ESAOTE

THE IMAGE OF INNOVATION™

C-SCAN DEDICATED MRI

DEDICATED MRI ARTOSCAN-C

MR

Service Manual

Service Manual

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Document revision level

The document corresponds to the version/revision level effective at the time of system delivery. Revisions to hardcopy documentation are not automatically distributed.

Please contact your local ESAOTE office to order current revision levels.

Disclaimer

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Part 0 Table of Contents

Part 1 Introduction

Overview

Parallel to the advent of a whole new generation of MR systems, a totally new service support philosophy is dawning, matching and tailored to the modularity and efficiency of the latest hardware technologies incorporated into this advanced line of machines. In keeping with this progress of newer and enhanced designs, it has become not only feasible but necessary to adapt to a service strategy making failure isolation and repair as economical as possible. In line with these trends, we have attained a level of service friendliness never before achieved. This introduction to the TSG documentation is designed to give you an overview of this new trouble-shooting concept for the system.

NOTICE	Any installation, assembly, maintenance, extensions, regulation, modifications, or repairs must be carried out by authorized personnel only.

General

This register contains an introduction to the service manual: what the service manual contains and how it can be best used. It will also attempt to present how the service manual and FUN are coupled together and complement one another. Here you will find a general explanation of the concept structure, the various sections comprising the service manual and how they can be used most effectively for trouble-shooting and repair.

Information on the new page format and on-line documentation are covered in the manual FUN, part Prefix, section "Documentation Intro“.

The contents of the service manual will support service technicians during on-site trouble-shooting and faulty component isolation. While the instructions are not a substitute for an in-depth knowledge of the system, its components or the underlying physics, they will facilitate, on the one hand, trouble-shooting procedures for the less experienced technician and, on the other, support the more experienced technician in performing essential measurements and tests. The instructions will also explain standard procedures such as measurements of power supplies, etc.

The service manual should not and does not take the place of an error catalogue. In most cases hardware faults are easily and quickly located. Intermittent errors require more time and patience.

It is not within the scope of the service manual to list all possible tests. Its purpose is to support the search for frequently occurring errors, to allow the technician to limit the error search to certain functional groups, and to propose measurements for localizing a faulty component.

We are aware that the first versions of this manual do not provide the reader with an entire spectrum of information. The manual will be updated accordingly in the future. Any feedback is strongly encouraged and will be warmly welcomed to provide you with the tools you need. We need your help!

Distribution

The goal is to distribute the Online-documentation as well as the paper version to the MR CSE's via a distribution list. This means that in the future this documentation will no longer be delivered with the system.

Service Manual structure

The troubleshooting guide is structured as shown below:

- Table of Contents
- Introduction/Safety
- System
- Software
- Host
- Control
- RF system
- Patient handling
- Gradient system
- Magnet
- Power distribution power
- Maintenance instructions
- Changes
- Index

Suggestions for use

The information for the different system components has been subdivided into:

- Test Strategy
- Test Procedures
- Diagrams
- Repair and Adjustment Procedures

Strategy

The flowchart is designed as a general guideline for selecting the appropriate trouble-shooting procedures.

The objective of the accompanying descriptions is not to give detailed step-by-step instructions into the finer art of trouble-shooting, but to offer a means of guiding you, given a particular problem, to the right test procedure, briefly and simply. If more detailed instructions are necessary, then the CSE will be referred to the appropriate procedures in the section "Test Procedures“.

Procedures

Here the CSE will find detailed test instructions. You will also find descriptions for "standard procedures“ - for example, starting the SeSo, connecting the laptop to the Host, reading log files, etc. This section also contains descriptions for interpreting the test results.

Furthermore you will find general information pertaining to parts location, fuse ratings, power supply information, measuring points, descriptions of LEDs and potentiometers in this section.

Repair

If a module needs to be replaced, procedures for its replacement and subsequent necessary adjustments are described in this section.

Index

An index at the end of the book provides you, in addition to the table of contents, with cross-references, to inform you about topics that you may wish to look into for further information. It is a helpful source of information when looking for related topics when you want to concentrate on items of interest. For example, if you would like to know more about the "adjust frequency“ you could either look under "A“ for "adjust“ or "F“ for "frequency“. Many topic listings are redundant to help make your search more successful.

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Part 2 Service Policy

Product Line Support Center

The Support Center provides all general activities targeted to customer support (manuals, training, Service Information, etc.)

Specific Service activities and responsibilities include:

- Service Manuals
- Service Information
- Service Training
- Product Part Lists
- Part repairing process
- On-line support (mail, phone, fax, etc.)

The support center are currently open from 8:00 a.m. to 5:00 p.m. (local time) between Monday to Friday, excluding Public Holidays and ESAOTE summer closing period.

All communications with the center must be in English at these addresses:

Esaote S.p.A
Via Siffredi 58
16153 Genoa Italy
Fax +39106547275
E-mail: MRI.Service@Esaote.Com

Sales and Service administration

The entire Service Administration is managed through your Sales Area Manager. Responsibilities include:

- Spare Parts Price List
- Order Processing
- Repair Administration (invoices and shipments)

Orders

Orders shall be issued to the Export Sales Department according to ESAOTE general rules and your Spare Parts Price List.

Part Numbers are required for prompt order process; items not included in Spare Part Price List cannot be ordered to ESAOTE.

All orders are subject to ESAOTE approval and orders below half million of Italian Lire are not accepted.

Delivery terms on spare parts range between 60-90 days.

Repairs

General conditions for repair

- Any Defective item under warranty shall be returned to ESAOTE for repair/substitution
- Parts declared ”non repairable” in the Spare Part Price List are not accepted once warranty expires
- Parts or products cannot be returned for upgrades unless the upgrade has been previously agreed in writing with ESAOTE
- Parts damaged because of traumatic events or improper handling (example: non-authorized modification or improperly performed modification) will be automatically considered out of warranty and can be declared non-repairable by ESAOTE
- Complete products cannot be returned for repair unless requested by ESAOTE or previously agreed in writing

Procedure for returning goods to ESAOTE

NOTICE	The modules shipped without following the correct procedure won’t be accepted

Follow this procedure to send back any item for reparation:

- Fill the Trouble Report (one for every broken module)
  - Make a copy of the T/R contained in this manual
  - Fill the T/R number field following this criteria: XX – 001 – 01

    XX = Distributor initials (ask Service Dep.)

    001 = Progressive trouble number

    01 = Current year
  - Leave empty the ESAOTE T/R number field

NOTICE	If you don’t have the T/R form, download it from the ESAOTE web site

- Send the filled T/R by fax to the attention of or by e-mail to: mri.service@esaote.com or christian.deferrari@esaote.com.

- If you want to send the broken module to ESAOTE, fill the RMA form in every field indicating:
  - **ITEM** name of the broken module
  - **P/N** part number of the broken module
  - **Item Ser/N** serial number of the broken module
  - **System Ser/N** serial number of the system

- **T/R** trouble report serial number
- **IC** index configuration number (only for E-SCAN)
- **Warranty** if the module is under warranty or out of warranty
- **Comments** for example, write if you need an urgent replacement of one of the broken modules

The Medical Device Directive (MDD 93/42) mandatory forces manufacturer, distributor and technician to guarantee the Ser/N traceability of some system components. See the below table. Every Trouble Report must have the Ser/N of the broken and new components.

Tab. 1: The Ser/N of these modules must be written in the Trouble Report

Code	Components
9102398000	Insulating Transformer
9100773003	Magnet
9101294000	GANTRY
9100934002	LNA
9101310001	RIB
9500649100	REGNTC
9700004003	Magnet and Covers
9101585000	Knee Coil N.1
9101034001	Large Knee Coil N.2
9101584000	Hand Coil N.3
9500877010	TRDIFF
9500166010	ACQ
9500176000	CNTR
9101533000	GRA
9101598000	RFA 250W
9100712001	RFR
9101148001	CTERM
9100805001	SINT02
9700020000	Electronic Units Left and Right
9500792010	DSP
9500722000	PRINT
9102274000	PC
9101721004	MONITOR CRT 19"
9101721005	MONITOR TFT 17"
9100711002	Magnetic Compensation Kit

NOTICE If you don’t have the RMA form, download it from the ESAOTE web site

- Send it by fax or e-mail to ESAOTE and wait for the RMA authorization form. It is a word file that you will receive by e-mail

NOTICE	Not all the out of warranty modules will be authorized (refer to the Repairable Item list)

- Print out the received RMA authorization form and place one copy on the shipment crate. Send the goods to the following address:

ESAOTE S.p.A.

Via Montecchi, 5

16153 Genova, ITALY

Att. Antonio Toso

NOTICE	The shipment without RMA authorization form attached will be rejects. In case parts have not been accepted for repair, a Notice of Rejection detailing the reasons will accompany goods.

- Make two orders and send them to silvia.bottino@esaote.com or by fax (+39 010 6547275):
  - under warranty modules at price zero
  - out of warranty modules insert the price contained into the Repairable Item list (50% off) of the Spare Part list

NOTICE	Indicate on the order the RMA number

Warranty after repair

If originally out of warranty, those parts are warranted after repair for a period of ninety days from ESAOTE shipment.

If in warranty, parts will be covered by saleable warranty or by the extended ninety days, whichever is greater. As an example, should the saleable warranty by expiring in 60 days, after repair warranty will be applied.

Part 3 System

Strategy

In this chapter you will find test strategies encompassing the complete system.

System functionality

All modules present in the system are necessary for different processes.

You must know how the system is composed and how it works in order to identify any kind of trouble.

You can identify some different chains:

- Transmitting gradient driving
- Transmitting coil driving
- Receiving driving
- Thermal control
- Images visualization and storing

You can perform different tests for every chain to identify the defective modules.

A detailed description of the different chains and the different tests is given below.

The most useful and powerful test is the System Check test.

In the next figures, the modules positions and connections are shown.

