.2.1. Program Functionality

This program has the following functions:

1)Setup the correct parameters in the video recorder so that the digital and analog signals can be recorded.

2)Lock on to the revolutions of the radar, so that the correct ACP and Azimuth value is known at any given time. This is done using a sort of PLL-routine locked to the ARP value. The program will indicate this using a turning indicator, showing the radars' absolute Azimuth in real time.

3)Measure the radar's interrogation per revolution rate, ACP per revolution and revolution count.

4) Defining the logging window: The radar video recorder samples in windows with limited Azimuth and range . The range depth of the window is limited to 34 µs, which can contain the longest type of Mode S interrogation . The Azimuthal width of this window is limited (theoretical) to 768 interrogations. The real maximum azimuth width will therefore depend on the IPR rate (Interrogations per Revolutions) and can be calculated from :

*Width = 768/IPR *360°.*

The term theoretical is used here because in practise, no such wide windows will be used for recording, because the amount of data to process (analyse) will be too much.
The video data is stored as 8bit, two channel data, so 2 bytes per data point.

Therefore two parameters must be defined in the setup stage of the program:
Azimuth start and Azimuth width.

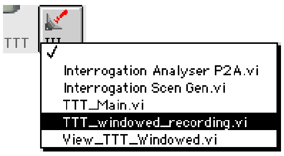
4.2.2. Overview of Functions

The following list explains the function of the buttons on the front panel of the windowed video recording program :

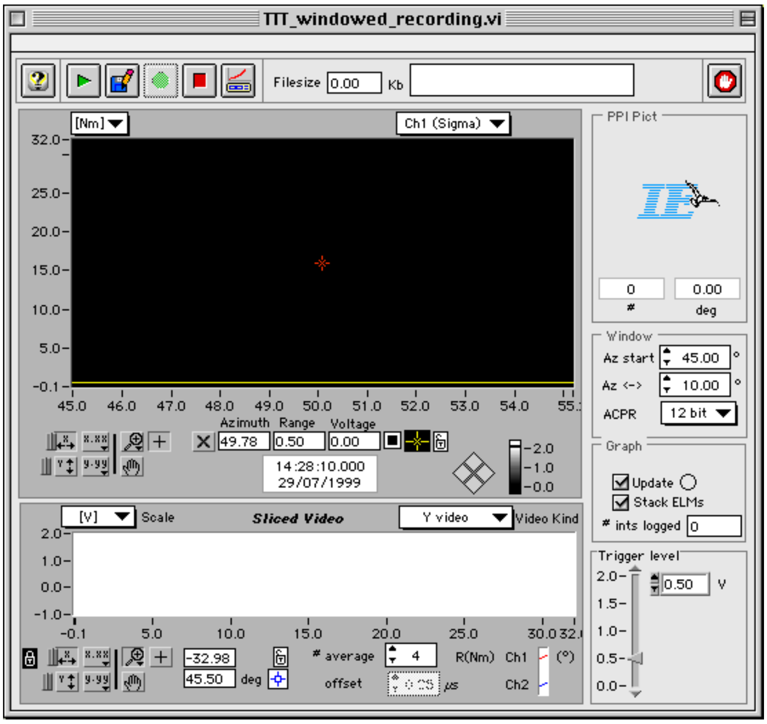
Help	Toggles the Help window On and Off.
Start	To start the program. The RVR will synchronise to ACP and ARP.
Record	Starts recording the windowed video data on the internal RVR harddisk.
Stop	Stops the recording to the internal RVR harddisk.
File	Defines a file for the data to be recorded in
Calibration	To open the PDM calibration routine.
Done	Halts the program completely, without closing the window.

4.2.3. Starting the Program

1. After connecting all signals according to the specifications given above, load the **"TTT_windowed_Recording"** tool.



Click the LabVIEW 'Run' button to start the program.



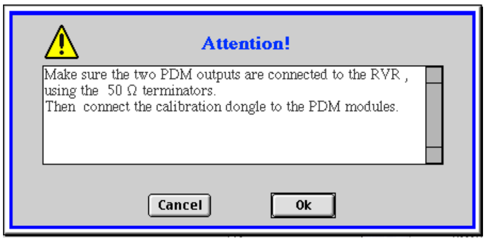
If the Radar Video Recorder is not proper connected, an error dialog can appear.

Make sure the RVR is connected and restart the software.

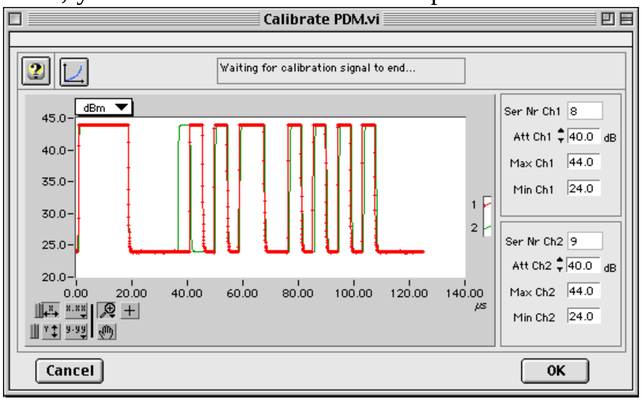
4.2.4. Calibrating the PDM Modules

3. If you use the PDM for the first time that day, the PDM calibration window will pop up automatically: Else, this function can be recalled by clicking the **Calibrate** button.

A dialog box will ask you to connect the Calibration dongle to the two PDM modules. Perform this action before proceeding.



When ready, Click Ok. Cancel halts the calibration procedure and continues with scenario generation.
Next, you should see the PDM test patterns in the calibration window:

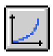


You can select the Y scale of this picture in two modes: ADs or dBms using the Y scale selector: 

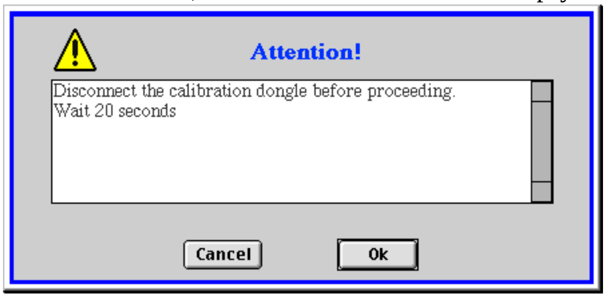
Once put in dBms, the minimum and maximum signal strength should read +4 and -16 dBm, plus the attenuation values of both channels.
The principle of the behind this calibration is that internally, the amplitude of the two levels in the test pulses are matched with the video amplitudes of a Mode S interrogation sampled at +4 or -16 dBm. In fact this procedure eliminates external influence such as cabling, termination, AD convertor of RVR etc.
The two AD values for the two levels are sampled and referenced towards the two power levels.

The display has been given a zoom function, which can be used to verify the accuracy of the PDM-BITE pulses. For example, the first pulse is 20µs high (almost corresponds to a P6 pulse), and the drop over this time should stay within the specified accuracy.

Make sure to enter the proper attenuator values for the input of the PDM modules .
Default this should be 60 dB, namely 40 dB of external attenuator values plus 20 dB of the POEMS coupler.

Once this is done, click the **Calibrate**  button, which copies the sampled AD values and equalises the sampled data values towards the preset power values.

Once calibrated, click the OK button and reply to the following dialog:

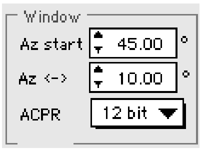


Now you **Must** disconnect the calibration dongle and wait for ±20 seconds for the signal to disappear. The calibration window remains open as long as the signal is present and warns you with this message in the status bar:

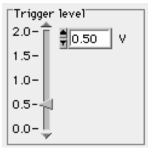
Once the calibration window is closed, it is safe to connect the PDM modules to the radar.