Fig. 1: System Layout

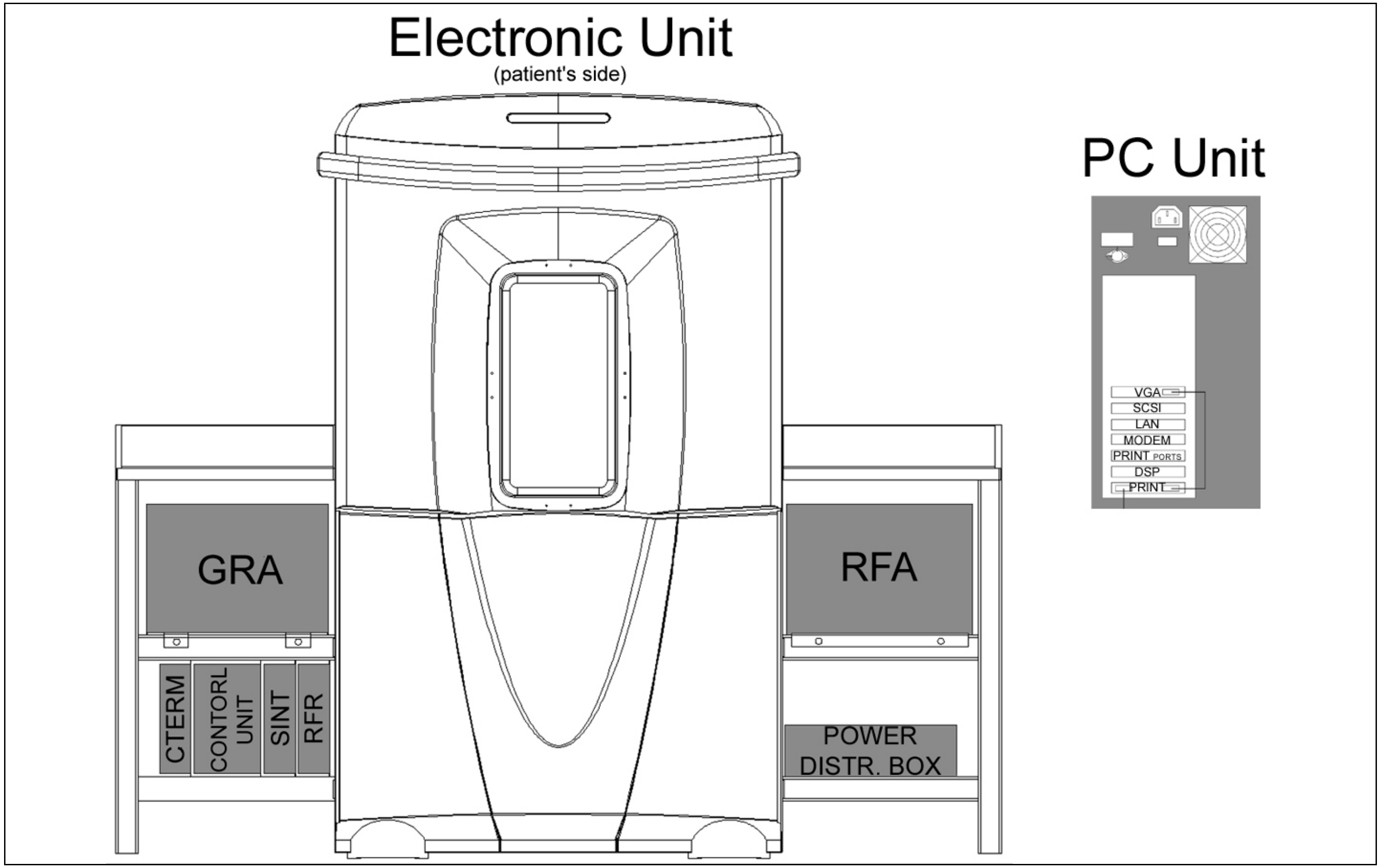


Fig. 2: Left Electronic Unit rear side

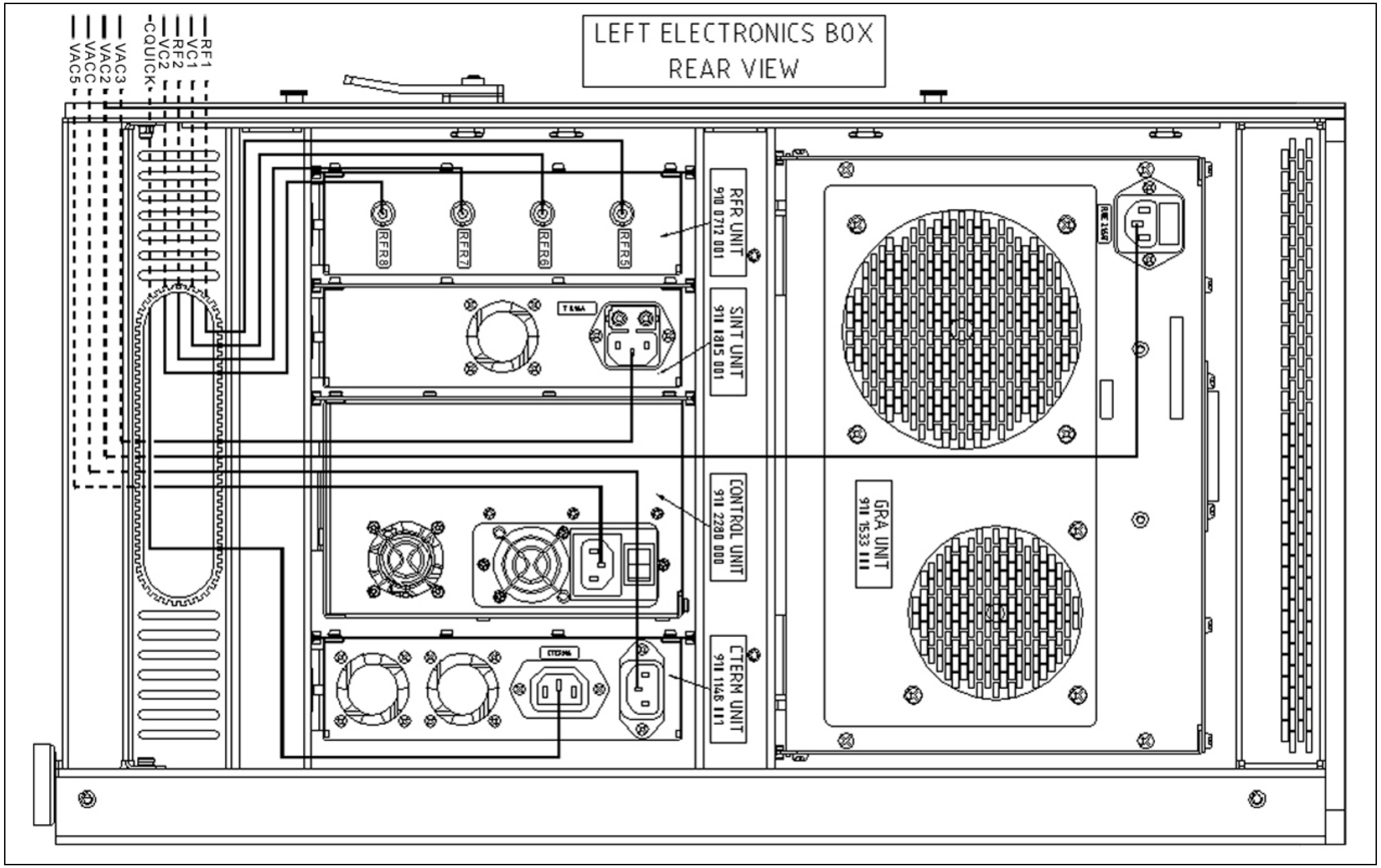


Fig. 3: Left Electronic Unit front side

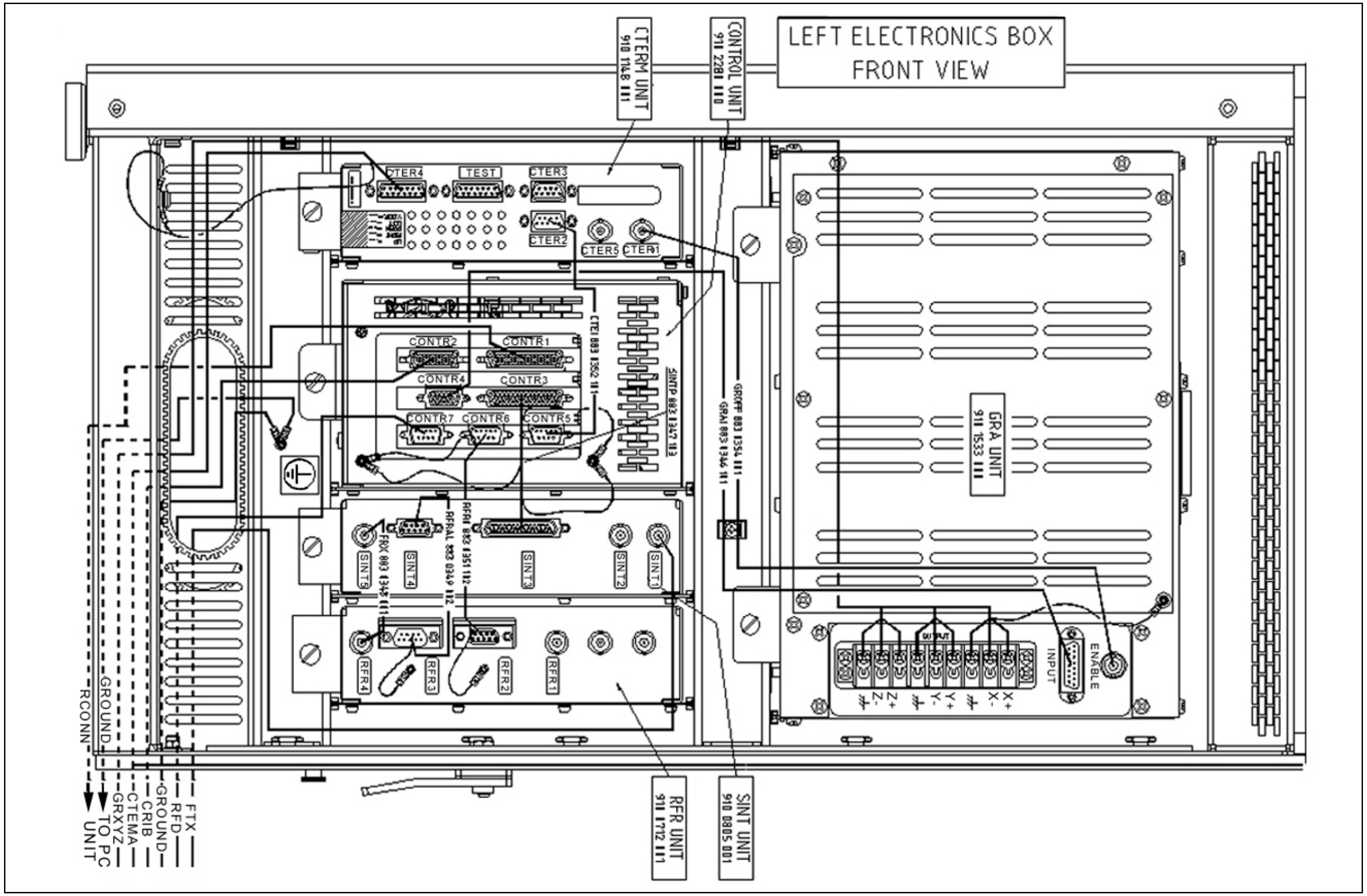


Fig. 4: Magnet top view

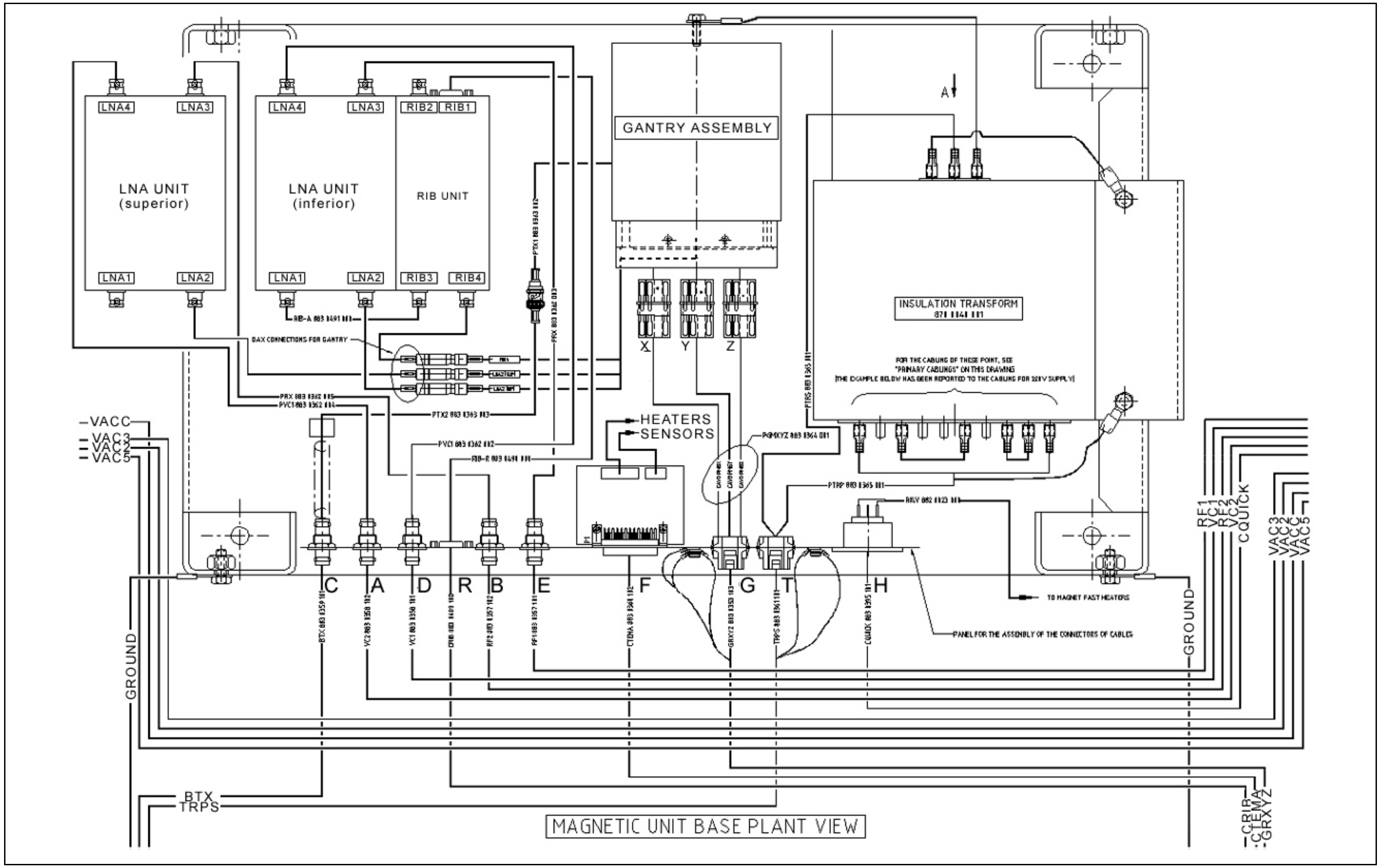


Fig. 5: Right Electronic Unit front side

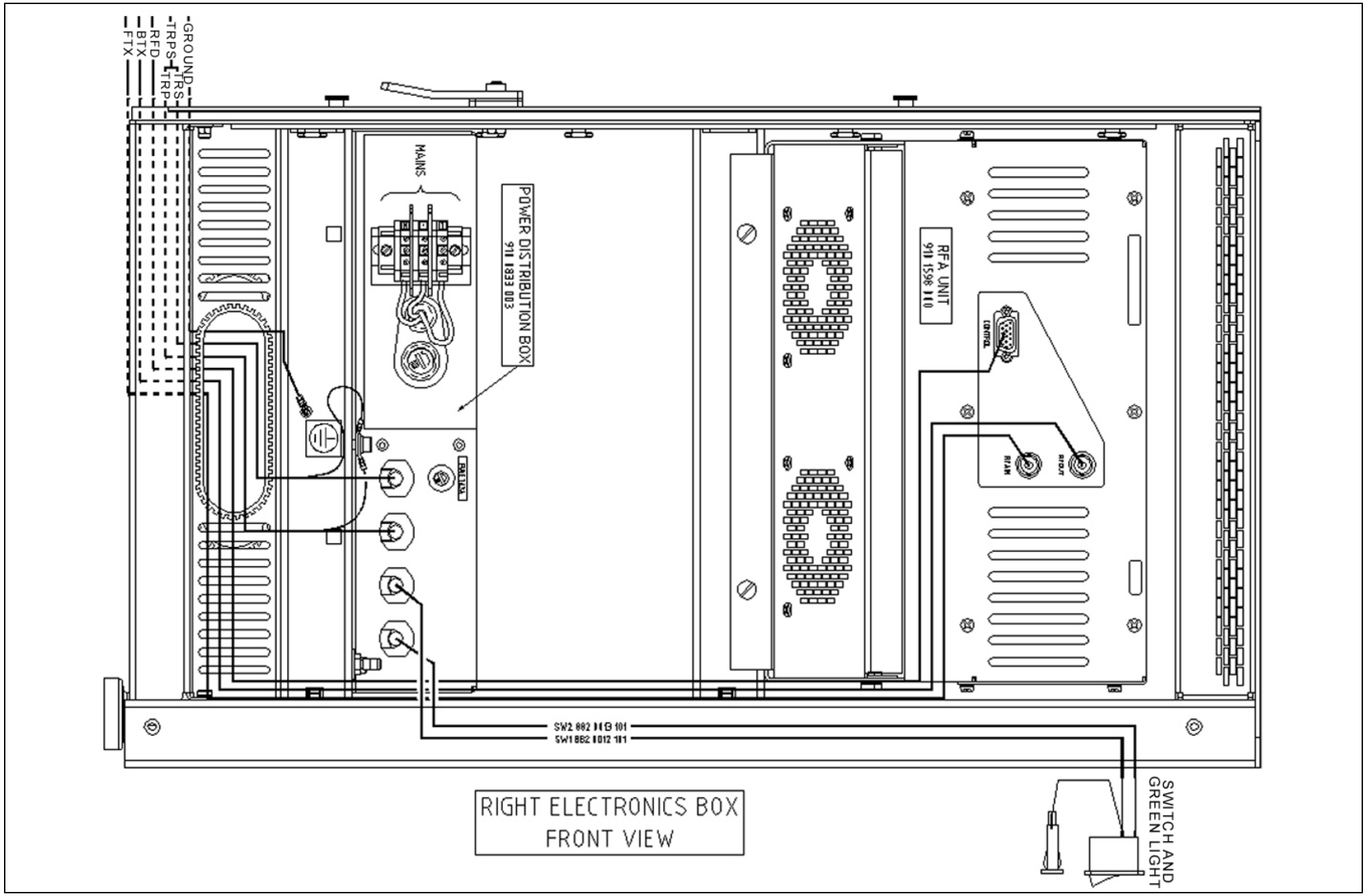
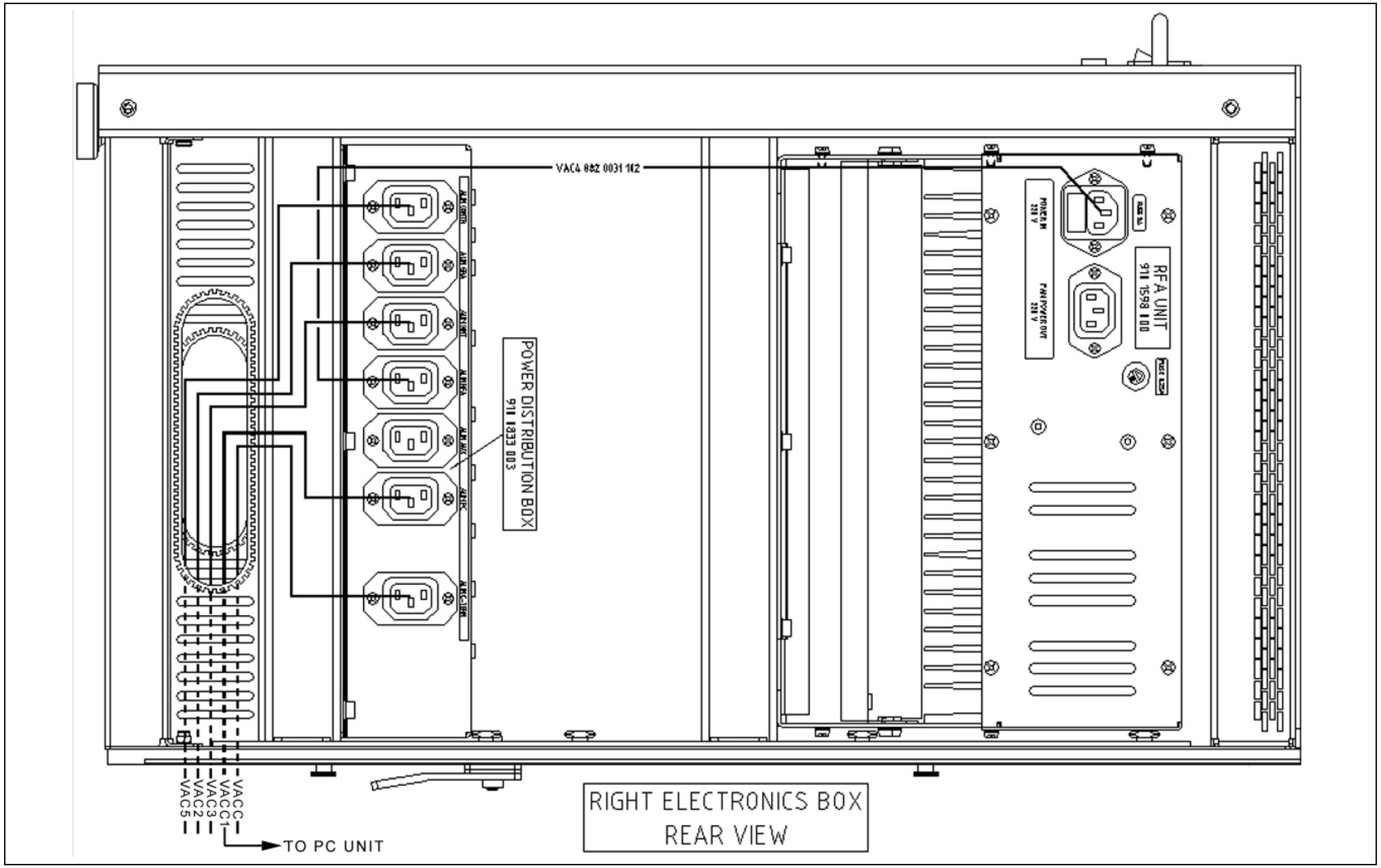


Fig. 6: Right Electronic Unit rear side



System error list

Window messages text syntax

`Error: (error code) "message":`

`Scan disabled`

The control is turned off and an unrecoverable error is indicated; the operator must click the "cancel" button to exit the message window.

`Warning: (error code) "message":`

`Do you want to proceed?`

There is a recoverable error and the user can continue to work; the operator must decide whether he wants to continue (button "Yes") or not (button "No"). After this he exits the message window.

`Note: (error code) "message"`

There may be a failure, but the user can continue to work; the operator must click the "cancel" button to exit the message window.

`System call error`

With this string we refer to a generic system error related to an operation (as opening/reading/writing file) which fails.

This kind of error causes a **NON RECOVERABLE** situation that might need service intervention.

`Configuration file error`

This string means that the data of the configuration file, which we are trying to read, are not in the expected format. This kind of error causes a **NON RECOVERABLE** situation that usually need service intervention.

Abbreviation codes

E: error

N: note

W: warning

Symbols used

COI: CPU control interface

LIF: lower control interface

OPI: operator interface

DSP: digital signal processing

Predef: files with all predefined scan data information

Error messages list

For every error code there is the type (E/W/N) and the description. The error codes are subdivided in paragraphs according to the situation that can give rise to them.

Generic codes

1 E: input error from LIF command.

9 E: general COI fatal error.

10 E: fatal timeout error from OPI after abort signal.

COI MIF command parsing time

101 E: invalid MIF command

102 E: system call error from MIF interpreter

COI and DSP scan execution time

201 E: bad input to scan execution MIF command.

202 E: system call error.

203 E: check error during preliminary phase of scan execution.

204 E: an error code has been returned by DSP during scan execution.

205 E: error during reconstruction on DSP board.

COI and DSP acquisition time

302 E: system call error.

303 E: data loaded from DSP have size greater than expected.

COI sequence compilation time

401 E: bad input to compile MIF command.

402 E: system call error.

403 E: check error during compile time.

406 E: syntax error on sequence source file.

COI scan data load time

501 E: bad input to scan data load MIF command.

502 E: system call error.

503 E: check error verifying scan data coherence.

506 E: format error on scan data file.

507 E: format error on predef file.

COI and DSP quit time

601 E: bad input to quit MIF command

602 E: system call error

604 E: error from DSP performing the quit command

COI load scan vocabulary time

701 E: bad input to load scan MIF command

702 E: system call error

703 E: check error during load time

706 E: syntax error on vocabulary file

COI and DSP initialization time

802 E: system call error

803 E: check error verifying execution environment and data structures loaded from DSP

804 E: an error has been returned from DSP initialization code

808 E: COI configuration error

810 E: timeout error waiting for DSP initialization code completion

Frequency calibration time

902 E: system call error

908 E: configuration file error

Gain calibration time

1002 E: system call error

1008 E: configuration file error

Calibration of the codification

1102 E: system call error

1108 E: configuration file error

90 calibration

1202 E: system call error

1208 E: configuration file error

Varicap calibration

1302 E: system call error

1308 E: configuration file error

Step frequency calibration

1402 E: system call error

1408 E: configuration file error

Noise level calibration

1502 E: system call error

1508 E: configuration file error

Temperature measurement

1602 E: system call error

1608 E: configuration file error

180 calibration

1702 E: system call error

1708 E: configuration file error

Noise measurements

1802 E: system call error

1808 E: configuration file error

Alarm codes

1901 E: gradient amplifier not powered

1902 E: gradient failure

1903 E: gradient failure, gradient amplifier not powered

1904 E: cterm failure

1905 E: cterm failure, gradient amplifier not powered

1906 E: cterm failure, gradient failure

1907 E: cterm failure, gradient amplifier not powered, and gradient failure

1908 E: RF amplifier failure

1909 E: RF amplifier failure, gradient amplifier not powered

1910 E: RF amplifier failure, gradient failure

1911 E: RF amplifier failure, gradient amplifier not powered, and gradient fail

1912 E: RF amplifier failure, cterm failure

1913 E: RF amplifier failure, cterm failure, and gradient amplifier not powered

1914 E: RF amplifier failure, cterm failure, and gradient failure

1915 E: RF amplifier failure, cterm failure, gradient amplifier not powered, and gradient failure

1916 E: RF amplifier not powered

1917 E: RF amplifier not powered, gradient amplifier not powered

1918 E: RF amplifier not powered, gradient failure

1919 E: RF amplifier not powered, gradient failure, and gradient amplifier not powered

1920 E: RF amplifier not powered, cterm failure

1921 E: RF amplifier not powered, cterm failure, and gradient amplifier not powered

1922 E: RF amplifier not powered, cterm failure, and gradient failure

1923 E: RF amplifier not powered, cterm failure, and gradient failure gradient amplifier not powered

1924 E: RF amplifier failure, RF amplifier not powered

1925 E: RF amplifier failure, RF amplifier not powered, gradient amplifier not powered

1926 E: RF amplifier failure, RF amplifier not powered, gradient failure

1927 E: RF amplifier failure, RF amplifier not powered, gradient failure, and gradient amplifier not powered

1928 E: RF amplifier failure, RF amplifier not powered, and cterm failure

1929 E: RF amplifier failure, RF amplifier not powered, cterm failure, and gradient amplifier not powered

1930 E: RF amplifier failure, RF amplifier not powered, cterm failure, and gradient failure

1931 E: RF amplifier failure, gradient amplifier not powered, cterm failure, gradient failure, and RF amplifier not powered

Timeout between OPI and COI

2065 E: error during initialization

2066 E: error during scan

Autofov

2166 E: system call error

2172 E: configuration file error

Automatic selection codes of calibrations

2266 E: system call error

2272 E: configuration file error

Calibration of magnetic compensation

2466 E: system call error

2472 E: configuration file error

Frequency calibration during scout

2666 E: system call error

2672 E: configuration file error

90 180 calibration

2766 E: system call error

2772 E: configuration file error

Alarm codes

2866 E: system call error

2872 E: configuration file error

Gain RF sweep codes

2966 E: system call error

2972 E: configuration file error

Temperature measurement codes during scout

3066 E: system call error

3072 E: configuration file error

Noise and temperature calibration

3466:E: system call error

3472:E: configuration file error

Frequency calibration

3566:E: system call error

3572:E: configuration file error

Frequency (phase measurement) calibration

3966:E: system call error

3972:E: configuration file error

Gradient Offset calibration codes

4066:E: system call error

4072:E: configuration file error

RX Offset calibration

4166:E: system call error

4172:E: configuration file error

Signal missing in calibration

18000W: frequency calibration, there is no signal

18001W: gain calibration, there is no signal

18002W: encoding calibration, there is no signal

18003W: 90 calibration, there is no signal

18004W: varicap calibration, there is no signal

18005W: frequency step calibration, there is no signal

18007W: 90-180 calibration, there is no signal

18008W: frequency calibration during scout, there is no signal

18009W: gain sweep calibration, there is no signal

Noise level codes

19000W: media noise calculated from FFT signal is over threshold

19001W: there are spikes in the signal

19002W: media noise over threshold and spikes in the signal

Bad signal codes

20000W: frequency calibration, the shape of the signal during calibration isn't in a wished form, there is something not OK, check the .rec files.

20001W: gain calibration, the amplitude of the signal during calibration isn't in a wished form, there is something not OK, and check the .rec files.

20002W: encoding calibration, the amplitude of the signal during calibration isn't in a wished form, there is something not OK, and check the .rec files.

20003W: 90 calibration, the amplitude of the signal during calibration aren't in a wished form, there is something not OK, check the .rec files.

20004W: varicap calibration, the amplitude of the signal during calibration isn't in a wished form, there is something not OK, and check the .rec files.

20005W: frequency step calibration, we can't obtain the number of intersections wished with zero, check the .rec files

20006W: 180 calibration, the amplitude of the signal during calibration isn't in a wished form, there is something not OK, and check the .rec files.

20007W: 90-180 calibration, the amplitude of the signal during calibration isn't in a wished form, there is something not OK, and check the .rec files.

20008W: frequency calibration during scout, we cannot obtain the number of intersections wished with zero, check the .rec files

20009W: gains sweep calibration, the max value of the signal after calibration is not in the wished range, there is something not OK.

20010W: 90 pulse calibration anomaly: insulating belt is recommended. Do you want to proceed?

Anomalous signal

20500W: temperature not in range

Signal out of range

22000N: signal not in range

Off-line calibration codes

23000N: Correct temperature, the temperatures are in the wished range

23001N: Incorrect temperature, one or more temperatures aren't in the wished range

23050N: Correct field, the frequency is in the expected range

23051N: Incorrect field, the frequency isn't in the expected range

23052N: There isn't signal during testing field

23100N: After calibration the value of 90 pulse is correct

23101N: After calibration the 90 pulse isn't in the wished range

23102N: There isn't signal during testing 90 pulse

23150N: After calibration the value of 180 pulse is correct

23151N: After calibration the 180 pulse isn't in the wished range

23152N: There isn't signal during testing 180 pulse

23200N: After calibration the varicap values are in the right range

23201N: After calibration the varicap values aren’t in the right range

23202N: No signal testing varicap tuning

23250N: Correct gain value after calibration

23251N: The signal after calibration isn’t in the correct range

23252N: There isn’t signal during calibration gain

23300N: Correct encoding gradient

23301N: Incorrect encoding gradient

23302N: There isn’t signal during encoding gradient calibration

24000N: After frequency step calibration the found values are in the wished range

24001N: After frequency step calibration the found values aren’t in the wished range

25000N: The average of the FFT noise signal is over threshold

25001N: The average of the FFT noise signal isn’t over threshold

25002N: the are spikes in the signal

25003N: media noise over threshold, spike in the signal

25100N: correct magnetic compensation

25101N: incorrect magnetic compensation

Timeout between OPI and COI

26000N: timeout on COI, incorrect scan duration

Alarm test codes

26500N: No alarms found

26501N: gradient amplifier not powered

26502N: gradient failure

26503N: gradient amplifier not powered, gradient failure

26504N: cterm failure

26505N: cterm failure, gradient amplifier not powered

26506N: cterm failure, gradient failure

26507N: cterm failure, gradient amplifier not powered, and gradient failure

26508N: RF amplifier failure

26509N: RF amplifier failure, gradient amplifier not powered

26510N: RF amplifier failure, gradient failure

26511N: RF amplifier failure, gradient amplifier not powered, and gradient fail

26512N: RF amplifier failure, cterm failure

26513N: RF amplifier failure, cterm failure, and gradient amplifier not powered

26514N: RF amplifier failure, cterm failure, and gradient failure

26515N: RF amplifier failure, cterm warning, gradient amplifier not powered, and gradient failure

26516N: RF amplifier not powered

26517N: RF amplifier not powered, gradient amplifier not powered

26518N: RF amplifier not powered, gradient failure

26519N: RF amplifier not powered, gradient failure, and gradient amplifier not powered

26520 N: RF amplifier not powered, cterm failure

26521 N: RF amplifier not powered, cterm failure, and gradient amplifier not powered

26522 N: RF amplifier not powered, cterm failure, and gradient failure

26523 N: RF amplifier not powered, cterm failure, gradient failure, gradient amplifier not powered

26524 N: RF amplifier failure, RF amplifier not powered

26525 N: RF amplifier failure, RF amplifier not powered, and gradient amplifier not powered

26526 N: RF amplifier failure, RF amplifier not powered, and gradient failure

26527 N: RF amplifier failure, RF amplifier not powered, gradient failure, and gradient amplifier not powered

26528 N: RF amplifier failure, RF amplifier not powered, and cterm failure

26529 N: RF amplifier failure, RF amplifier not powered, cterm failure, and gradient amplifier not powered

26530 N: RF amplifier failure, RF amplifier not powered, cterm failure, and gradient failure

26531 N: RF amplifier failure, gradient amplifier not powered, cterm failure, gradient failure, and RF amplifier not powered

26600 W: the signal after sweep calibration is in the wished range

26601 W: the signal after sweep calibration is not in the wished range

26602 W: during gain sweep calibration there is no signal

Broken Modules Identify

A malfunction involving the CPU, HD, SVGA, monitor, keyboard, mouse and optical disc (and/or relative SCSI card) should be immediately obvious since their operation (or failure) is plainly ”visible”. If the message ”**Non recoverable error. Scan disabled**” appears this means that the software has found problems with one or more modules, which compound the system.