4.2.5. Setting up Parameters

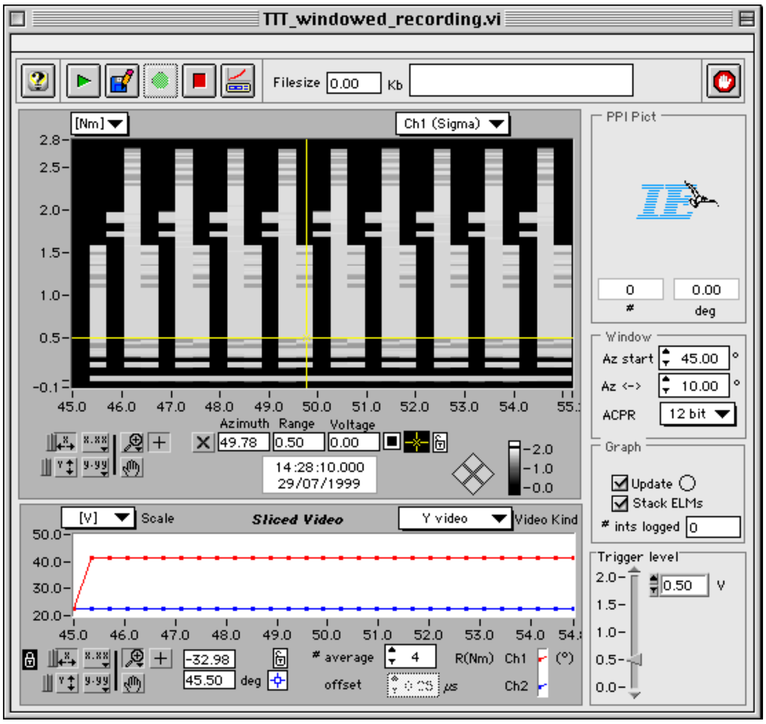
4. Select the start Azimuth for the recording window and enter the Window width (Az <->) . Beware : the window can not contain more than 512 interrogations.
*(# interrogations = Azimuth width /360 * IPR)*



Also the video trigger level of Ch1 has to be selected. Triggering is only performed on data of Ch1. Note that changing the trigger level while recording, will cause a restart at the next north.



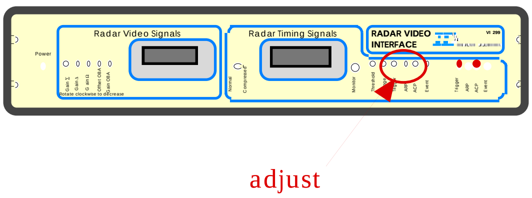
5. Now start the program using the **"Start"** button in the top-left corner of the window. This is the "Viewing" mode of the program, in which no recording is performed.



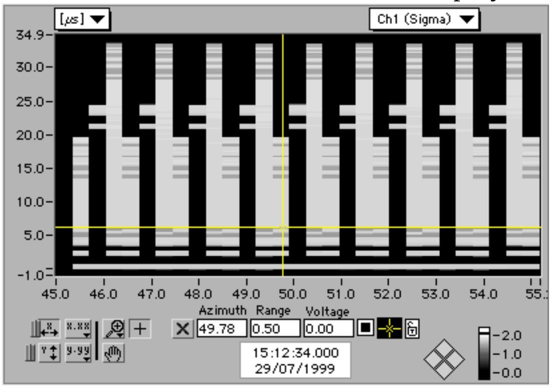
The Azimuth indicator will start turning. The blue needle indicates the current Azimuth of the radar system. The green pie is an indication on the position of the Azimuth window.

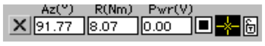
6. If the Azimuth indicator does not start rotating, make sure the ARP and ACP pulse is connected to the RVI and all other connections are properly made (Check the ARP LED on the RVI box). If no ARP is detected, adjust the ARP detection level of the RVI.
The first 2 revolutions, the software will disable the **“Recording”** button, to prevent the user from starting the measurement before the revolutions are stable. After 2 revolutions the IPR indicator should be stable and the Azimuth indicator should turn regular.

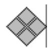
If the ACPR indicator is not stable (or an insane value), check the ACP LED on the RVI box. If this is not continuously lit (it should be flashing at the ACP frequency), adjust the ACP detection value on the RVI box.



7. After 2 or 3 revolutions, the video display should show some video data.



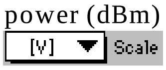
The video window contains two cursors, both indicating range, azimuth and power (dBm) 

The cursor can also be moved using the cursor control pad: 

The **Centre Cursor** button centres the cursor in the middle of the video intensity graph.

8. The horizontal cursor line selects a vertical cutout of the video image and shows this cutout in the "**Sliced Video**" graph when the **Video Kind** selector is set to X video.

This graph shows azimuth in its X axis and sampled video level (Volt -0.25->2.25V or power (dBm) in its Y axis (depending on the **Scale** selector. .)



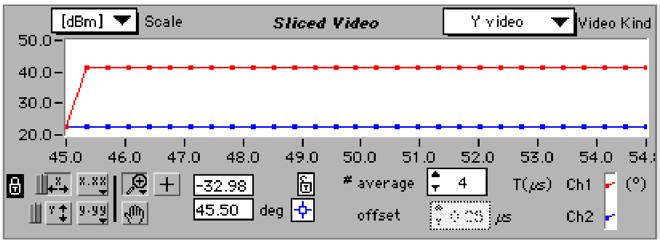


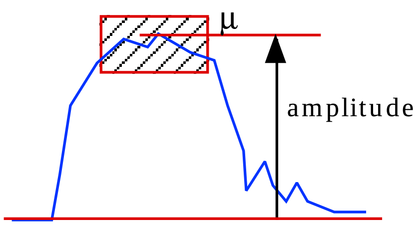
Fig. 6 : Y video

The curve is build up by plotting the average amplitude of the pulses under the yellow horizontal cursor versus their azimuth.

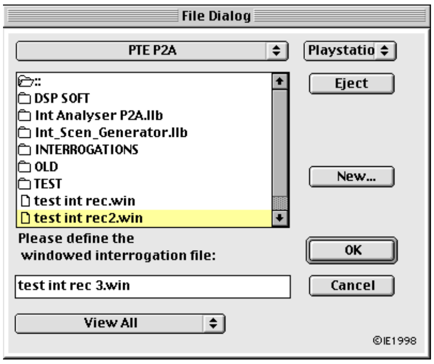
A number of samples of each pulse is taken and averaged.

The number of samples can be set by the "width" parameter in the 'sliced video' graph.

$$Y = \sum_{i=0}^{i=N-1} Ki \ / \ N$$



9.Next, we can record the video data such that it can be stored and retrieved at a later stage.For this, we must select a filename first by clicking the **file** button: 
The filename will be shown in the filename indicator:



Recording is started by clicking the **"Record"** button. The button will remain activated until you deselect it.

 **Record**

When the recording is active , the progress bar shows the recording progress. The amount of megabytes currently recorded is shown in the indicator next to it.

The recording can be halted by either deselecting the **"Record"** button, or by clicking the **"Halt"** button.

 **Halt**

The 'Record' button can be selected and deselected as many times as required, such creating a data file with different scans recorded one after the other.

You have to click the 'Start' button again and wait 2 scans before a new recording can be started.

 **Start**

14. Use the **"Stop"** button to end the video recording .

 **Stop**

15. After saving the measurement click the 'Done' button to end the program.

 **Done**

5.0. Analysing the Interrogation Data: View TTT Windowed .vi

5.1. Program Functionality

This program performs almost the same functions as the recording window in the video recording program, except that this time data is fetched from a disk file rather than directly from the Radar Video Recorder.