Try to repeat the bootstrap and if it’s completed successfully, you are advised to run the alarm diagnostics. With this procedure, you can check whether amplifiers (GRA and RFA) and CTERM are operating correctly. In the event of a malfunction, a message appears identifying the failed module. The acronyms used have the following meanings:

- GRA-OFF: direct power supply failure to the gradient amplifier. This event may also be due (besides to the fuse being blown, or a disconnected 220VAC cable etc.) to failure to receive acknowledgement from the CTERM module.
- GRA: gradient amplifier malfunction (failed PLL connection of its internal switching amplifier and/or output voltage clamp). Not significant when GRA-OFF is present.
- RFA-OFF: direct power supply failure to the RF amplifier. This event may also be due (as well as to the fuse being blown, or disconnected 220VAC cable etc.) to overheating of the amplifier (T > 50°C).
- RFA: RF amplifier malfunctioning (duty cycle over 25% and/or reflected power greater than 40 watt). Not significant when RFA-OFF is present.
- CTERM: direct power supply failure to the CTERM module. This event may also be due (as well as to the fuse being blown or to a disconnected 220VAC-cable etc.) to overheating of at least one side of the magnet. This failure is detected by the temperature sensors (2 NTC in series) located on the side, or by a short circuit or an open circuit on at least one of the four groups of the NTC sensors.

After verifying that the standard part of the PC (successful completion of the bootstrap routine without any error messages) and the power modules (GRA, RFA and CTERM are operating correctly, with the diagnostic alarms), you can proceed to run the <**System Check**> diagnostic. If the plot operates correctly, it is safe to assume that, generally speaking, the control subsystems (DSP and CNTR) and the acquisition subsystems (DSP and ACQ) are operating correctly too. In particular, it is best to first display the values relative to the driving of the receiving subsystem (modules RFR, and BRX) which are generated and monitored from within the module ACQ. Their correct behavior confirms substantially that acquisition is operating correctly. From <**System Check**> you can also verify the correct operation of ”Gradients” and ”RF Pulse”. Regarding the RF pulse, you must know the correct amplitude ratio between transmitted and reflected RF pulse (P_d/P_r>4) which shows that the connection is correct and that the transmitting coil (BTX) tuning is correct. Conversely, the absence of the RF pulse may be due to:

- A malfunction of the SINT module: if, for instance, the module is not receiving power (fuse, cable, etc.). You can also make sure that the SINT is working at the correct frequency. To test this, connect SINT5 (the local oscillator output, normally connected with RFR4) to a scope and check that the frequency (f_0) and the signal amplitude (1.2 Volt p-p) are correct. Another way is to use the AINT service module.
- Bad tuning of the transmitting coil. If the ratio is about 1 (i.e. all the power is reflected), the problem could be due to a bad connection between RF amplifier and transmitting coil or a broken component inside the transmitting coil. For example the central capacitor on the tuning circuit inside the ”gantry”.
- A wrong value of the frequency set in the ”Homogeneity” calibration.

As for the receiving chain, you are advised to use the standard machine settings (central frequency search, noise level, S/N for the various receiving coils and sequence calibration, etc.).

Procedures

Recording files introduction

This section explains the possibility of evaluating information regarding the system operations. In fact this information is written in some recording files which can be seen by the operator.

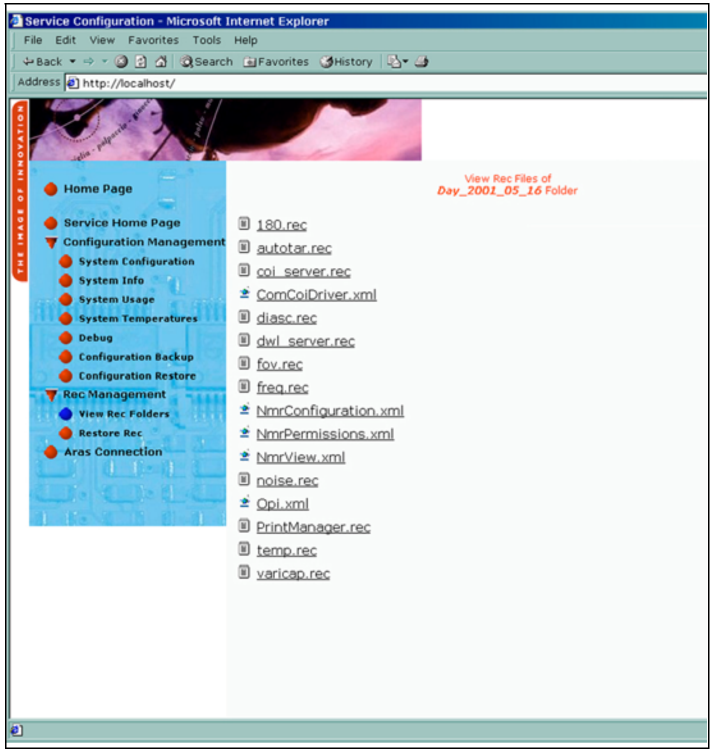
The following paragraph gives the recording files list, in which the name of every file is followed by an extension name ".rec".

The Rec Files contain all the operations performed by the system. Some of them are generic other are more specific. The system creates a new folder every day and every folder contain only the rec files filled in that day.

All the rec files are self-explaining and not always are created by the system every day.

To have access to the rec files, open the Internet Explorer and, from the homepage, open the **Rec File Management** folder then **View Rec Folder**: from this page you have to select the interested day, opening it the system will show the compiled rec files.

Fig. 7: REC File folder

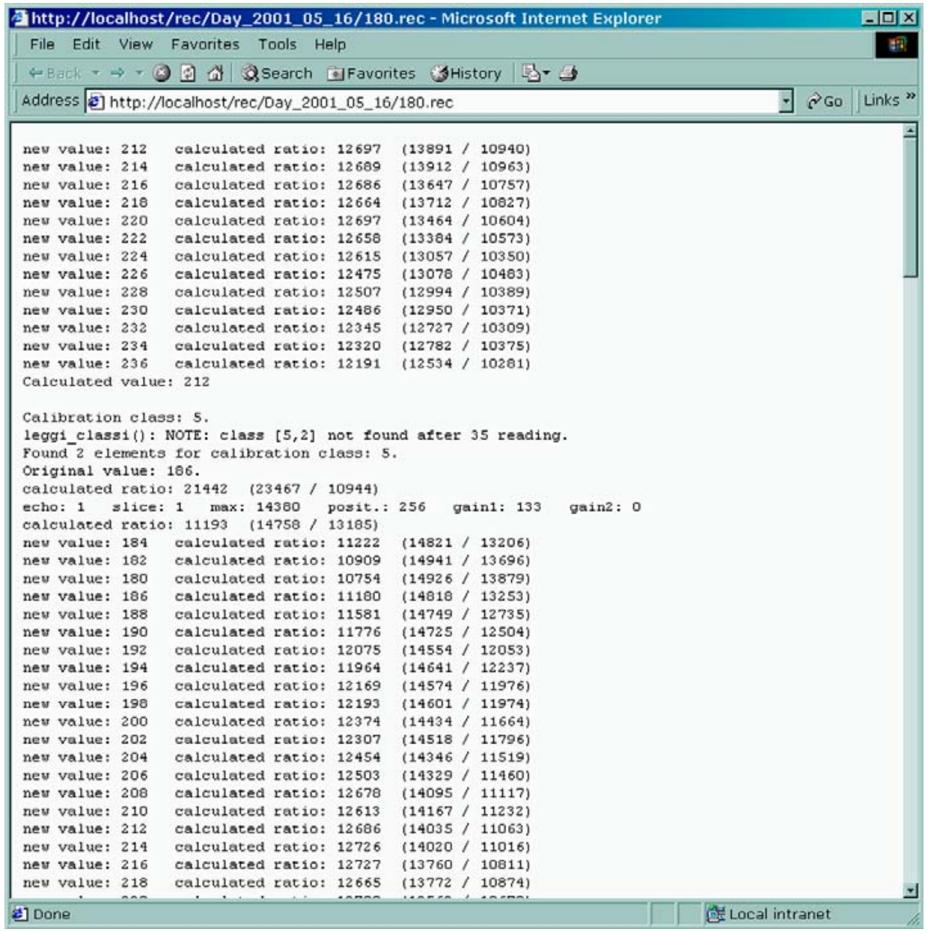


Rec file list

Tab. 2: Rec file list

Rec file name	Meaning
opierr.rec	The file contains the sentences written every time an Error Message Window is displayed
opi.rec	The file contains all the sentences written by the Operator Interface (*OPI*) during the examination
sn.rec	The file contains the <**S/N Check**> obtained by pressing a button from the Operator Interface
header.rec	The file contains the image information obtained and viewed by pressing the <**Service**>/<**Image info**> button from the Operator Interface
coi.rec	The file keeps a record of the activity of every work session of the *Control Interface* (*COI)*
opicoi.rec	The file contains information about the UNIX **core** file
90.rec	The file contains the 90 pulse values
180.rec	The file contains the 180 pulse values
varicap.rec	The file contains the varicap The file contains the 180 pulse values
autotar.rec	This file contains information about two different gain processes
freq.rec	The file contains the fine step frequency values
freqstep.rec	The file contains the course step frequency values
noise.rec	The file contains the shielding test values
temp.rec	The file contains the temperature and power values of the magnet
fov.rec	The dimensions along the Y and X-axes of the object are stored in this file
alarms.rec	Alarm messages are stored in this file
diascope.rec	The file is the file to which *“Diascope”* writes every time it runs
ortho.rec	The file is the trace (recording) of the activity of the executable *ortho*
resl_s_shm.rec	The file is the trace (recording) of the activity of the executable *resl*
work.rec	The file is the trace of the general activity of the machine
ping.rec	The file contains the results of the inquiry to the other system
stab.rec	The file contains the data for the stability test
results.rec	The file contains the data of the shimming calculation

Fig. 8: 180.rec




```
new value: 212   calculated ratio: 12697  (13891 / 10940)
new value: 214   calculated ratio: 12689  (13912 / 10963)
new value: 216   calculated ratio: 12686  (13647 / 10757)
new value: 218   calculated ratio: 12664  (13712 / 10827)
new value: 220   calculated ratio: 12697  (13464 / 10604)
new value: 222   calculated ratio: 12658  (13384 / 10573)
new value: 224   calculated ratio: 12615  (13057 / 10350)
new value: 226   calculated ratio: 12475  (13078 / 10483)
new value: 228   calculated ratio: 12507  (12994 / 10389)
new value: 230   calculated ratio: 12486  (12950 / 10371)
new value: 232   calculated ratio: 12345  (12727 / 10309)
new value: 234   calculated ratio: 12320  (12782 / 10375)
new value: 236   calculated ratio: 12191  (12534 / 10281)
Calculated value: 212

Calibration class: 5.
leggi_classi(): NOTE: class [5,2] not found after 35 reading.
Found 2 elements for calibration class: 5.
Original value: 186.
calculated ratio: 21442  (23467 / 10944)
echo: 1   slice: 1   max: 14380   posit.: 256   gain1: 133   gain2: 0
calculated ratio: 11193  (14758 / 13185)
new value: 184   calculated ratio: 11222  (14821 / 13206)
new value: 182   calculated ratio: 10909  (14941 / 13696)
new value: 180   calculated ratio: 10754  (14926 / 13879)
new value: 186   calculated ratio: 11180  (14818 / 13253)
new value: 188   calculated ratio: 11581  (14749 / 12735)
new value: 190   calculated ratio: 11776  (14725 / 12504)
new value: 192   calculated ratio: 12075  (14554 / 12053)
new value: 194   calculated ratio: 11964  (14641 / 12237)
new value: 196   calculated ratio: 12169  (14574 / 11976)
new value: 198   calculated ratio: 12193  (14601 / 11974)
new value: 200   calculated ratio: 12374  (14434 / 11664)
new value: 202   calculated ratio: 12307  (14518 / 11796)
new value: 204   calculated ratio: 12454  (14346 / 11519)
new value: 206   calculated ratio: 12503  (14329 / 11460)
new value: 208   calculated ratio: 12678  (14095 / 11117)
new value: 210   calculated ratio: 12613  (14167 / 11232)
new value: 212   calculated ratio: 12686  (14035 / 11063)
new value: 214   calculated ratio: 12726  (14020 / 11016)
new value: 216   calculated ratio: 12727  (13760 / 10811)
new value: 218   calculated ratio: 12665  (13772 / 10874)
```

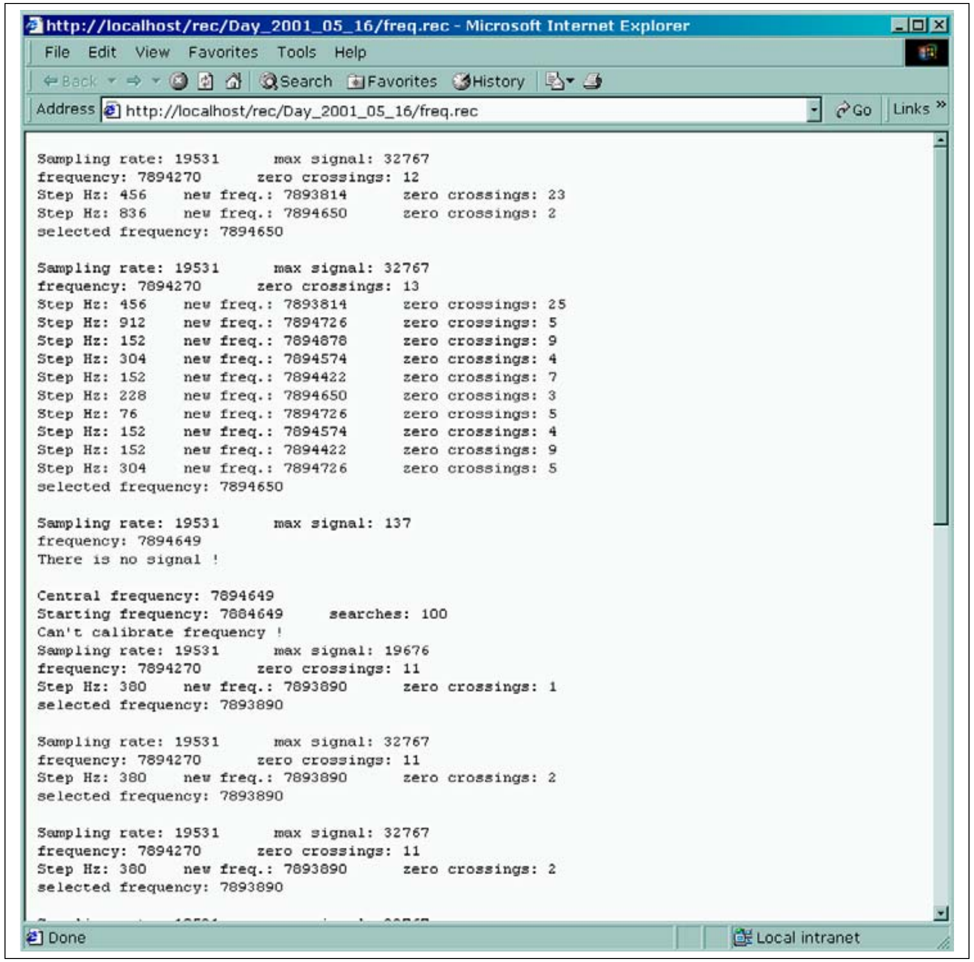
The 180° Pulse calibration is automatically done by the system every scout acquisition to calibrate the necessary energy to rotate the spin during the sequence acquisition.

The 90° Pulse is automatically calculated by the system starting from the 180° Pulse value.

The 180.rec file is also filled in during the Service automatic calibrations.

Looking at this file is possible to understand when the system wasn't able to calibrate the pulse and why the images went black, for example.

Fig. 9: Freq.rec




```
Sampling rate: 19531      max signal: 32767
frequency: 7894270      zero crossings: 12
Step Hz: 456    new freq.: 7893814      zero crossings: 23
Step Hz: 836    new freq.: 7894650      zero crossings: 2
selected frequency: 7894650

Sampling rate: 19531      max signal: 32767
frequency: 7894270      zero crossings: 13
Step Hz: 456    new freq.: 7893814      zero crossings: 25
Step Hz: 912    new freq.: 7894726      zero crossings: 5
Step Hz: 152    new freq.: 7894878      zero crossings: 9
Step Hz: 304    new freq.: 7894574      zero crossings: 4
Step Hz: 152    new freq.: 7894422      zero crossings: 7
Step Hz: 228    new freq.: 7894650      zero crossings: 3
Step Hz: 76     new freq.: 7894726      zero crossings: 5
Step Hz: 152    new freq.: 7894574      zero crossings: 4
Step Hz: 152    new freq.: 7894422      zero crossings: 9
Step Hz: 304    new freq.: 7894726      zero crossings: 5
selected frequency: 7894650

Sampling rate: 19531      max signal: 137
frequency: 7894649
There is no signal !

Central frequency: 7894649
Starting frequency: 7884649     searches: 100
Can't calibrate frequency !
Sampling rate: 19531      max signal: 19676
frequency: 7894270      zero crossings: 11
Step Hz: 380    new freq.: 7893890      zero crossings: 1
selected frequency: 7893890

Sampling rate: 19531      max signal: 32767
frequency: 7894270      zero crossings: 11
Step Hz: 380    new freq.: 7893890      zero crossings: 2
selected frequency: 7893890

Sampling rate: 19531      max signal: 32767
frequency: 7894270      zero crossings: 11
Step Hz: 380    new freq.: 7893890      zero crossings: 2
selected frequency: 7893890
```

Like for the 180.rec, the frequency calibration is automatically done by the system every scout acquisition to find the magnet frequency in that moment.

A small frequency shift is normal and compensated by the system.

A frequency shift is related to a thermal shift, usually, due to the environmental thermal shift.

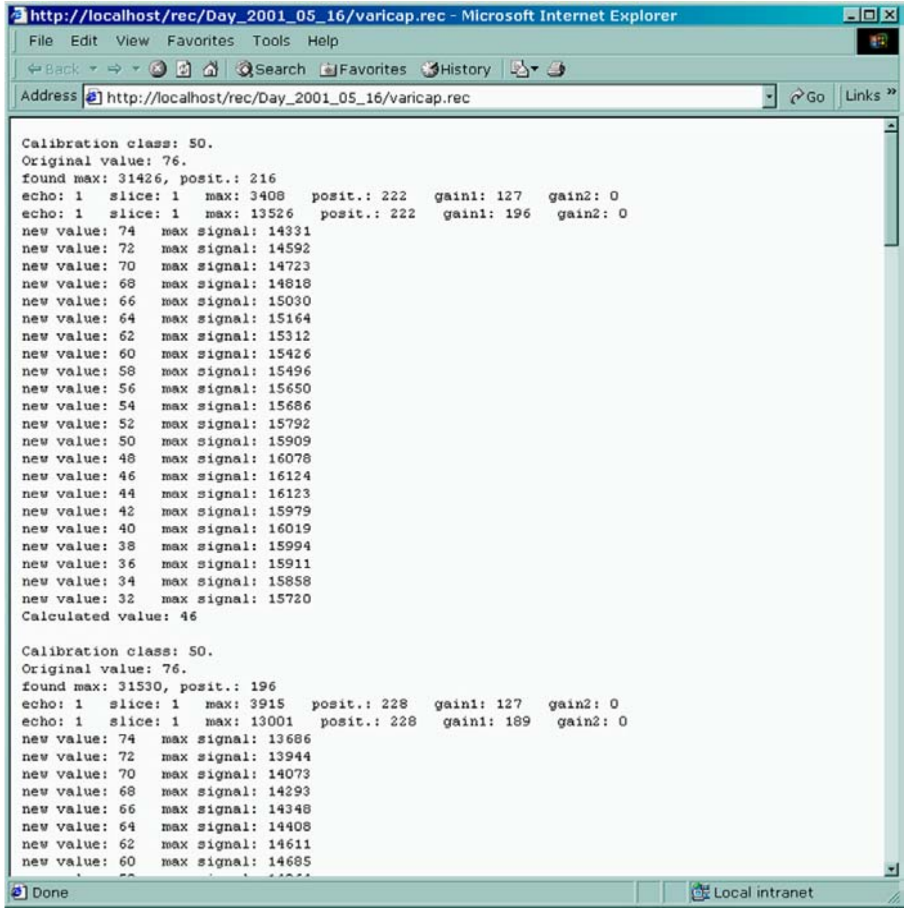
During the day the temperature of the room increase and the CTERM has to follow this shift decreasing the power sent to the Magnet to warm up it.

In case of big Magnet thermal shift, perform the System Monitor to follow in real time the temperature and provided power to every channel.

Remember that the system is calibrated to the Magnet central frequency and it must be stable, all the specification written in the Planning Guide and related to the installation room must be met.

Stable frequency means good image quality.

Fig. 10: Varicap.rec



The Varicap is a voltage value (0 – 9V) sent by the RFR to the Coil in order to set it to the Magnet frequency taking care of the inserted load.

Every Coil has its own Varicap value: when you save it manually don't overwrite the other values.

Also the Varicap is automatically calculated by the system during every Scout acquisition.

The rec file is filled in by the system every time the varicap is calculated either when is done automatically or manually by the Service technicians.

If the Varicap is not correct or cannot be calculated by the system means that an error in the receiving channel occurred.

Service RecFilePlot introduction

This section deals with the monitoring and subsequent analysis of various quantities whose time evolution is interesting while evaluating:

- The characteristics of the environment in which the system must operate (with particular reference to temperature and Magnetic DC field strength)
- System adjustments while responding to changing environmental conditions (with particular reference to thermal and magnetic compensation activities)
- System parameters (with particular reference to central precession (Larmor) frequency and operating noise level).

This environment is organized in this way: analysis of the time evolution of the above mentioned quantities plays a critical role in identifying troubles relating to the presence of incorrect environmental conditions and/or damage or malfunctioning of thermal and magnetic compensation units. Moreover, the analysis performed over a long period of time can provide meaningful information (from a statistical point of view) about the relationships between failures and certain environmental conditions.

In order to provide a complete tool, the monitoring procedure can be performed in three different ways, characterized by different time ranges:

- For a maximum period of a day (<**System Monitor**>: short period analysis)
- For a maximum period of one year (<**System History**>: analysis performed over a part of the lifecycle of the system)
- During a cycle of thermal stress (<**Stress**>: analysis performed over a maximum period of three days, the appropriate sequences inspect the system's thermal stress by observing the relationships among the measured quantities listed below).

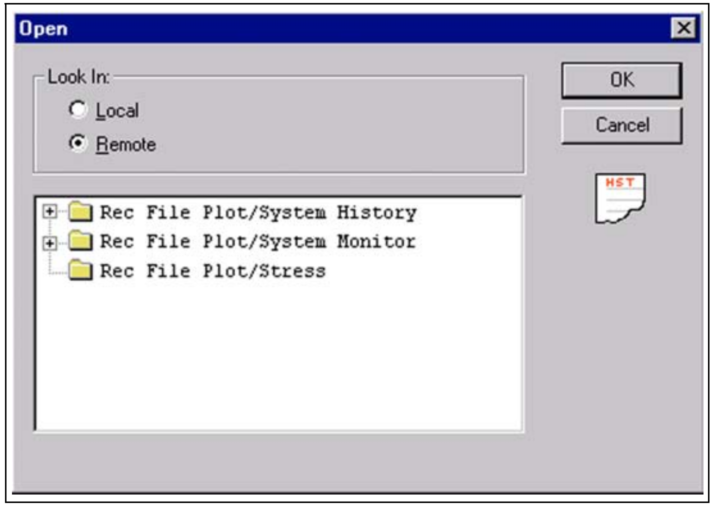
The practical tool used to inspect the quantities versus time functions resulting from the monitoring procedure is again the *"Diascope"* whose characteristics and functions are tailored for this specific application as described below.

Monitored quantities

Three folders are available under the <**Hist**> icon of the ARAS toolbar: <**RecFilePlot/System History**>, <**RecFilePlot/System Monitor**> and <**RecFilePlot/Stress**>. They make it possible to display the data items previously collected with one of the time ranges defined above. Here is a detailed list of the monitored quantities.

NOTICE	These files are created by the system only when the corresponding test are performed (e.g.: the <System Monitor> test compiles the <RecFile-Plot/System Monitor> history file)

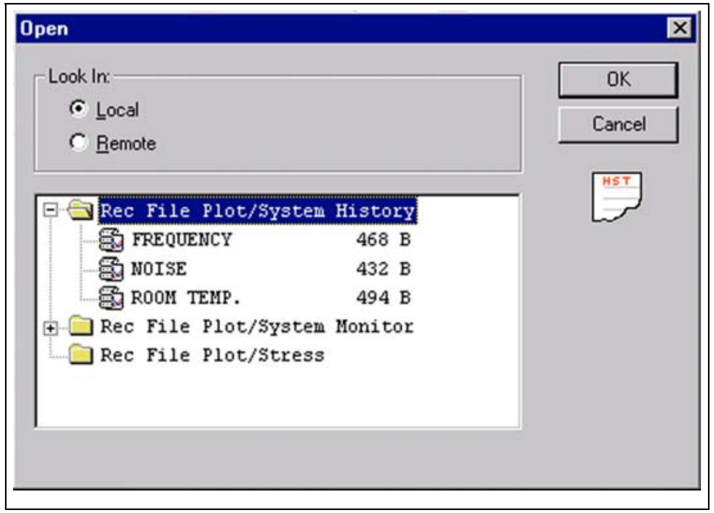
Fig. 11: History File Selection



System history

- Environment temperature
- Central precession (Larmor) frequency of static magnetic field
- Noise (average FFT)

*Fig. 12: <**RecFilePlot/System History**> folder*

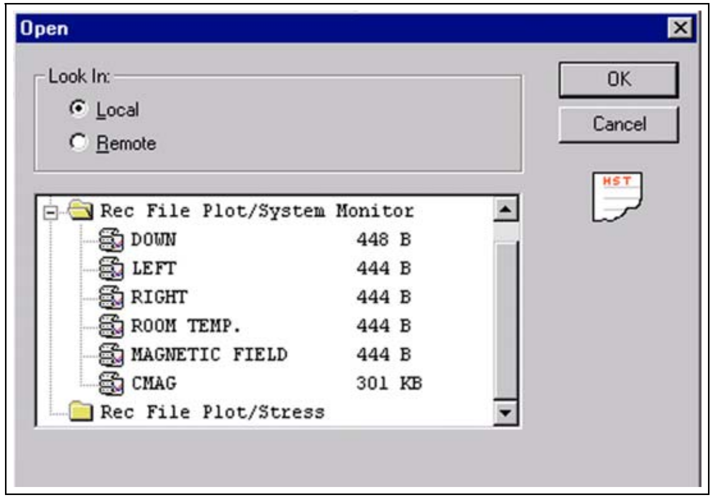


System monitor

- Temp/Power UP INNER; DOWN OUTER; DOWN INNER and UP OUTER (Temperature/power associated with each of the four heaters)
- Environment temperature
- Magnetic field strength
- Magnetic field strength/Magnetic field strength in the gantry

(The last logical channel is fundamental also as a tool while performing magnetic compensation)

*Fig. 13: <**RecFilePlot/System Monitor**> folder*

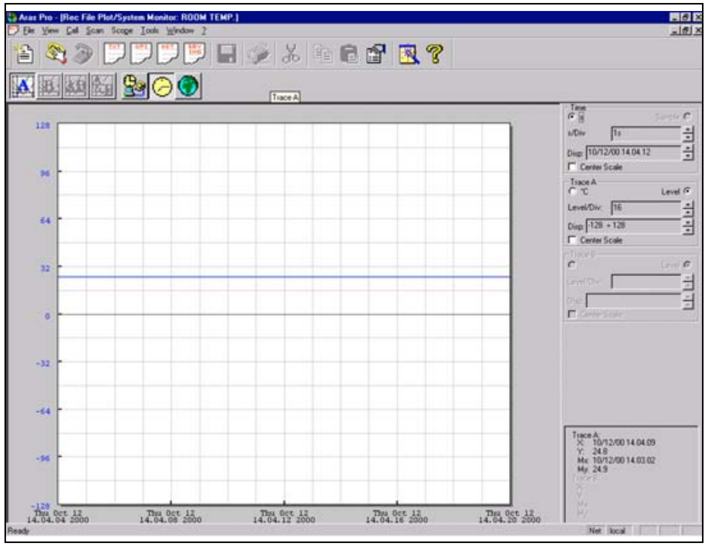


Stress

- Temp/Power UP INNER; DOWN OUTER; DOWN INNER and UP OUTER (Temperature/power associated with each of the four heaters)
- Environment temperature
- Central precession (Larmor) frequency of static magnetic field

Like in all the other system features the scales can be set by the user to better visualize the history data.

Fig. 14: History file Diascope visualization



System Check

Description

The <**System Check**> menu contains several functions allowing the operator to perform various checks of the system operation.

After entering this environment, the system will display *"Diascope"* instrument.

Operation

Perform the following operations to access the <**System Check**> environment:

- Turn on the system and wait for the operator interface to appear on the screen. If after 20 seconds no error messages are displayed ("**Non recoverable error. Scan disabled**."), this means that the computer has successfully completed its self-configuration (all modules are present) and is receiving the basic clock (for control and acquisition) from the SINT module.
- Open the ARAS program then select <**Tests**> <**Hardware**> <**System check**> and press <**Run**>

You have now entered the <**System check**> environment, from which you can test the apparatus electronics.

After approx. 10 seconds, you will hear the noise of pulsating gradients. After another 10 seconds, the screen will turn into a 2-channel oscilloscope, displaying on the left a large window displaying a pair of signals at the rate of about one pass per second, and on the right a column containing a menu of commands. A detailed explanation is given in the following paragraph.

Please note that data is acquired with a 16-bit resolution in a two's complement mode and the display range of our oscilloscope (with <**Res. Div.**> =1.0 and <**Displacement**> =0) is between -32768 and +32767. Values exceeding the display range are shown with a tangent line to the upper or lower edge of the window. Displacement is relative to the visualization and not to the signal.

The message "**Note (26000) Incorrect scan duration**", that is displayed when quitting, is not a warning of a malfunction, but rather indicates the time (longer than in a normal scan) that the <**System Check**> environment has been active.

Functions

You can run the following tests from the System Check environment:

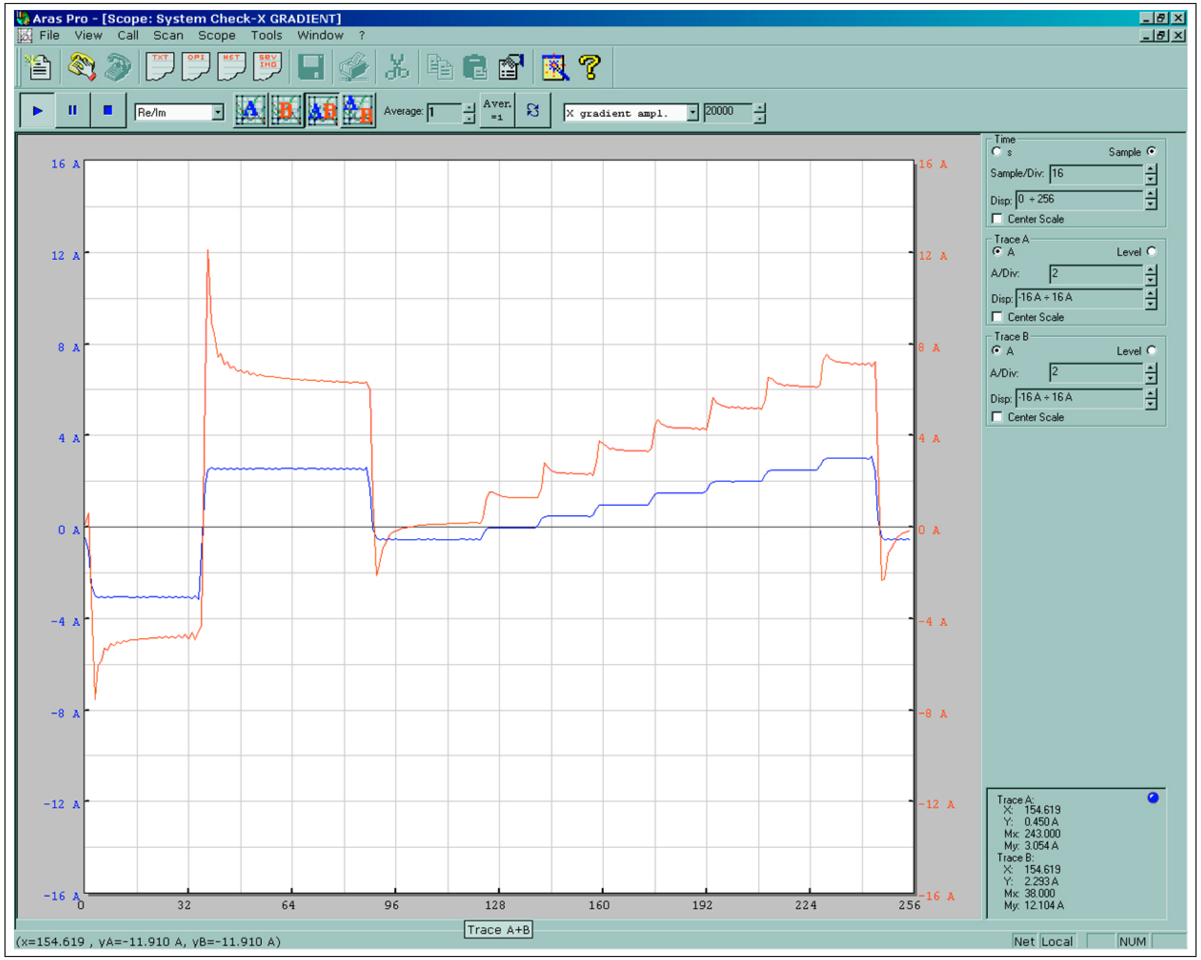
- X, Y and Z Gradients Coil Driving
- Receiving Chain Driving
- Transmission Chain Driving

The control software operating on the DSP sends, on cable HSSLO, the digital data, which are necessary to CNTR PCB. Both CNTR and DSP are in the PC unit.

Within the CNTR command, data are processed and transformed into analogue signals driving the gradient amplifier (GRA) and sent to the same amplifier by the GRA cable and reaches the GRA "INPUT" connector.

Gradients are sent to the magnet side through the filter panel to the magnet connection panel (rear side). Gradient X, Y and Z coils are fixed into the "GANTRY" to the magnet and are made of multi layer rigid circuit matter.

Fig. 15: System Check X,Y and Z channels



The first three channels of the System Check test are the gradient waveforms. The blue traces are the output of the CNTR board and the input of the GRA module. The red traces are the output of the GRA module.

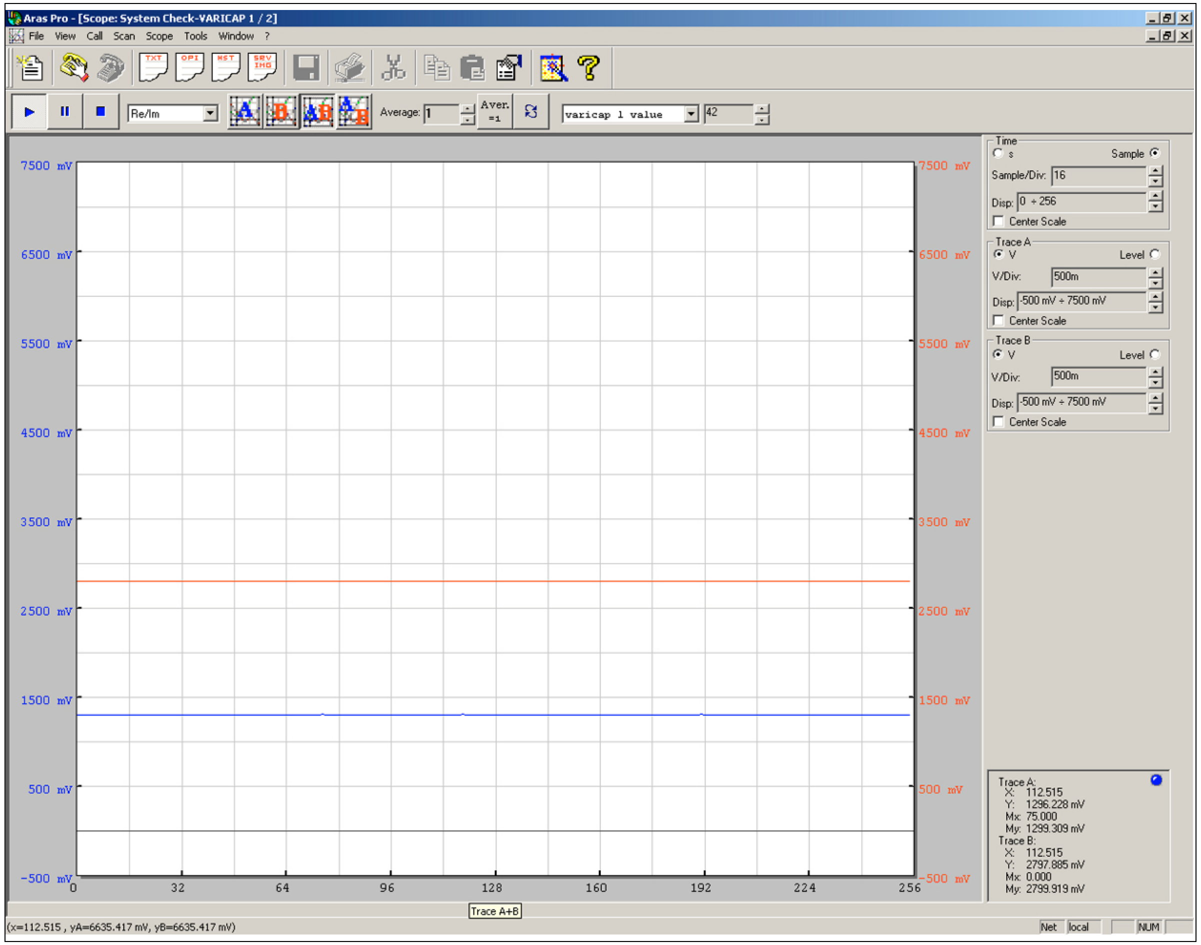
If the input traces are not present means that or the CNTR is broken or the cable between the CNTR and the GRA is broken.

If all the output traces are flat probably the GRA is broken or not powered or disabled by the CTERM module.

If only one of the output trace is flat, swap the gradient cables (e.g.: X is flat, invert X with Y).

If the problem moves to another channel means that the problem is from the GRA on (cables or Gantry); if the problem is still on the same channel means that the gradient board is broken.

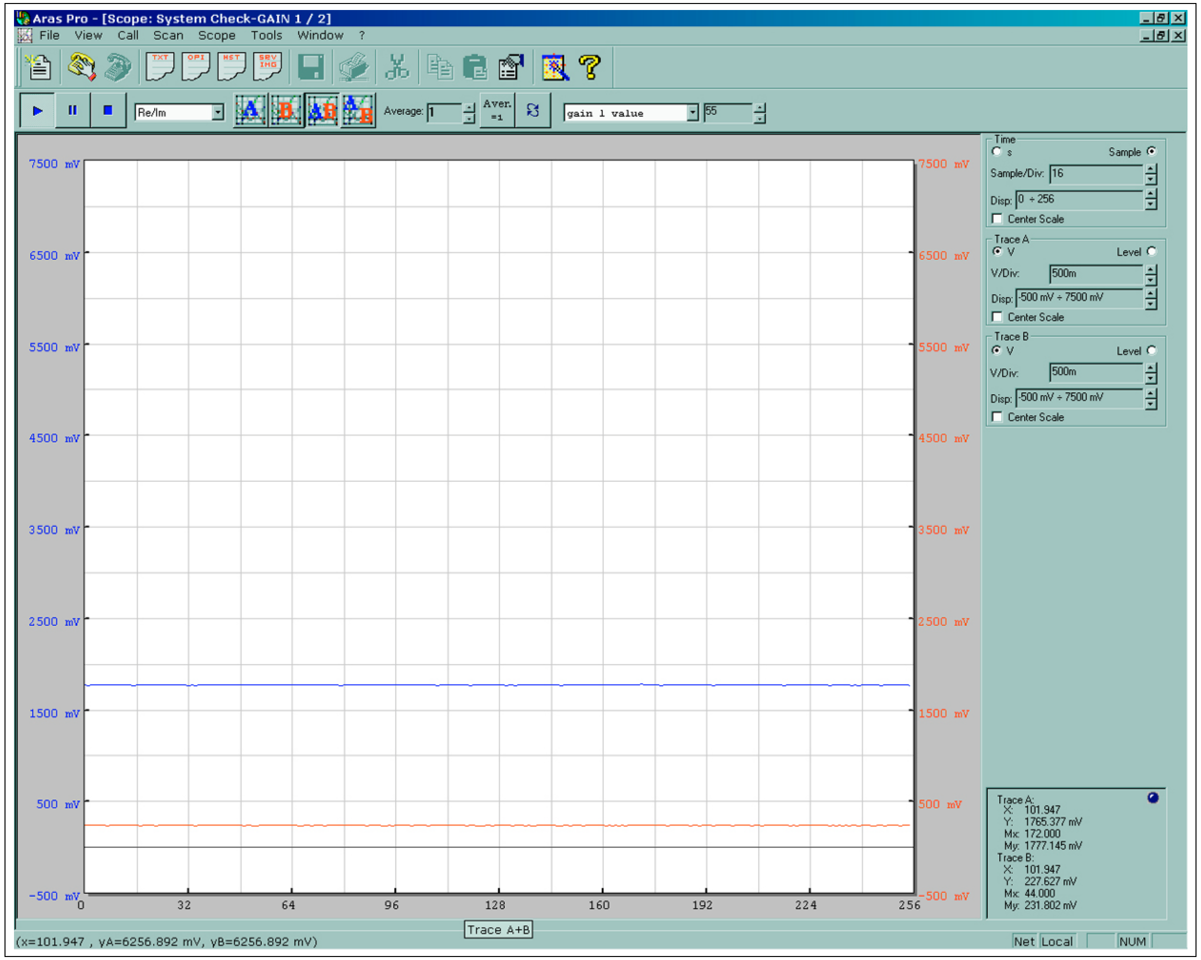
Fig. 16: System Check Varicap 1 and 2



The Varicap is a voltage value (o – 9V) that the RFR sends to the Coil in order to set it at the magnet central frequency taking care of the inserted load: different load, different varicap value.

Change the varicap value (0 – 255) and see if the voltage value changes, if not means that the RFR is broken or that the cables from the RFR to the Coil are broken (short circuit).

Fig. 17: System Check Gain 1 and 2



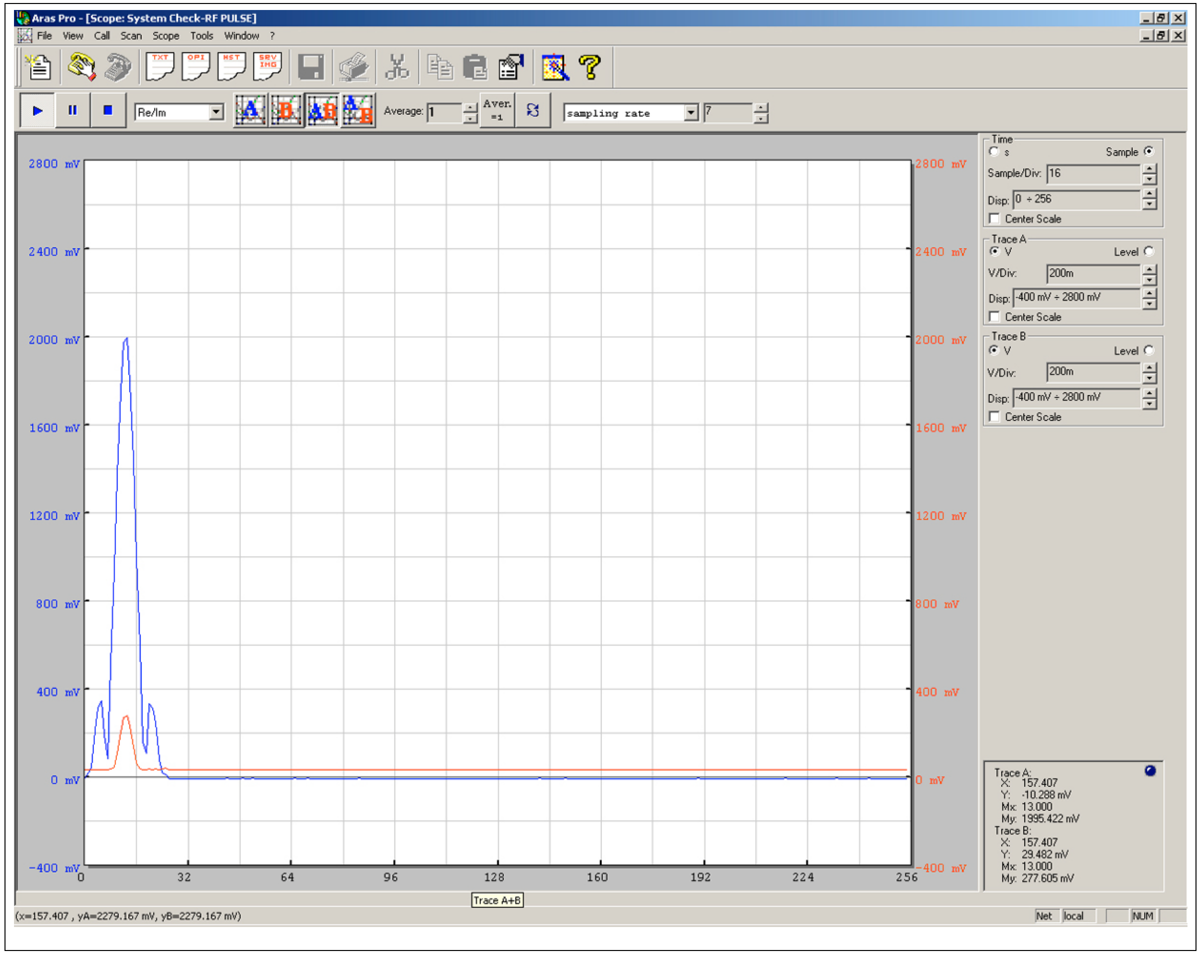
The Gain signals are operational amplifier gains present into the RFR module.