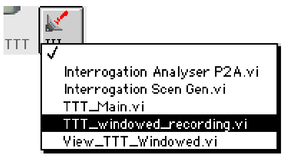
5.2. Overview of the Functions

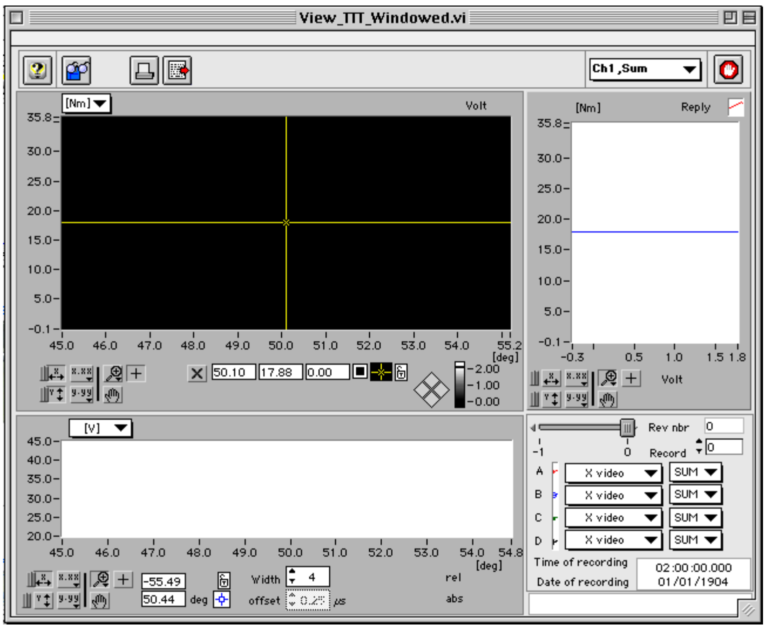
The following list explains the function of all used buttons of the analysing tool :

Help :	Toggles the Help window on and off.
Load file:	Loads a windowed Interrogation recording file.
Export:	To export the recorded interrogation data.
Print :	To print out the data.
Done:	Halts the program completely, without closing the window.

5.3. Using the Program

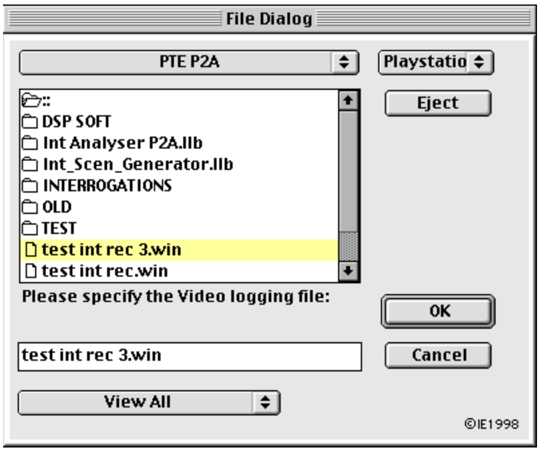
1. After connecting the video recorder or another device containing the video data files, the **"View TTT Windowed.vi"** tool can be loaded.