Performing a Scout acquisition using the Knee Coil 1 and the Geometrical phantom in axial position Gain 1 must be lower than 255 and Gain 2 must be zero.

Change the Gain values (o – 255) and check if it’s possible to move the trace on monitor: 255 = 10V.

If the traces don’t change their values means that the RFR is broken.

Fig. 18: System Check RF pulse



To change the spin orientation we have to send power to the phantom or patient. The RFA takes care to amplifier the signal received from the SINT module and sent it to the Gantry (transmission circuit).

The blue trace is the direct pulse: the energy that the RFA is transmitting to the Gantry.

The red trace is the energy that we are losing because the Gantry is not equal to the ideal load (50Ω). It must be lower than 20% of the direct pulse.

If the red trace is flat means that the SINT module is broken or the cable between SINT and RFA.

If the blue trace is flat disconnect the output cable and connect a dummy plug (50Ω) to the RFA output: if the trace is still flat means that the RFA is broken otherwise the Gantry or the cable are broken.

Image quality

Common interference problem analysis

The most frequent cases are the presence of artifacts on the image generated by external radio frequencies, interference created by some electronic modules inside the electronic unit or ”spikes”.

A typical case of the radio-frequency problem generates a strip on the image; this can be more or less thick. In both cases, the noise is selective, but when the strip is thin, this means that the noise has only a single frequency. On the other hand, if the strip is thick, it is typically a frequency modulation. Instead, the ”spikes” could be classified as a large bandwidth problem that is usually generated by poor power supply or by certain motors (e.g. from elevators, air conditioning, etc.).

In the same way you can study RF interference using the <**Rx Chain**> service menu. Also in this case you can have different kinds of disturbance:

1. A well determined RF interference (one thin strip on the image)

2. A frequency modulation (example: band of strips on the image)

In the first case, set <**FFT**> mode in the <**RX Chain**> (ARAS program, <**Test**> and <**Manual**>) environment to see a thin peak, whereas, in <**Echo**> modality a sinusoidal signal will appear. While if a frequency modulation (case 2) is present on the images, always in <**FFT**> something like a narrow rectangle, formed by a given number of peaks, will be displayed.

Fig. 19: Example of selective noise with a given frequency

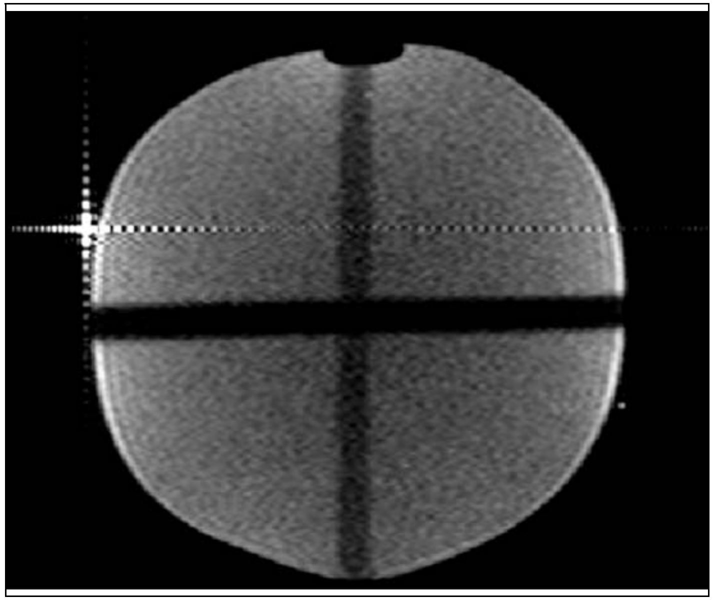
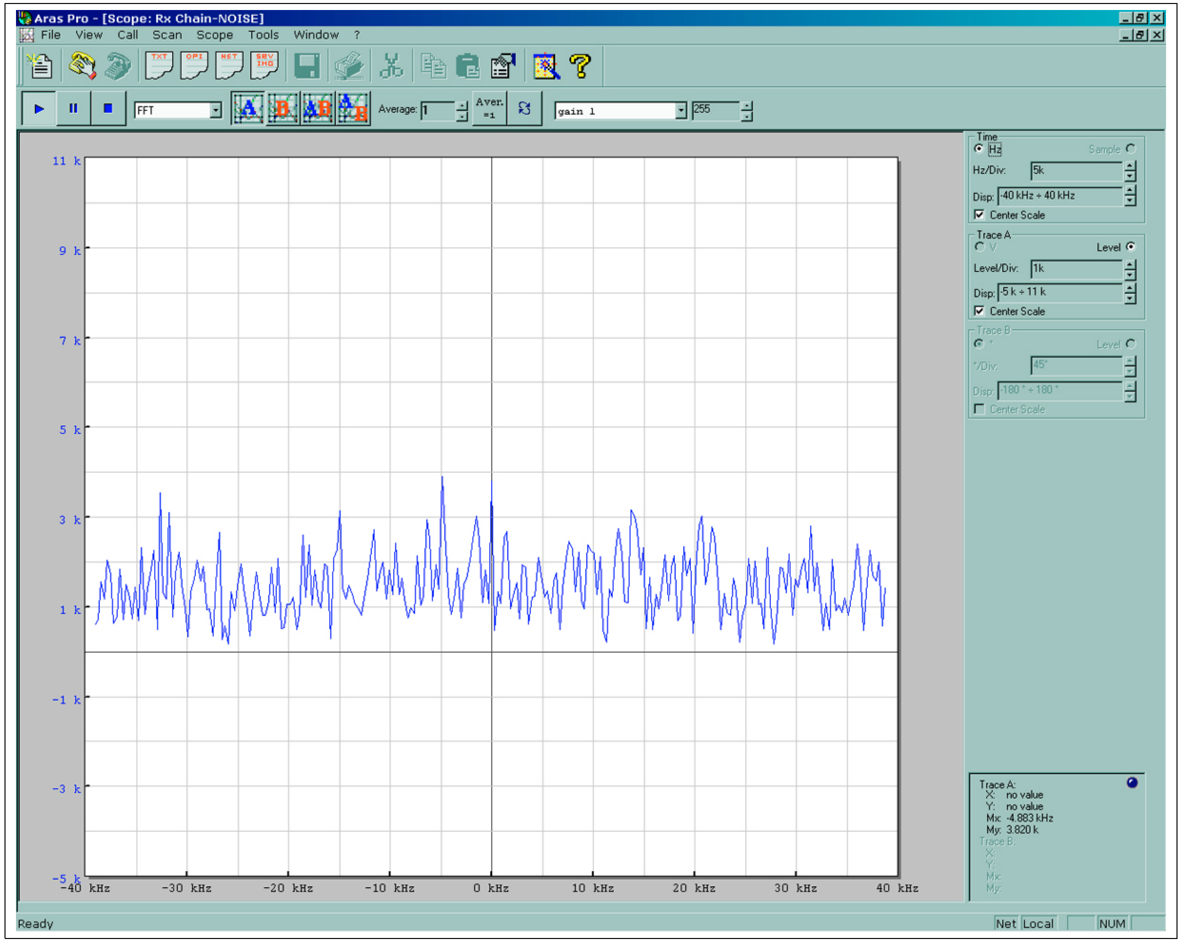


Fig. 20: RX Chain test, FFT visualization



When this window appears, select the FFT mode then the A visualization and apply these settings to all the channels (right button mouse, check the <Apply to all channel> box then click on <OK>).

Set the Frequency to 5K to visualize a larger bandwidth (at least ±20 kHz from the central magnet frequency).

Set the Y-axis to 1K.

If a central peak appears is the SINT oscillator and means that the Phase and Quadrature offsets are not properly calibrated to the zero level.

The meaning of this test is check if any radio frequency peaks appear close to the magnet central frequency (indicated by 0 kHz): if they appear they can generated noises on the images.

Fig. 21: Example of frequency modulation

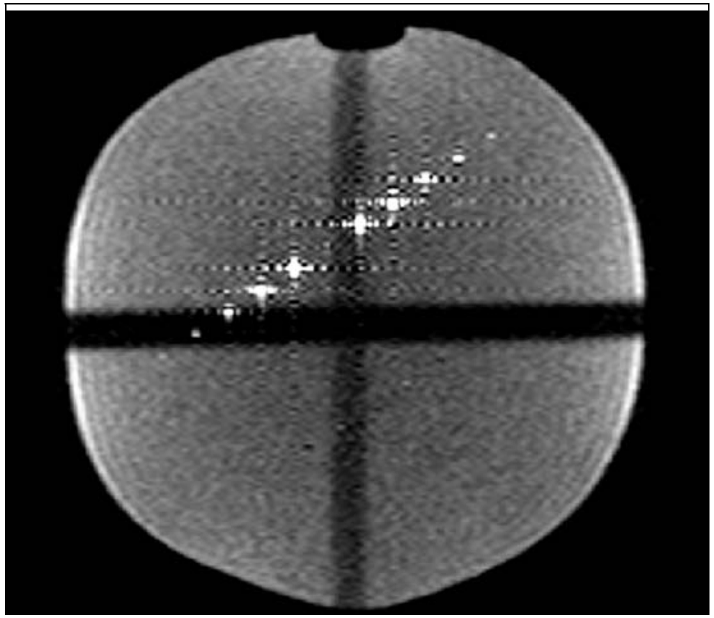


Fig. 22: Example of artifact due to the present of "spikes"

General problems regarding noise

This section covers some problems regarding high noise levels in the system room and their possible solutions.

These kinds of problems could be generated by several things, such as: the power line cable lacking a good filtering system, network lines to transmit data between different computers, the laser camera installed close to the system or any other source not perfectly shielded. In all these cases, the normal noise level increases until it exceeds the warning noise threshold, to the detriment of the quality and resolution of the images so obtained.

This is to say that everything (line cables, personal computer, network cable, central phone line, etc.) in the room must be checked very carefully before installing the system to avoid any problems after installation.

Therefore to reduce the noise level in the room, you must ascertain in advance which are the possible causes of the problems by acquiring images in different conditions. For example, this can be done by turning off all possible sources of problems, step by step, then checking the average-fft value by clicking on the <**Shielding**> in the <**Automatic**> service menu. If the problem has not been identified yet, proceed by making sure that all power lines use a line filter, that there are no other critical instruments in the system room and that every ground cable of the machine is properly connected.

With regard to these problems, we recommend putting the power line through an UPS system, so that the power line that arrives at the system or at other instruments is without noise, without selective interference or noise with a large bandwidth.

Another critical factor for the noise level is the presence of personal computers or other instruments that could create some interference by increasing the noise level. This noise could be selective interference (lines on the images) or, more likely, white noise (noisy images). However, in any case, the image quality decreases significantly.

Both the machine ground and the central ground must also be checked, because they sometimes generate problems. As a matter of fact, it has often been noted that, if the grounding problem is solved, the average-fft level decreases to a normal value (around 500).

A short list including things to be avoided during installation is given below:

- Power lines without an UPS system
- Power lines must not pass close to the system
- A layout of cables that creates a coupling between them
- Avoid putting other kinds of instruments in the same room, such as a personal computer, laser printer, mediator, etc.
- Ground cables wrongly connected
- Bad central ground

A method to understand how the noise level changes during the day is described, so it will be possible to look at noise variations in real time. Here are the operations useful for this check:

- Put the homogeneous phantom inside the knee coil
- Inside the ARAS program select <**Test**> <**Manual**> <**RX Chain**> menu then <**Run**>
- set the <**FFT**> modality
- Set the Y-axis to 1K. It is thus possible to visualize the noise peak better. In this modality two kinds of noise may occur
- <u>Selective noise with a given frequency</u>: a single peak will be displayed at that frequency; the higher the dB of the noise the higher the peak

- A large bandwidth noise (white noise): the whole level of the signal increases; this means that the noise in the room is too high
- To improve the signal display, click on the <**Average**> button and set a number around 20

When the previous operations are completed verify if the level of the signal is close to 1K (first step) of the vertical grid, or if the **"May"** variable in the information window has a value of around 1350, that means that the noise level is good (average-fft less then 500).

On the contrary, if the level is higher, then you can carry out two different trials:

- Verify the noise level putting a Dummy cup in the suitable support supplied in the Gradient Tuning Kit
- Verify the noise level when a patient puts a limb inside the coil

Regarding the first case you can reach this conclusion: if the noise level is again in the specifications with the Dummy cup, this means the problem could be external, otherwise some parts of the electronic unit would create a rise in the noise level. Check each module and cable, one at a time.

If the problem is external you must check as described in the previous points. In fact when a patient's limb is inside the coil every external disturbance is increased, because the patient acts as an antenna.

Therefore, at first you must check to see if the shielding parts are correctly applied to the patient and if each ground cable is fixed, then check what source could create the rise in noise.

If you find something such as a personal computer, telephone or laser printer, that could be a source of noise, you will probably have to apply the solutions described previously, decreasing the noise level in the room (average-fft value around 400) until good quality images are obtained.

Detecting artifacts on images

Simulation of examinations

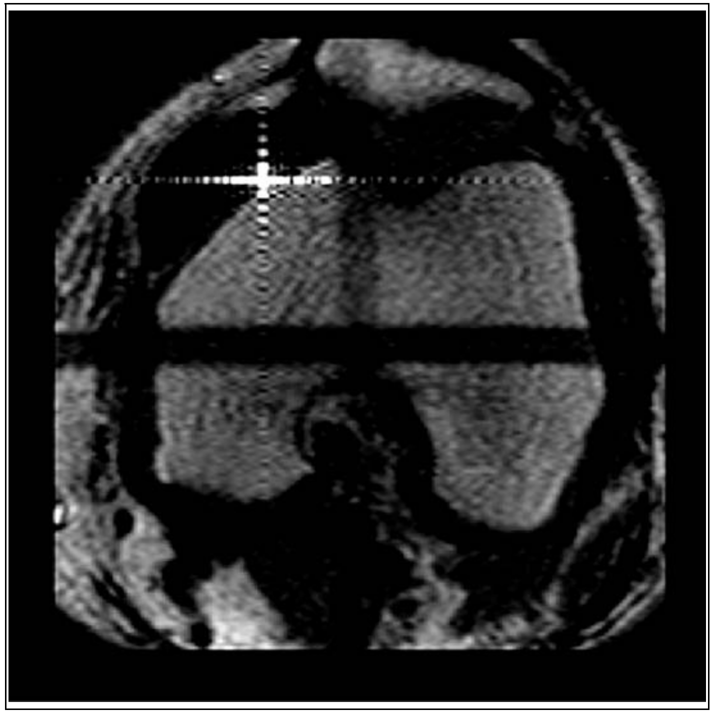
After performing all the system's calibrations and the relative quality tests, check that the system is operating smoothly by performing scans on patients using different sequence types (GE, Spin-Echo, Turbo-Multi-Echo, etc.). For this type of testing, perform several acquisitions on all the four coils and assess the quality for each type of sequence.

More specifically, the images obtained must be observed in order to exclude the presence of artifacts (such as lines, light spots, bands, etc.) and magnetic fluctuations in DC mode (e.g. blurring) and in AC mode (e.g. ghosts). In order to check that the signal/noise ratio is good and that the contrast is appropriate.

Consider that some related problems (for instance lines, spots, etc.) may be caused by:

- RF external frequencies
- RF frequencies within the system due to the failure of any hardware modules

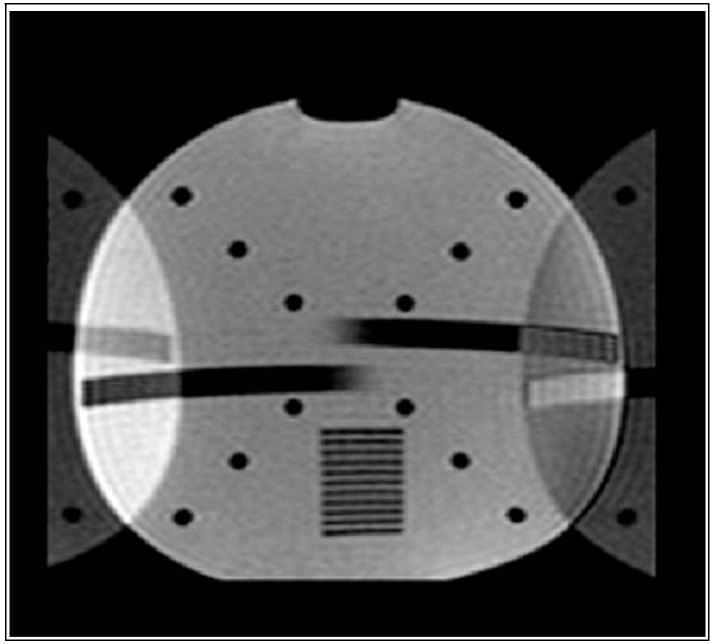
Fig. 23: Radio frequency probably due to external factors



Consider that some related problems, for instance ghost images, may be caused by:

- Phase and quadrature offsets a long way out of the zero level
- Fluctuation of the signal due to external fields at about 50/60 Hz and 16.6Hz

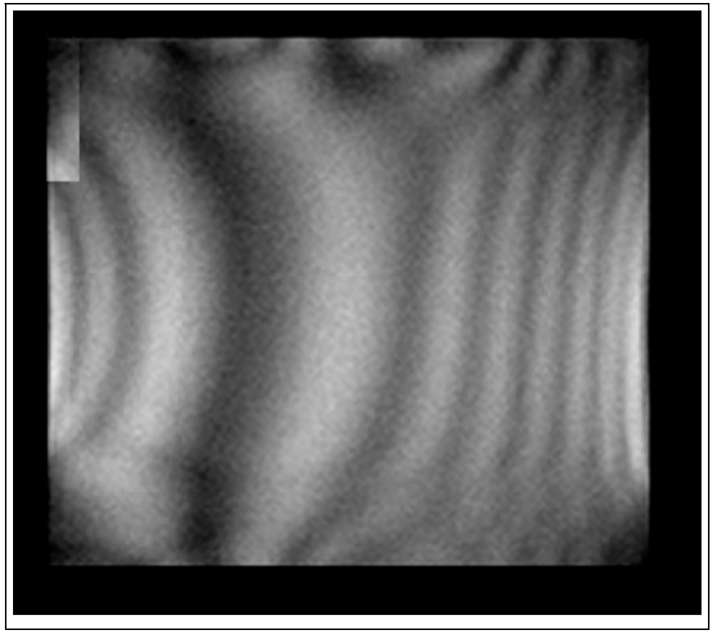
Fig. 24: Ghosts generated by external 50Hz



Consider that some related problems, for instance, out of focus images called ”blurring” effect, may be caused by:

- Thermal instability of the system;
- Fluctuation of the signal due to DC magnetic interference;
- Fluctuation of the signal due to miscellaneous HW problems.

Fig. 25: ”Blurring” artifact probably due to external DC



Consider that strong spikes in the power line may cause some problems, such as the “moire” artifact.

Fig. 26: ”Moire” artifact probably due to strong spikes on the power line

If the operator detects the above-mentioned artifacts in the images, he/she must first analyze them carefully.

A list of scans can be found in the OPI program (<**Protocol List**> folder). The Service operator may use them to check the image quality, hence to identify any of the above-mentioned problems.

All the current scans are to be taken in multi slice mode with the slices oriented as desired. Have at least one standard direction and one double oblique slice for each scan and change the directions between scans.

Please note that, since before each scan an automatic fine calibration of resonance frequency and of the receiving chain gain is performed, any problems should be detected through the calibration procedures and suitably signaled. It may be advisable, however, to check the results produced by calibration in the store files (**freq.rec** and **autotar.rec**).

Shielding efficiency

The purpose of this calibration is to check that no external noises are present in the signal picked up by he coil, such as radio-frequencies which would generate lines or light spots on the image. Moreover, the procedure checks that the noise level does not exceed a pre-set threshold value.

Fig. 27: Line generated by radio frequencies

The program is based on running a sequence that carries out a simple acquisition of the noise picked up by the receiving coil. By submitting it to Fourier's transform, you can detect the spikes resulting from external radio frequencies and to calculate the average noise level.

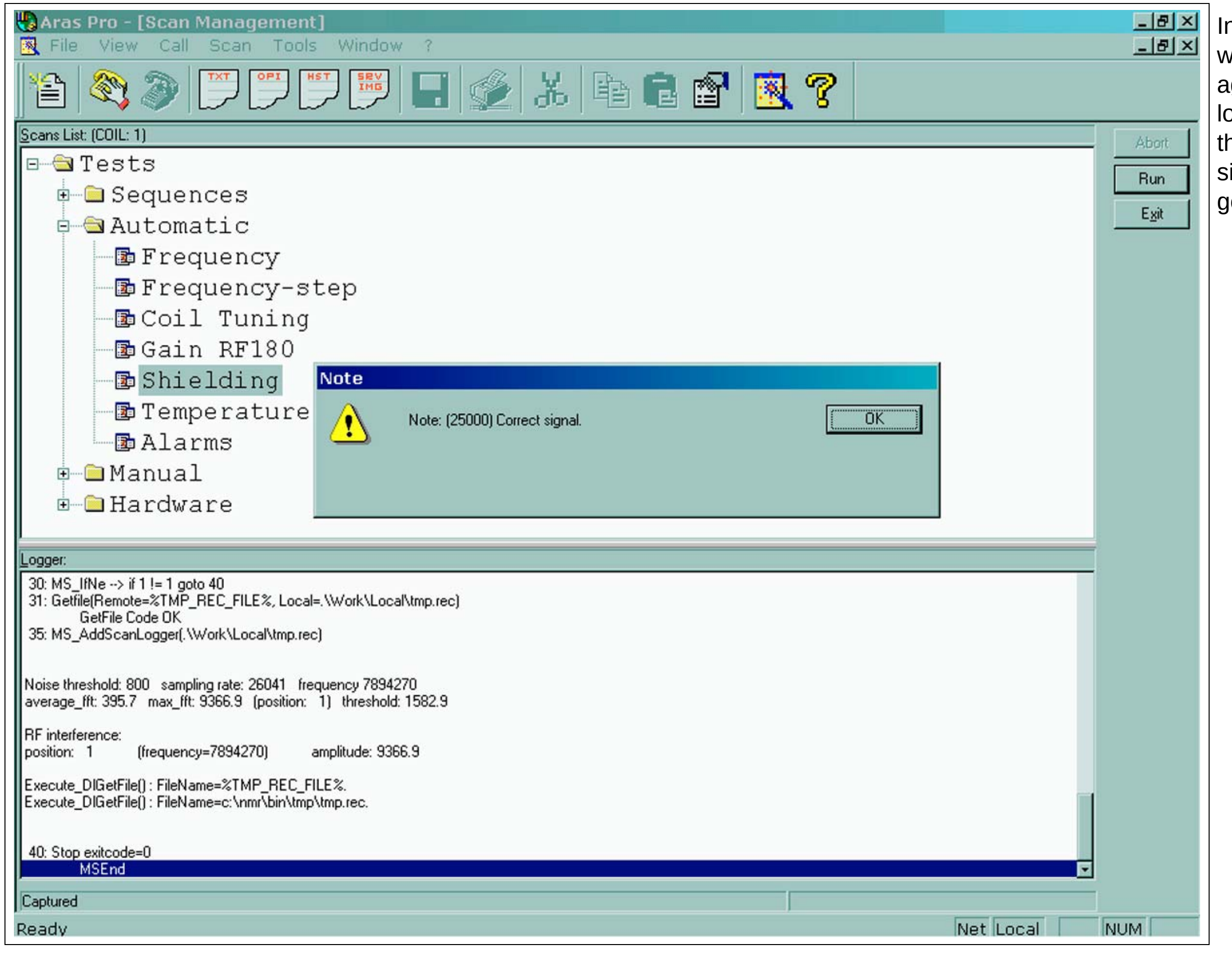
Necessary tools

– Geometrical phantom and its support

Operations

- Position the knee coil 2 with the geometrical phantom placed in axial position
- From the ARAS program select <**Tests**> <**Automatic**> <**Shielding**> then <**Run**>
- Look at the message sent by the calibration procedure. If this was not successful, do not continue, but rather check the store file "**noise.rec**"
- Exit by clicking on <**OK**> button

Fig. 28: Shielding Test



In the bottom part of the window, look for the Average_fft value: if it's to lower than 400 means that the system has a good signal to noise ratio and is good shielded.

In the event of noise or of signal spikes exceeding the threshold (threshold_f), the program indicates their position (co-ordinate, range 1 to 256), amplitude and frequency.

Please note that a continuous signal corresponds to co-ordinate 1. This is the so-called offset that is always present. Therefore, this spike must not be considered for the purpose of evaluating the situation.

In the event of persistent interference, on-site measurements must be taken exactly like those taken before installation. In addition, you must check that noise is not generated by the electronics. You must also make sure that any type of lines or spots does not damage the images. For this reason, some test scans must be taken.

Conversely, if the noise level exceeds the threshold, it is likely that the receiving chain is malfunctioning or not properly calibrated. Please note that the cause of this might be white noise picked up directly by the coil. Therefore, you are advised to check that there are no possible sources near the machine and that the shielding is properly sealed.

The noise level is represented by average_fft, whose threshold value is written in the software and has been set taking into account the situation of the first machines.

Please note that this calibration may also be performed from the operator’s interface as a diagnostics scan.

Repair

In case of not perfectly shielding efficiency check all the system grounds or provide a dedicated ground.

If you noticed that a RF spike causes noise of images, shift the magnet central frequency changing the NTC board (send an order to ESAOTE specifying system ser/n, magnet ser/n, magnet frequency, frequency of the RF noise and desiderated new magnet frequency).

If the image problems are generated by magnetic interference follow this chapter to compensate them.

Procedure

Magnetic Compensation

This chapter describes the Magnetic Compensation Procedures for external DC and AC (50, 60 and 16.6 Hz) noise.

Necessary tools

- Gradient Tuning Service Kit
- Magnetic Compensation Kit
- Small and flat screwdriver
- Allen wrenches 4mm

Sources of DC Interference

Trucks, subways, elevators, escalators and fans or other kinds of iron masses running close to the magnet can generate DC noise.

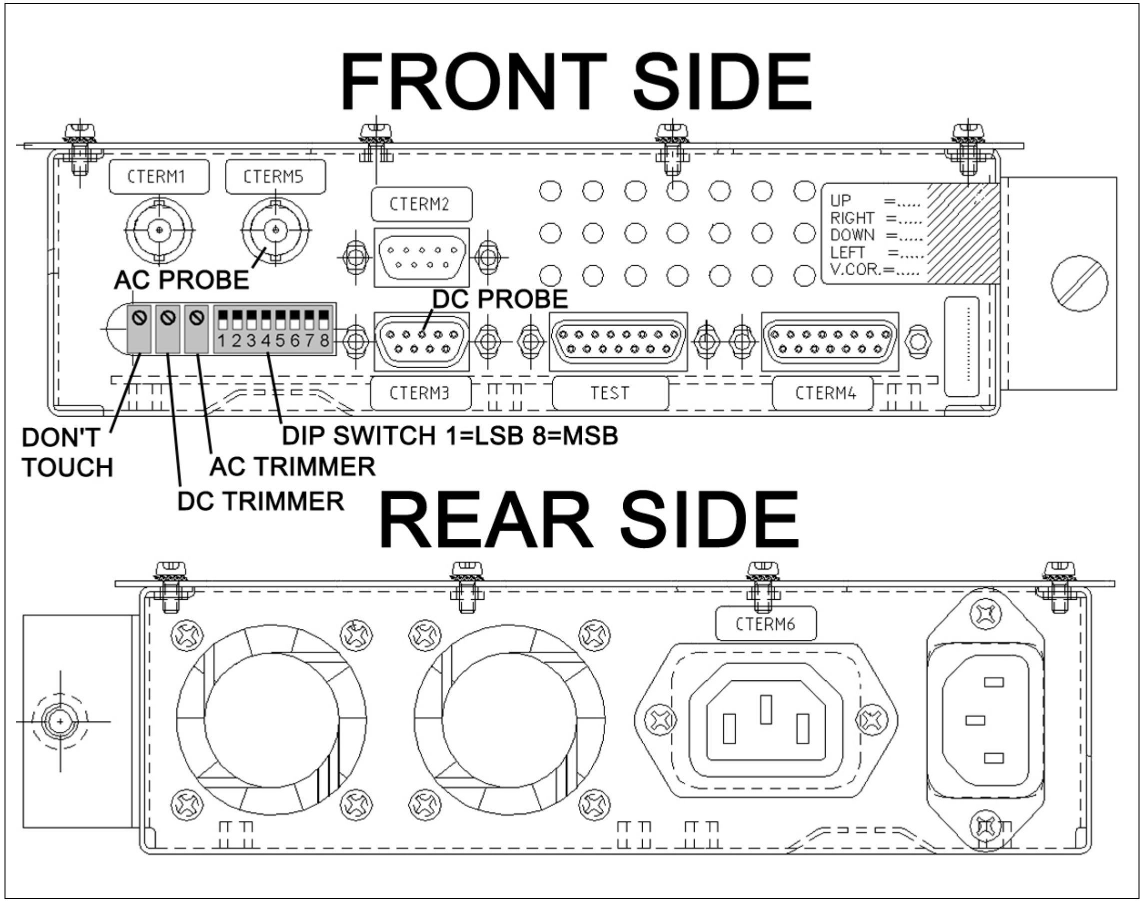
NOTICE	It is possible to compensate only one DC source

Sources of AC interference

Power cable or railways close to the site.

Perform compensation during working hours when all the Systems are on and the noises are usually stronger.

Fig. 29:CTERM module front and rear side



On the CTERM module front side all the Magnetic connections are present.

Also the trimmers (dedicated to the Magnetic compensation gains) and the trimmers (dedicated to the Ac magnetic compensation phase) are placed on the CTERM front side.

On the rear side there are the CTERM fans and plugs.

The upper plug is the power supply for the unit. The magnet fast heaters are connected to the lower plug and the CTERM module provides or not powers to them automatically.

DC Compensation

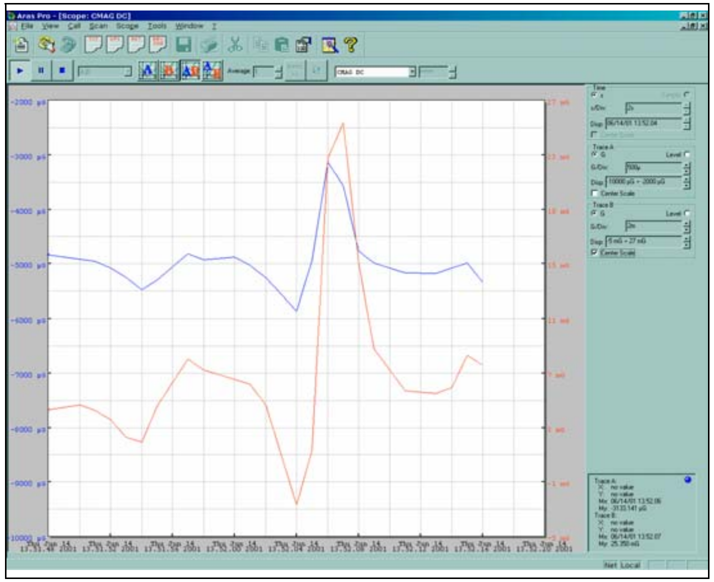
NOTICE	The probe must be fixed on the wall at the end of the magnetic compensation procedure; use tape to fix it during compensation

- Remove the console front covers (plastic and metallic)
- Connect the DC probe to its connector on the CTERM front side

Fig. 30: DC probe

- Put the Knee Coil 1 with the homogeneous phantom (115 mm) inside
- Select <**Test**> <**Hardware**> <**CMAG DC**> then <**Run**>
- Set the Diascope visualization settings in order to visualize both traces inside the test window
- Rotate the **DC** trimmer counter clockwise (remove the factory compensation effect) until you hear the click

Fig. 31: Internal field not compensated

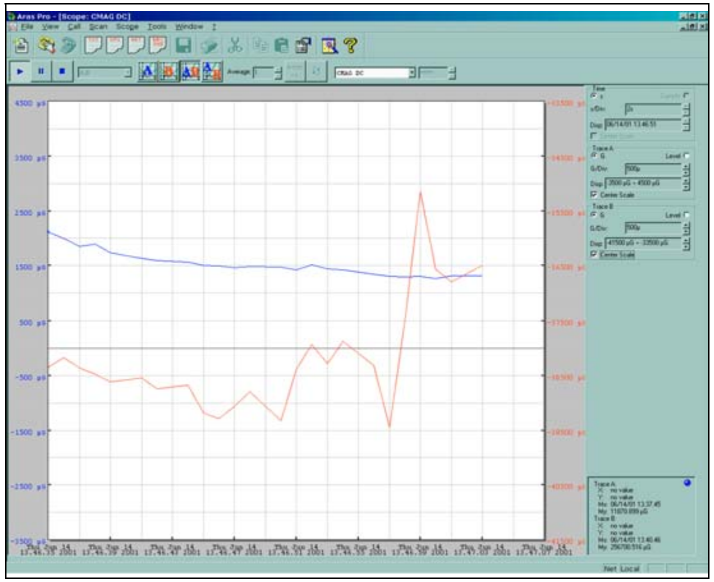


- Check that the internal field has the same shape as the external one (since in the previous step any kind of compensation is removed) as shown in the next figure. The internal field is the difference between the internal noise (due to the external magnetic variations) and the signal we sent to the magnet to compensate the external noises

- Keeping the DC probe horizontally, at the same magnet center height and with the out wire in the magnet direction, move it along the wall to identify the direction of the noise. Leave the probe where the external noise is strongest
- Rotate the **DC** trimmer clockwise flattening the white trace (internal field) till to meet the specification (maximum 1mG)

NOTICE Un-checking the Automatic Scroll option inside the Scope menu, it's possible to modify the Time division

Fig. 32: Internal field with compensation



- Change the level division scale of the internal DC field to display it better (as shown in the next figure)
- If the internal field is displayed larger or in the opposite phase with respect to the external field trace, you are overcompensating: rotate the trimmer in the opposite direction and try again
- When the specification is met, fix the probe to the wall using the suitable screws

AC Compensation

It is possible to compensate only one AC source (50 or 60 Hz).

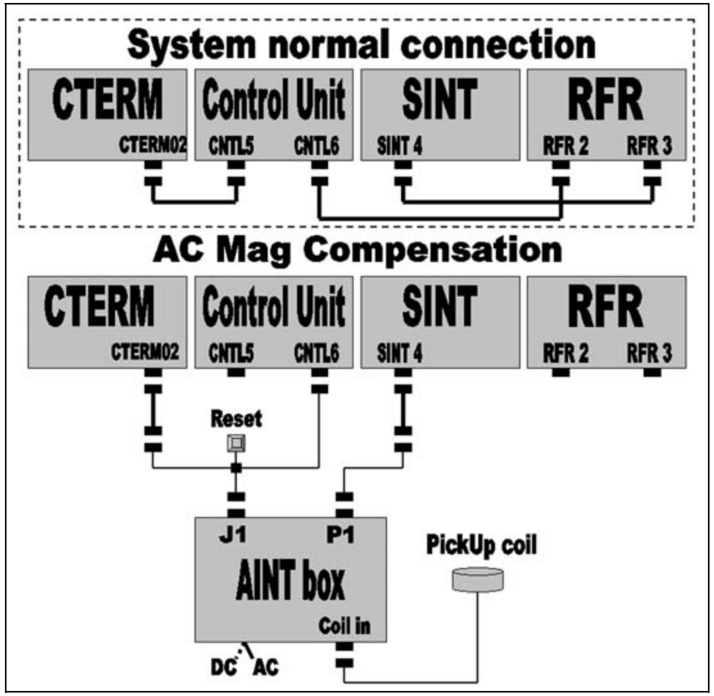
NOTICE	Perform the DC Compensation (if necessary) before the AC Compensation. If it is not necessary to compensate for the DC noise, connect the DC dummy plug (contained in the Magnetic Compensation Kit) to the **PROBE DC** connector of the CTERM module

NOTICE	The probe must be fixed on the wall at the end of the magnetic compensation procedure; use tape to fix it during compensation

<u>**Hardware Connection**</u>

- Remove the electronic left side cover (patient side)
- Disconnect the cable connected to the **Control6** connector of the Control Unit module, then disconnect the cable connected to the **RFR3** connector of the RFR module and connect it to the **P1** connector of the AINT box (use the extension cable provided with the kit if necessary)
- Disconnect the cable connected to the **Control5** connector of the Control Unit module
- Connect the reset cable (code 8830505000) to the connector **J1** of the AINT box, to **Control6** of the Control Unit box and to **CTERM02** of the CTERM module trough the cable already present and put the AINT box switch to **AC** and set the AINT box counter to 0-0-0
- Connect the pick up coil to the **COIL IN** bnc of the AINT box and place it into the magnet at the X position of the gradient tuning support

Fig. 33: Connection for AC Compensation



- Connect the AC probe to the **AC** bnc of the CTERM module

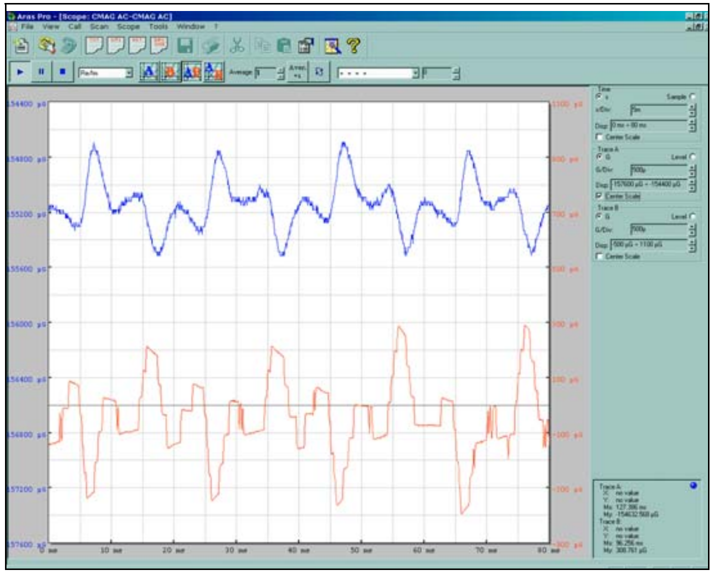
NOTICE	If the DC probe is not installed, you must connect to the DC probe connection of the CTERM module the enable connector contained into the AC-DC compensation kit

Fig. 34: AC Probe and its support

Compensation

- From the ARAS program, select **<Test> <Hardware> <CMAG AC>** (blue internal field, red external)

Fig. 35: Internal field not compensated



- Rotate the **AC** trimmer counter clockwise (remove the factory compensation effect) until you hear the click
- Keeping the probe horizontally and with the output cable in the magnet direction, move the 50Hz probe to find where the AC noise is strongest. This is where the noise is coming from: fix the

probe on the wall using tape. Place the AC probe between the magnet and the noise source. The best probe position is between the noise source and the magnet but not too close to the noise source (e.g.: cables and ferromagnetic material), at the level of the magnet center (if possible). There should be a minimum distance of 1 meters between probes (AC and DC)

- Turn the **AC** trimmer clockwise until you reduce the internal field as much as possible. If you cannot meet the specification turn the **AC** trimmer slightly clockwise then change the dip switches configuration as in the following steps
- Change the dip switches configuration to shift the compensation signal phase to minimize the internal field. There are 8 dip-switches: number 1 is the LSB; number 8 is the MSB. The possible combinations are from 00000000 to 11111111 following the mathematical binary code rule. It means that the LSB value is more or less 3° for 50 Hz. See the next table for dip switches configuration conversions
- Start with 20° step (dipswitch 4) and increase the dip switches configuration to reduce as much as possible the internal field. When the noise is over compensated come back 20° and start with smaller adjustments (dipswitches 1 to 3)
- Now try again with the **AC** trimmer to reduce the internal field till to meet the specification (maximum 1.5mG)

NOTICE Also changing the dip-switches configuration the internal and external noise don't shift on monitor.

It's possible to understand when the system generates a signal in phase with the external noise because it's possible to reduce the internal field

---

Tab. 3: Dip switches configuration for 50 Hz

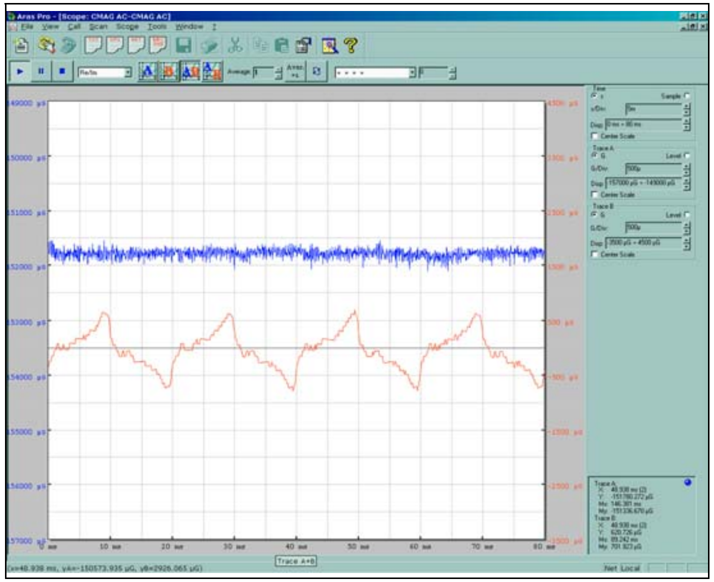
Φ(phase) °	**DIP SWITCH (LSB-MSB)**	**DECIMAL**
2.6	10000000	1
23.1	10010000	9
41.1	00001000	16
82.2	00000100	32
102.8	00010100	40
123.4	00001100	48
162	00000010	64
185	00010010	72
205.6	00001010	80
267.3	00010110	104
360	00110001	128

Tab. 4: Dip switches configuration for 60 Hz

Φ(phase) °	DIP SWITCH (LSB-MSB)	DECIMAL
6.1	10000000	1
21.7	11100000	7
41.1	10110000	13
82.2	01011000	26
99.2	00000100	32
123.4	00010100	40
162	00101100	52
185	00111100	60
198.4	00000010	64
267.3	00101010	84
360	00101110	116

- When the correct dipswitch configuration is found, turn the trimmer **AC** (try both directions) to decrease the internal field. The specification is less than 250µG.
- If the internal field doesn't reach the specification repeat the procedure
- If the white trace is displayed larger with respect to the gray trace, you are overcompensating: rotate the trimmer in the opposite direction and try again

Fig. 36:Internal field compensated



- At the end of the compensation procedure fix the AC probe to the wall using the suitable screws

Part 4 Software

Trouble shooting strategy

Software repair is a difficult task due to the complexity of today's software.

In most cases the first question that comes to mind is: "Is the problem caused by hardware or software?"

Reinstalling the software will answer this question quite reliably, but will possibly cause other problems such as loss of data (e. g. images of patients, customer protocols or system specific dynamic data that has not been saved).

To make software trouble-shooting as effective as possible some procedures to assist you in dealing with software problems are given below.