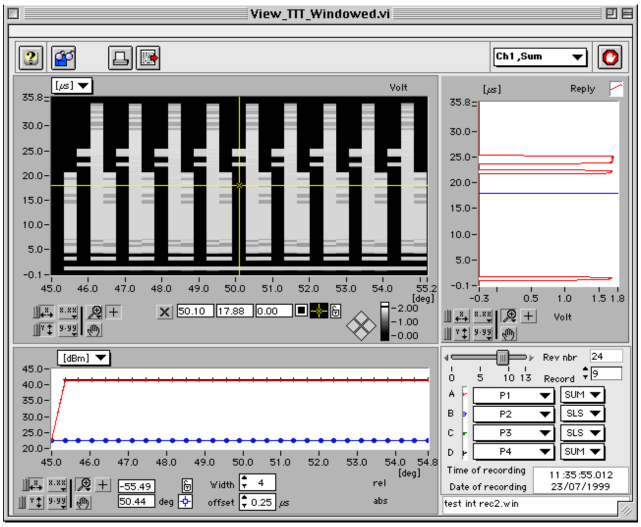


2. Run the program by clicking the LabVIEW 'Run' button.

3. After clicking the  **Load** button, a file dialog window will appear, asking you to specify a video data file. Select a file and click the **"Ok"** button.

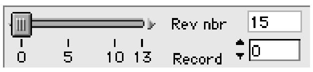


4. The selected file will then be loaded.



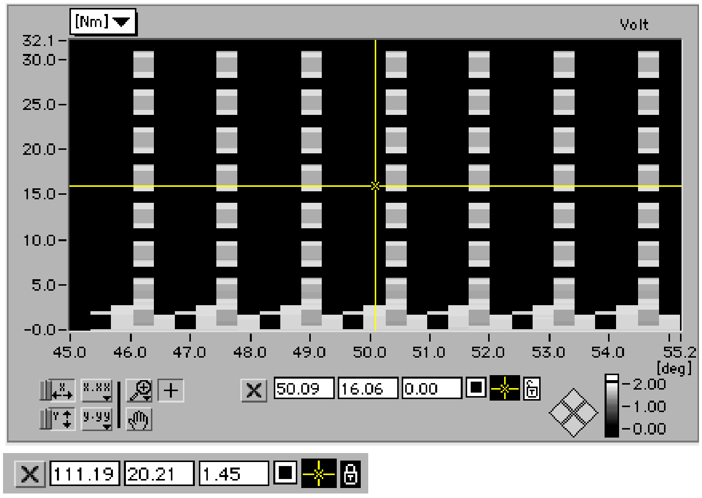
The filename is also shown in a window in the right bottom corner.

5. A video recording consists of several log numbers, most commonly these log numbers correspond to revolution numbers (except for recordings where the recording was intermediately halted.). Select a logging using the **"record number"** slider. This is a slider and numeric control at a time, so the record number can be entered manually, or you can page through the data to get a quick glimpse. The logging's date and time are shown in an additional indicator. The corresponding scan number is also shown.

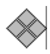


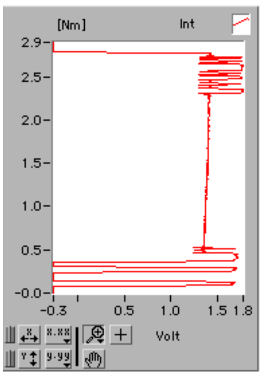
6. Video data can be viewed in the Video Display. The X axis represents the Azimuth (degrees), the Y axis range or time (Nm or µs). The updating of this display is performed when the log number is changed.

The **"Display"** selection menu selects data from either channel 1 (Σ) or channel 2 (SLS) of the radar video recorder.



8. The video image contains two cursors. Using the mouse pointer these lines can be moved. The horizontal cursor will be tracked by the degrees indicator just below the video image.
The vertical line will be tracked by the range indicator below the video image. The cursor point will be tracked by the voltage indicator of the cursor.