Procedure

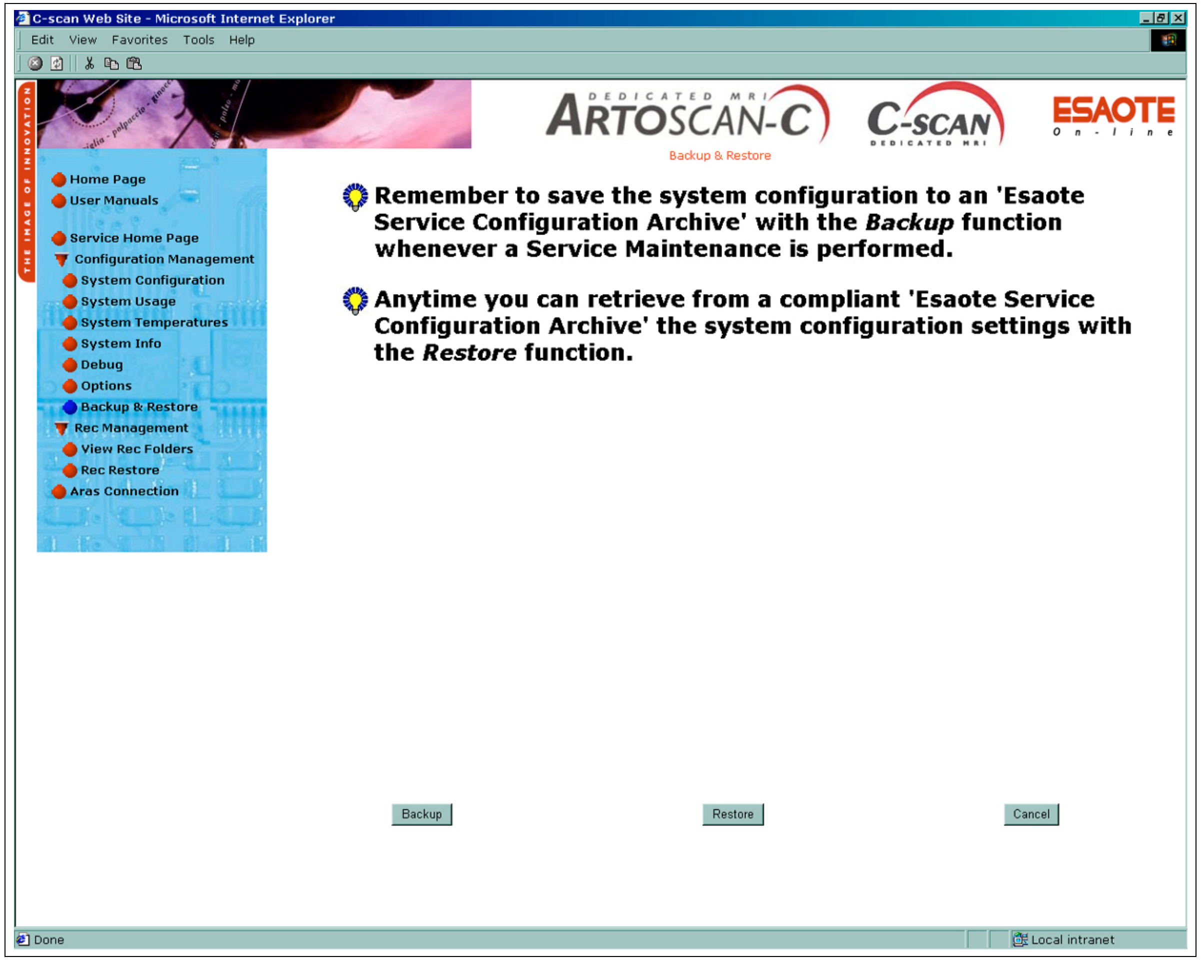
Configuration Backup

This function allows the creation of a copy of the system calibration data and user's protocols and configurations, but does not save the customer's images.

To create a system back up:

- Log on the system like SERV (typing the correct password) and click on the Internet Explorer icon
- Insert a optical cartridge into the ODD 3 ½
- From the homepage, select Configuration Management and Backup & Restore (like shown in the next figure)
- Follow the SW indications

Fig. 37: Configuration backup



This page allows to create the system software back-up.

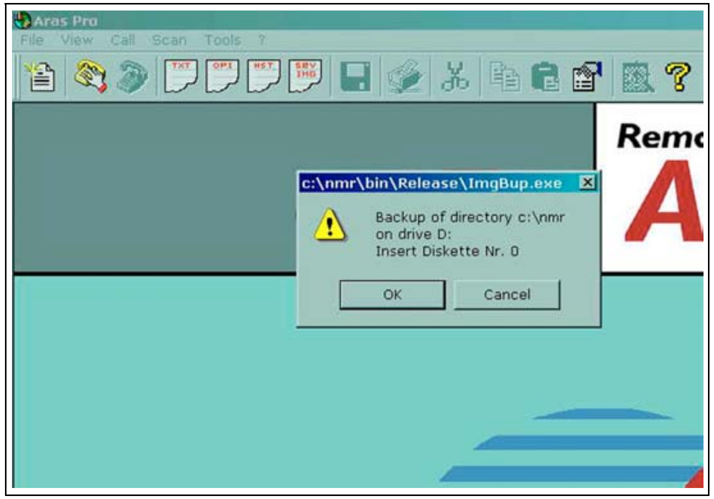
Don’t create the system back up immediately after the installation but do it during the first maintenance when the system parameters are stabilized and the customer created his own protocols.

Images Back up

To create a User's images backup, act as described:

- Log the system as SERV and type the correct password
- Launch the ARAS program
- Select **TOOLS** and **Images Backup**

*Fig. 38: **Images Backup** window*



- Insert an empty optical cartridge and store the images

Repair

Complete Software installation

⚠ WARNING	**Use this procedure only if the procedure contained into the Installation Guide, Software chapter doesn't work properly or in case of HD failure or in case of OPI incorrect starting!**

⚠ WARNING	**Using this procedure all the data contained into the HD will be lost during the formatting procedure of the Operating System installation!**

Operating System SW Installation

- Switch on the system
- Type the **DEL** key during the BIOS boot and enter in the **BIOS SETUP** menu typing the correct password (that same as the user **SERV**)

NOTICE	Ask the correct Password to your headquarter!

- Select the **BIOS FEATURES SETUP** menu and set the following Boot Sequence using the PAG UP, PAG DOWN keys: **CDROM, A, C**
- Take the WIN2000PRO CD provided with the System and insert it into the CDROM (the CD must be inserted into the CD-RW if installed)
- Quit from the BIOS SETUP saving the new configuration and the system will perform a re-boot automatically

NOTICE	For some BIOS releases is necessary to press a button in order to perform the boot from CD-ROM

- Now the System performs the boot from CD (if the written "**Press any key to boot from CD**" appears press **ENTER**)
- When the window "**Welcome to setup**" appears, press **ENTER** to continue
- Press **F8** to agree with the End User License
- Press **ESC** to continue with the installation without repairing the present software (if you are installing on a brand new HD this message doesn't appear)
- Press **D** to delete the current partition
- Press **ENTER** and then **L** to confirm the previous selection
- Press **ENTER** to start the SW installation
- Choose the **NTSF** partition and press **ENTER**
- At the end of the formatting procedure, the system copies the data on the HD and then performs some re-boots

- In the “**Regional Setting**” window, check if the **English language** and **US Keyboard** are set then press **NEXT**
- In the “**Personalize your software**” window, insert the System data then press **NEXT**
- In the first “**WIN2000PRO setup**” window (**Your Product Key**), insert the Product Key code copying it from the label placed on the Computer case then press **NEXT**
- In the second “**WIN2000PRO setup**” window (**Computer Name And Administrator Password**), insert the **Computer Name** but leave empty the **Administrator Password** field then press **NEXT**
- In the third “**WIN2000PRO setup**” window (**Date And Time Settings**), check if the present DATE and TIME settings are correct then press **NEXT**
- In the fourth “**WIN2000PRO setup**” window (**Network Settings**), select **Typical Settings** then press **NEXT**
- In the fifth “**WIN2000PRO setup**” window (**Workgroup Or Computer Domain**), select “**No this computer is not on a network…**” then press **NEXT**
- In the sixth “**WIN2000PRO setup**” window (**Completing the WIN2000 Setup Wizard**), press **FINISH**
- Remove the SW CD during the automatic re-boot
- In the first “**Network Identification Wizard**” window, press **NEXT**
- In the second “**Network Identification Wizard**” window, select “**User must enter a user name…**” then press **NEXT**
- In the third “**Network Identification Wizard**” window, press **FINISH**
- Perform the log-on like **Administrator** user (NO PASSWORD NEEDED)
- Uncheck the box “**Show this screen at startup**” and press **EXIT** to close the window
- From the desktop, select <**START**> <**SETTINGS**> <**CONTROL PANEL**> and the <**DISPLAY**> icon. In the **Display** window select <**SETTINGS**>. Inside the **SETTING** window, **MONITOR** tab, set “**True Color**” and “**1280x1024**” screen resolution then press the “**Advanced**” button and set the refresh frequency to “**75Hz**”, save and quit pressing **OK** in all the opened windows
- From the <**CONTROL PANEL**> window, select the <**ADMINISTRATIVE TOOLS**> icon then in the opened window select <**Local Security Policy**> <**Local Policies**> <**User Right Assignments**> <**Change The System time**> <**Add**> <**Users**> <**Add**> <**Ok**> then close it
- Insert the WIN2000PRO CD and close the automatically opened window
- From the <**CONTROL PANEL**> window, select the <**Add/Remove Programs**> icon then **Add/Remove window components** and wait for the System refresh, then check the **Internet Information Services** box and press **NEXT,** wait for the end of the installation procedure then press **FINISH** and **CLOSE**
- From the <**CONTROL PANEL**> window, select the <**SYSTEM**> icon then <**Hardware**> <**Device Manager**> and verify that all the System Peripherals are correctly installed (No “**!**” or “**?**” signs close the components), otherwise select the Device the press the right mouse button and then press “**Up-date driver**” choos-

ing the correct drivers form the DRIVER CD provided with the System

- Remove the inserted CD and re-boot the System
- Type the **DEL** key during the BIOS boot and enter in the **BIOS SETUP** menu typing the correct password
- Select the **BIOS FEATURES SETUP** menu and set the following Boot Sequence using the PAG UP, PAG DOWN keys: **C only**
- Quit from the BIOS SETUP saving the new configuration
- Go ahead with the following procedure

Operating System Service Pack 3 Installation

CAUTION	**Perform this procedure before the OPI installation!!!** **The patch is contained into the ESAOTE SW Release CD-ROM!!!**

- Insert the ESAOTE CD-ROM into the CD-ROM driver
- The following HTML page will be automatically displayed

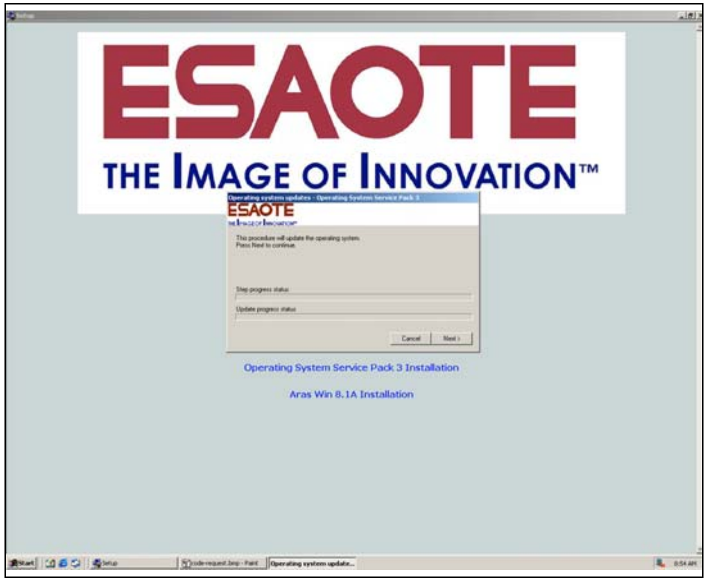
Fig. 39: Selection page

- Select the **Operating System Service Pack3 Installation** and the system will ask you to insert the activation code

Fig. 40: Selection page: code request

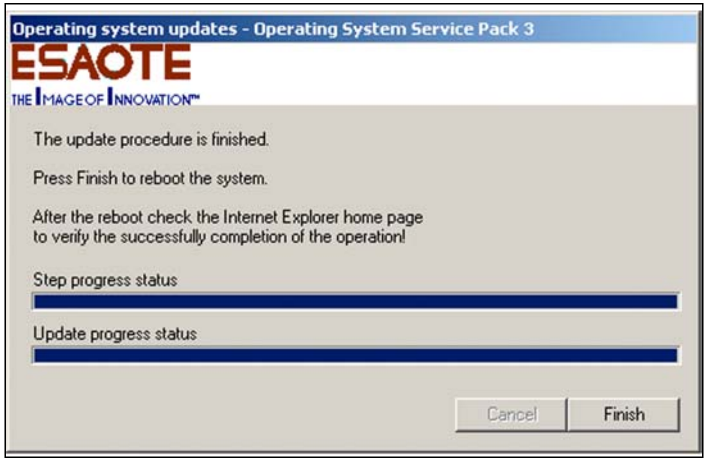
- Write **1209** and confirm it pressing the **OK** button to start the patch installation

Fig. 41: WIN2000 SP3 installation



- The procedure goes ahead automatically and will take more or less 30”. Don’t interact with the system and wait for the window shown in the next figure
- When the next window appears click on the **FINISH** button to re-boot the system

Fig. 42: WIN2000 SP3 installed

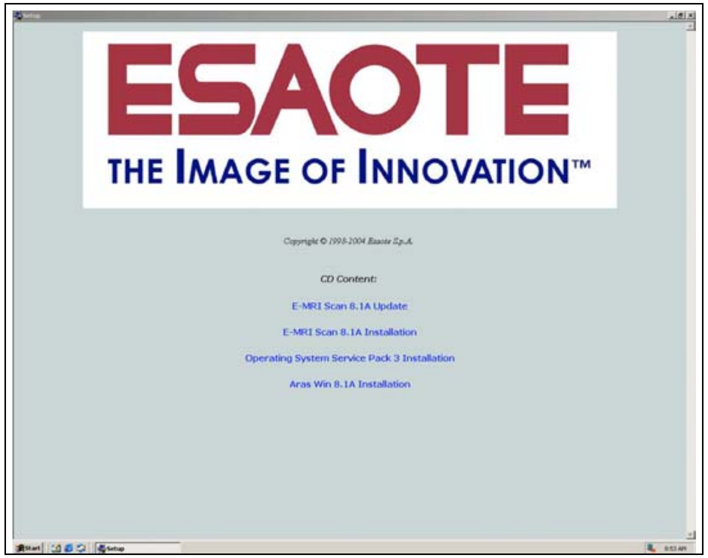


- Perform a log on as **ADMINISTRATOR** (no password required) to complete the patch installation then re-boot the system
- Proceed with the OPI SW Release installation

OPI SW Installation

- Switch on the System and perform the log on like user **ADMIN-ISTRATOR** (no password required)
- Insert the ESAOTE CD, if already present open the CD-ROM drive and close it back to start the autoplay function
- The following HTML page will be automatically displayed

Fig. 43: Selection page

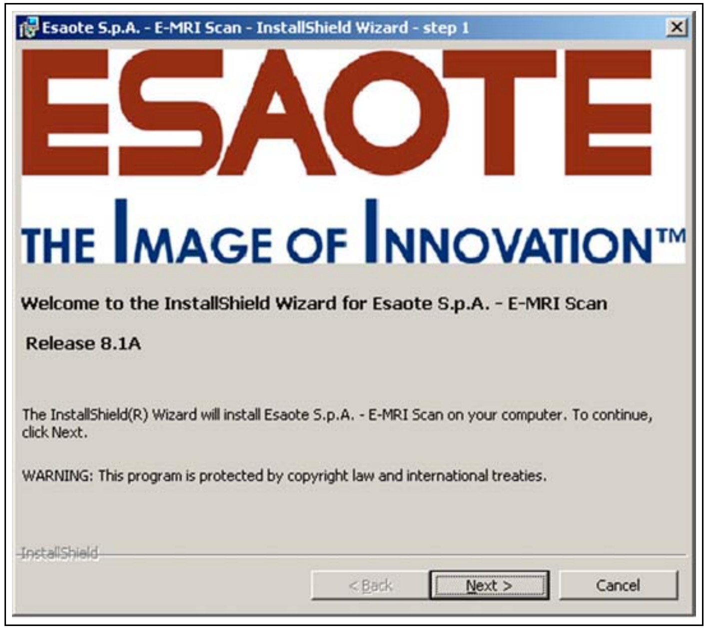


- Select the **E-MRI Scan 8.1A Installation** and the system will ask you to insert the activation code

Fig. 44: Selection page: code request

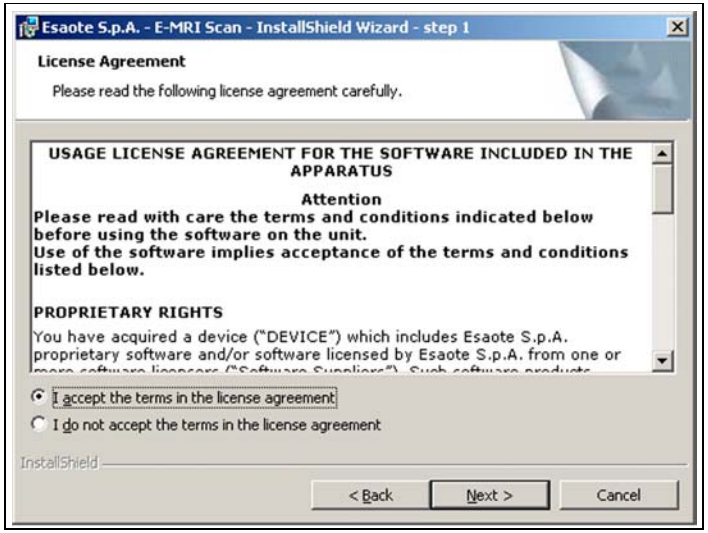
- Write **1611** and confirm it pressing the **OK** button to start the OPI installation
- When the next window appears click on the **NEXT** button

Fig. 45: 8.1A installation step1



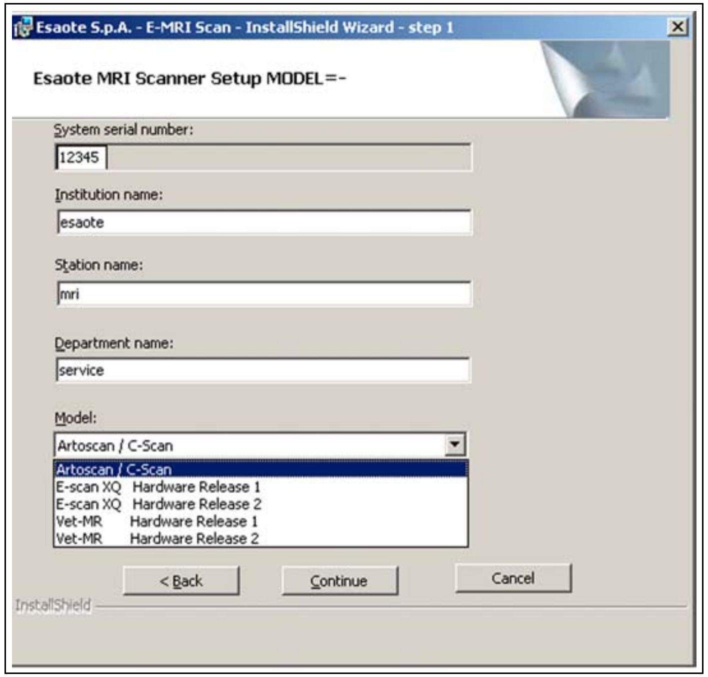
- When the next window appears click on the sentence "**I accept the terms in…**" then click on the **NEXT** button

Fig. 46: 8.1A installation step2



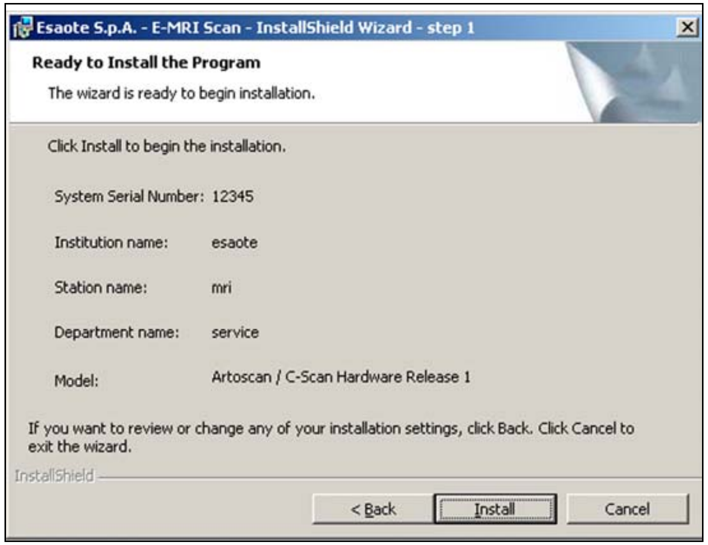
- When the next window appears insert the system own data or the generic data as shown in the next figure, remember that the system serial number must not start with 0 (zero), select the correct system you are installing then click on the **CONTINUE** button

Fig. 47: 8.1A installation step3



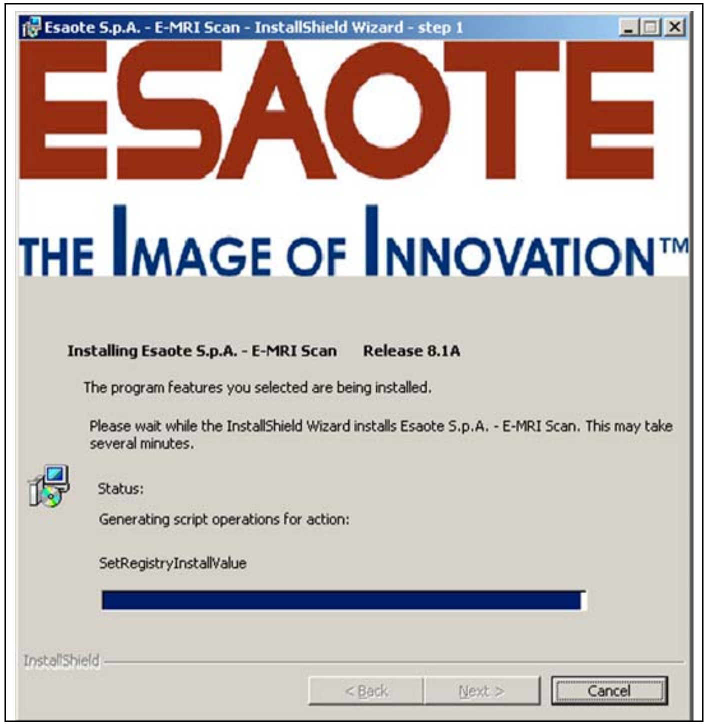
- Check if the inserted data are correct and click on the **INSTALL** button to proceed with the OPI installation otherwise go back clicking on the **BACK** button to change the inserted data

Fig. 48: 8.1A installation step4



- The procedure goes ahead automatically and will take more or less 30”. Don’t interact with the system till that the log on mask is shown!!!