The cursors can also be moved using the cursor control pad: 

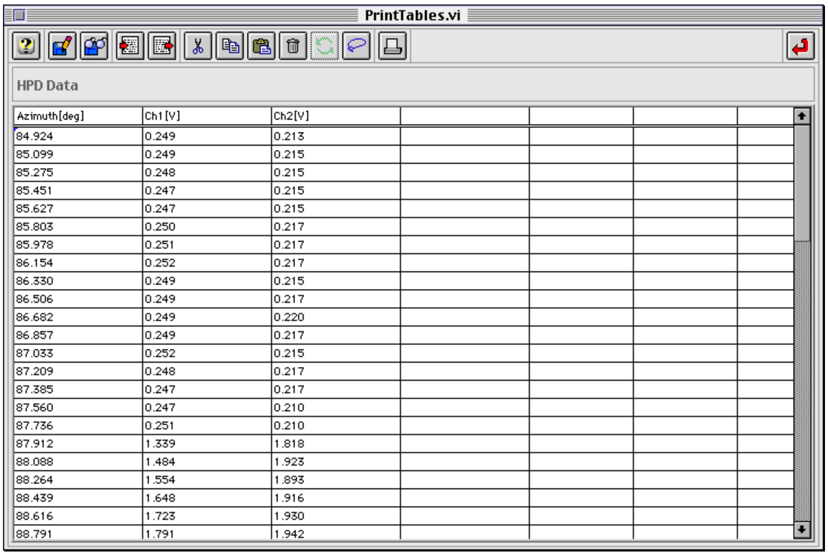


The vertical cursor selects a vertical cutout of the video image and shows this cutout in the **"reply"** graph. This graph shows time in its Y axis and sampled video level (in Volts) in its X axis.
The "display" switch also selects if the replies image contains data from channel 1 or channel 2.

9. The horizontal cursor line determines the position that is used for the calculation of the amplitudes of the different pulses present in the interrogation data.

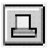
The curve is built using the same algorithms as in the windowed recording. The diagram is plotted with Azimuth (equivalent to interrogation #) in its X axis and averaged Volts or dBms in its Y scale.

10. It is possible to export the video data available in the 'Sliced Video' graph to a spreadsheet. The resulting file consists of a text file containing a table.
This table is TAB separated and can be imported by any Spreadsheet program.
The file consists of three columns:
Azimuth [deg] ; CH1 [V] ; CH2 [V] .
The numerical data is put to a string format with a 3 digit precision.

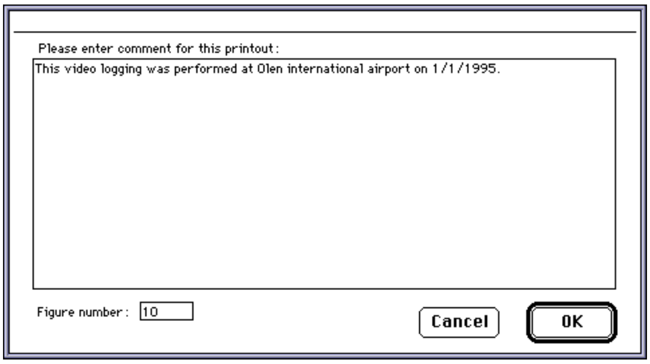


Azimuth[deg]	Ch1 [V]	Ch2[V]
84.924	0.249	0.213
85.099	0.249	0.215
85.275	0.248	0.215
85.451	0.247	0.215
85.627	0.247	0.215
85.803	0.250	0.217
85.978	0.251	0.217
86.154	0.252	0.217
86.330	0.249	0.215
86.506	0.249	0.217
86.682	0.249	0.220
86.857	0.249	0.217
87.033	0.252	0.215
87.209	0.248	0.217
87.385	0.247	0.217
87.560	0.247	0.210
87.736	0.251	0.210
87.912	1.339	1.818
88.088	1.484	1.923
88.264	1.554	1.893
88.439	1.648	1.916
88.616	1.723	1.930
88.791	1.791	1.942

11. Finally, the video data can be printed in a RASS-S / PTE report format using the print function .

 **Print**

A comment input window will appear to allow you to enter comment. Click the "OK" button to confirm printing, or press cancel to return with no printing.



12. Use the 'Done' button to stop program execution and continue with other RASS-S / PTE functions.

 **Done**