Fig. 49: 8.1A installation step5 (installation)

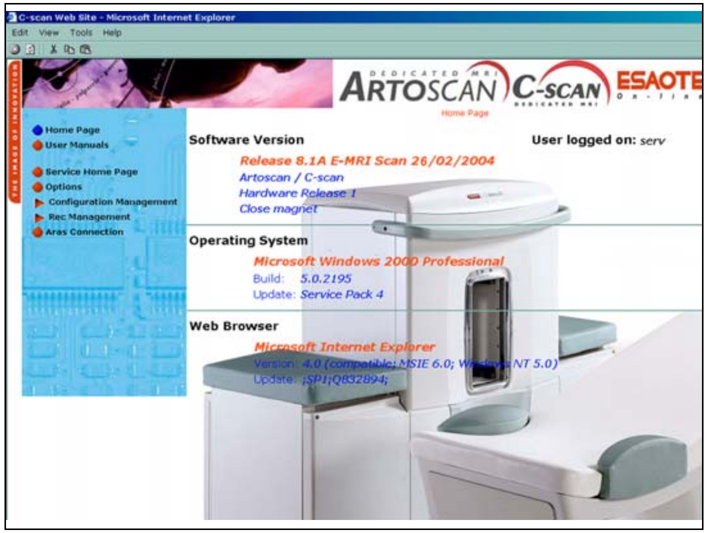


- If the following message appear click on the **OK** button

Fig. 50: 8.1A installation step4

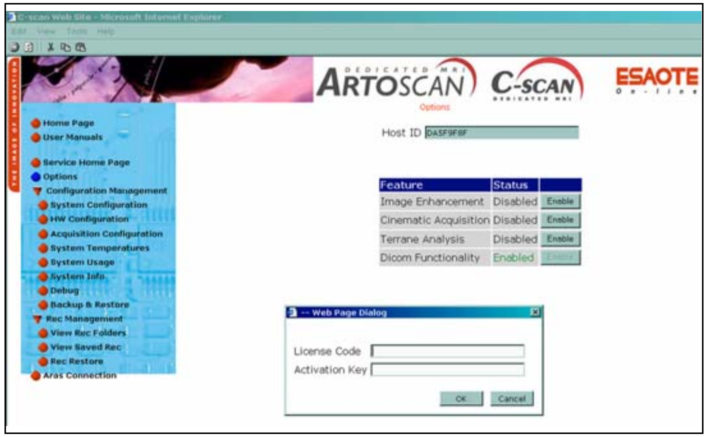
- After the last re-boot remove the ESAOTE CD-ROM and perform a log on with every user (Serv, Servdriver, ESAMRI and ADMIN)
- Perform a log-on as SERV and check in the IE homepage if the Operating System SP3 has been correctly installed (compare the shown data against the date shown in the following figure)

Fig. 51: IE homepage



- Activate the system options opening the IE Options page

Fig. 52: IE Options page

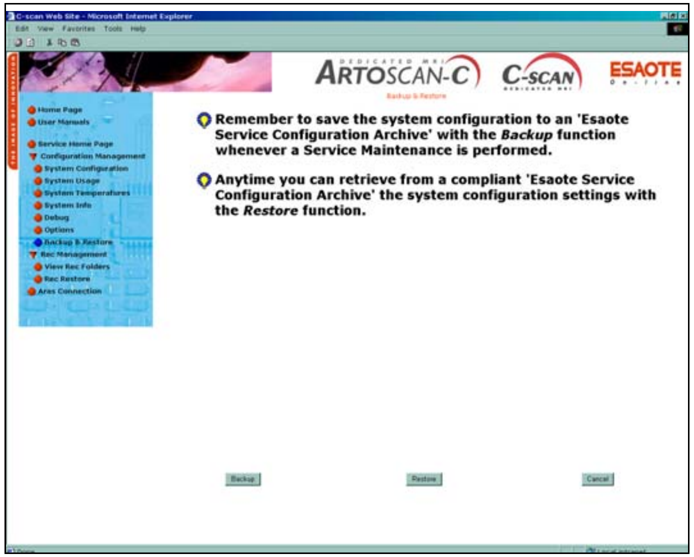


- Set the Hardware Configuration page in according with your system component status
- The procedure is finished, proceed with the System restore or data inserting and/or calibrations

Configuration restore

- Log on the system like SERV (typing the correct password) and launch Internet Explorer
- Insert the back up optical cartridge (created during the Back up procedure) into the ODD 3 ½
- From the homepage, select Configuration Management and Backup & Restore (like shown in the next figure)
- Follow the SW indications

Fig. 53: Configuration Restore



Images Restore

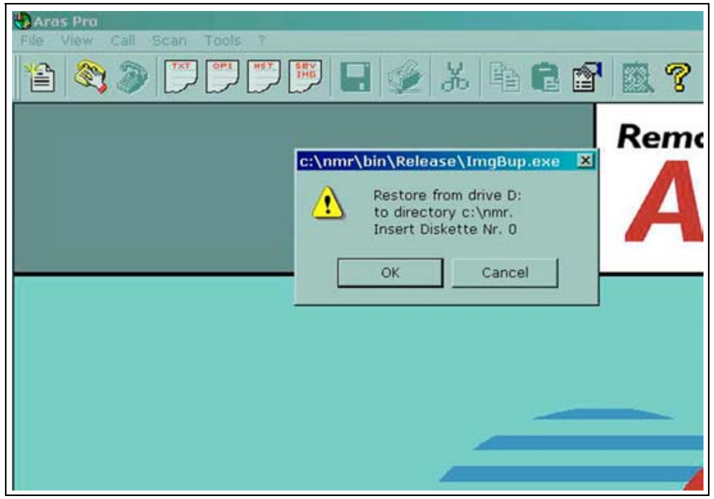
To restore the User's images from the created backup, act as described:

NOTICE	The restore procedure erase the images contained on the system Hard Disk

NOTICE	The restore procedure works only if on the system Hard Disk and on the Backup Cartridge is present the same SW Release and on the same System that created the Backup Cartridge

- Log the system as SERV and type the correct password
- Launch the ARAS program
- Select **TOOLS** and **Images Restore**

Fig. 54: ***Images Backup*** *window*



- Load the images from the backup cartridge

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Part 5 Host

Trouble shooting strategy

In this chapter you will find test strategies encompassing the complete host system.

Images visualization and storing

Image visualization and storing is an important system chain. It contains all the modules responsible for the last part of the image process.

The modules contained in this chain are: CPU, SVGA, HD, PRINT, ODD 3 ½, SCSI, CD-ROM and CD-RW.

Procedure

This section is designed to give the CSE an in-depth description of trouble-shooting procedures for the complete host system.

Use the data present in the following section to check the host part of the system.

Repair instructions

In this chapter you will find repair instructions encompassing the complete host system.

Mother Board Bios

Switch on the system and press the “delete” key during the boot to enter in the CPU board bios set-up.

Standard CMOS set-up

Date (mn/date/year) : xxx,xxxx xx xxxx								
Time (hour/min/sec) : xx:xx:xx								
HARD DISKS	TYPE	SIZE	CYLS	HEAD	PRECOMP	LANDZ	SECTOR	MODE
Primary Master	Auto	0	0	0	0	0	0	LBA
Primary Slave	None	0	0	0	0	0	0	-------
Secondary Master	Auto	0	0	0	0	0	0	LBA
Secondary Slave	None	0	0	0	0	0	0	-------
Drive A:		1.44M 3.5 inch						
Drive B:		None						

Floppy 3Mode Support:	Disabled
Video	EGA/VGA
Halt On	All, but keyboard

Bios features set-up

CPU Internal Core Speed	750MHz	PCI/VGA Palette Snoop	Disabled
		Video ROM BIOS Shadow	Enabled
Boot Virus Detection	Disabled	C8000-CBFFF Shadow	Disabled
Processor Serial Number	Enabled	CC000-CFFFF Shadow	Disabled
CPU Level 1 Cache	Enabled	D0000-D3FFF Shadow	Disabled
CPU Level 2 Cache	Enabled	D4000-D7FFF Shadow	Disabled
CPU Level 2 Cache ECC Check	Disabled	D8000-DBFFF Shadow	Disabled
BIOS Update	Enabled	DC000-DFFFF Shadow	Disabled
Quick Power On Self Test	Disabled	Boot Up NumLock Status	On
HDD Seuqence SCSI/IDE First	IDE	Typematic Rate Setting	Enabled
Boot Sequence	C Only	Typematic Rate (Char/sec)	6
Boot Up Floppy Seek	Enabled	Typematic Delay (Msec)	250
Floppy Disk Access Control	R/W	Security Option	Setup
IDE HDD Block Mode Sectors	Disabled		
HDD S.M.A.R.T. Capability	Enabled		
PS/2 Mouse Function Control	Auto		
OS/2 Onboard Memory > 64M	Disabled		

Chipset features set-up

SDRAM Configuration	By SPD	Onboard FDC Controller	Enabled
SDRAM CAS Latency	3T	Onboard FDC Swap A & B	No Swap
SDRAM RAS to CAS Delay	3T	Onboard Serial Port 1	3F8H/IRQ4
SDRAM RAS Precharge Time	3T	Onboard Serial Port 2	2F8H/IRQ3
DRAM Idle Timer	10T	Onboard Parallel Port	378H/IRQ7
SDRAM MA Wait State	Normal	Parallel Port Mode	EPP
Snoop Ahead	Enabled	ECP DMA Select	Disabled
Host Bus Fast Data Ready	Disabled	UART2 Use Infrared	Disabled
16-bit I/O Recovery Time	4 BUSCLK	Onboard PCI IDE Enable	Both
8-bit I/O Recovery Time	8 BUSCLK	IDE Ultra DMA Mode	Disabled
Graphics Aperture Size	64MB	IDE0 Master PIO/DMA Mode	Auto
Video Memory Cache Mode	UC	IDE0 Slave PIO/DMA Mode	Auto
PCI 2.1 Support	Enabled	IDE1 Master PIO/DMA Mode	Auto
Memory Hole At 15M-16M	Disabled	IDE1 Slave PIO/DMA Mode	Auto
DRAM are 64 (not 72) bits wide			
Data Integrity Mode	Non-ECC		

Power management set-up

Power Management	User Define	** Fan Monitor **	
Video Off Option	Suspend → Off	Chassis Fan Speed	Ignore
Video Off Method	V/H Sync Blank	CPU Fan Speed	4891RPM
		Power Fan Speed	Ignore
** PM Timers **			
HDD Power Down	Disabled	** Thermal Monitor **	
Suspend Mode	Disabled	CPU Temperature	N/A
		MB Temperature	Ignore
** Power Up Control **			
PWR Button < 4 sec	Soft On	** Voltage Monitor **	
PWR Up On Modem Act	Disabled	VCORE Voltage	XxxV
AC PWR Loss Restart	Enable	+3.3V Voltage	XxxV
Power Up By Keyboard	Disabled	+5V Voltage	XxxV
Wake On LAN	Enabled	+12V Voltage	XxxV
Automatic Power Up	Disabled	-12V Voltage	XxxV
		-5V Voltage	XxxV

PNP and PCI set-up

PNP OS Installed	Yes		
Slot 1 IRQ	Auto	DMA 1 Used By ISA	NO/ICU
Slot 2 IRQ	Auto	DMA 3 Used By ISA	NO/ICU
Slot 3 IRQ	Auto	DMA 5 Used By ISA	NO/ICU
Slot 4/5 IRQ	Auto		
PCI Latency Timer	32 PCI Clock		NO/ICU
IRQ 3 Used By ISA	Yes	SYMBIOS SCSI BIOS	Auto
IRQ 4 Used By ISA	Yes	USB IRQ	Enabled
IRQ 5 Used By ISA	NO/ICU	VGA BIOS Sequence	AGP/PCI
IRQ 7 Used By ISA	Yes		
IRQ 9 Used By ISA	NO/ICU		
IRQ 10 Used By ISA	NO/ICU		
IRQ 11 Used By ISA	NO/ICU		
IRQ 12 Used By ISA	NO/ICU		
IRQ 14 Used By ISA	NO/ICU		
IRQ 15 Used By ISA	NO/ICU		

Hard disk

The hard disk must be set at “Primary Master”. Look for the jumpers at the back of the HD and look at the labels at the top for their correct configuration.

Fujitsu M2513 Optical disk drive

Set the DIP-switch in the upper part of the ODD 3 ½” as follows:

Tab. 5: SW1

Key	function	position	mode
01 02 03	SCSI ID	off off on	ID = 4
04	SCSI data bus parity check	on	Enabled
05	SCAM mode	off	Disabled
06	Device type mode for INQUIRY command	on	Fixed disk
07	Spindle automatic stop mode	off	Disabled
08	LED mode	off	Normal

CD ROM

Must be set “**Secondary Slave**” and connect to the Secondary IDE port of the Mother board.

CD RW

If present, must be set like “**Secondary Master**” and connect to the Secondary IDE port of the Mother board.

SCSI

Changing from the Adaptek 2910 to the Tekram Ultra SCSI DC-315U follow this procedure if the Tekram board was already installed it’s enough to change it mechanically

- Switch off the System and open the Computer case
- Remove the SCSI board and install the new one
- Close the Computer case and switch on the System
- Perform the log-on like SERV
- Minimize the OPI window
- When the window “**Found new hardware Wizard**” appears, select the “**Search for a suitable driver for my device (recommended**” and press **NEXT**
- Select “**Specify Location**” and insert the DRIVER CD and select the correct drivers
- If the window “**Digital signature not found**” appears, means only that the driver are not certified by Microsoft and press **YES** to close it
- Click on **FINISH** and re-boot the System

Computer board set-up

The table lists the adjustments required after replacing individual boards or assemblies.

Tab. 6: Test and adjustment

MODULE	TEST	ADJUSTMENT
PC : MODEM	Try to connect the system or vice-versa try to connect a PC to the system	No adjustment required
PC : LAN	Try to connect the system to another system	Insert the new Filter Codes (Explorer, Options)
PC : CPU	Check the BIOS (refer to this chapter) when the system is booting the Solaris software	Load into the software system the correct driver for the CPU SVGA (Service Utilities)
PC : PRINT BOARD	Try to print some images	No adjustment required
PC : SCSI	Check if the operator system recognizes the SCSI Try to read some images from the ODD	No adjustment required
PC : HD	Switch on the system, go inside the bios set-up and recognize the new HD	Insert the system data and the customer's protocols, repeat all the system calibrations
DEVICES (ODD, CDR, CDWR)	Check if the operator system recognizes the drive Try to read some images from the drive	Check the jumper on rear side

Part 6 Control

Trouble Shooting Strategy

This chapter contains the test strategies encompassing the complete control system.

Procedure

This part contains the exchange procedures and the necessary adjustment procedures. Please observe normal safety precautions in connection with the particular area in which you are working and overall safety precautions in general.

This part is designed to give the CSE an in-depth description of trouble-shooting procedures for the complete control system.

DSP test

To perform the standard peripheral controls the procedure is:

CNTR test

Follow this procedure to perform the CNTR test:

Necessary tools

- Not necessary

Operation

- Refer to the System Check description

Repair instructions

This chapter contains repair instructions encompassing the complete control system.

Change DSP

- Switch off the system and disconnect the rear power cable from the PC unit
- Open the PC unit
- Take out the broken DSP and change it
- Close the PC unit
- Re connect the power cable and switch on the system
- Refer to the following table for necessary tests and adjustment

Change CNTR or TRDIFF boards

- Switch off the system
- Open the Electronic unit left (patient side) covers front and rear
- Disconnect all the cables from the Control box
- Remove and open it
- Take out the broken board and change it
- Close the Control box and insert it
- Re connect all the cables and close the Electronic unit
- Switch on the system
- Refer to the following table for necessary tests and adjustment

Tab. 7: Test and adjustment

MODULE	**TEST**	**ADJUSTMENT**
PC : DSP	Try to acquire one image	No adjustment required
PC : CNTR	From ARAS select <**Test**> <**Hardware**> <**System check**> and look for the gradient the X, Y and Z input to the SGRA module	No adjustment required

Part 7 RF Subsystem

Trouble Shooting Strategy

General

One of the essential prerequisites for the excellent image quality of an MR- system is a correct and stable RF system.

However, due to the complexity of a MR- system, image quality is influenced by a great variety of components and functions, such as

- Communication systems (e. g.: general data transfer, etc.)
- Control systems (e. g. Host, etc.)
- Image generating systems (e. g. RF system, gradient system, etc.)
- Image acquisition, processing and archiving systems
- Software performance

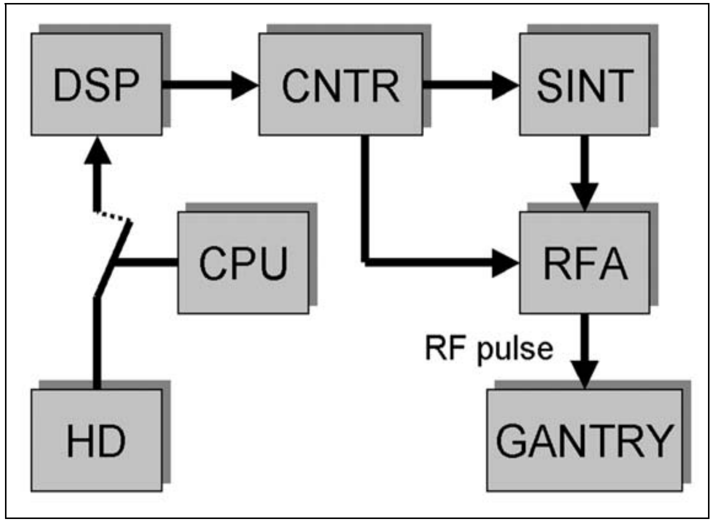
For more explanations about the module described in this chapter refer to the Functional Description manual RF chapter.

Procedure

Transmitting Coil Driving

A description of the process and identification of the modules responsible for the transmission process is shown in the following figure.

Fig. 55: Transmission chain description (coil driving)



The control software operating on DSP sends the digital commands necessary for driving the transmission coil to the CNTR. The CNTR is in the Control Box while the DSP is in the PC box.

These commands are processed (multiplexed and synchronized) inside the CNTR and sent, to SINT, inside SINT3 connector.

SINT processes the commands received by CNTR digitally and sends, on SINT1, the driving RF signal to RFA (in connector RF). Inside SINT, PCB, SINT2 connector, the GATE signal is also available to enable the GRFA. This signal is a TTL type-high active signal (RFA enable).

RFA amplifies the RF signal (impulse) and sends it through RFOUT connector to the RFAOUT of the filter panel connected to the MBTX connector of the magnet panel (BTX, flexible pressed matter circuit, fixed inside GANTRY). On RFA there is another connector called CONTROL connected (RFD cable) to the ACQ module. Inside the CONTROL connector, there are the reference signals from reflected and direct RF power, GATE signal and ALARM RFA signal.

Use of System Check

You can display reflected and direct RF power using <**System Check**> and examine the envelope of the RF pulse, as measured at the RF amplifier output (RFA module) by a reflectometer. It gives a voltage proportional to the square root of the transmitted power (blue track or channel A), another voltage proportional to the square root of the reflected power (red track or channel B).

If their ratio (Pd/Pr) is close to 1, you can locate the error by connecting a 50-Ohm load to RFOUT:

- If you cannot see the direct pulse, the RFA is out of order
- If you see the direct pulse this means that the trouble is on the cables or on the Gantry

Check if the transmission circuits in the gantry are tuned to the correct frequency, which may be out of tune or not adjusted: the signal going out from SINT5 allows checking of the frequency. If the frequency is correct, check the tuning capacitor inside the gantry with a tester to identify any open or short circuit.

It is thus possible to check both the correct envelope form (generated with the contribution of the DSP, CNTR and SINT modules and, of course, of the RFA module) and the quality of the coupling with the transmission coil (BTX). If the ratio between the two direct and reflected voltages (measurable in <**Pause**>) is less than 4 there may be a tuning problem on the transmission coil or a malfunction in the RFA output.

If the ratio is close to 1 (e.g. the tracks are virtually overlapping), the RFA-BTX connection may be broken.

<**Channel**> **=** ”**7**” is used to modify the sampling frequency of the acquisition subsystem (<**Sampling rate**>). It corresponds to the time base of a regular oscilloscope and allows enlarging or reducing the RF pulse envelope.

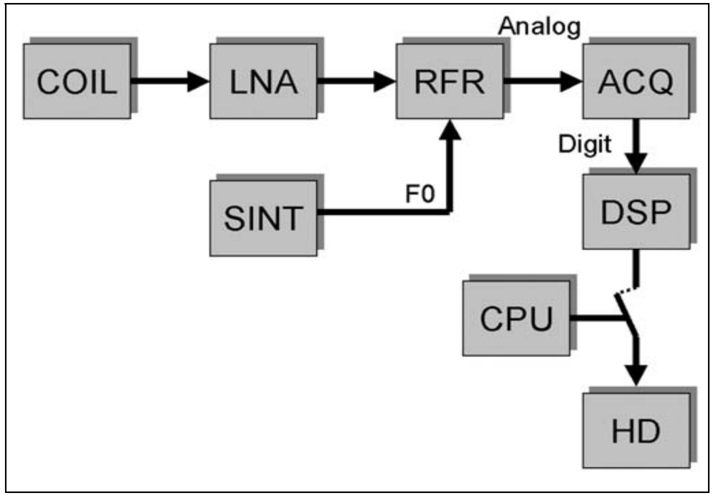
In this case too, before displaying the two signals, click on <**Scale**>**,** then select the <**Dec**> mode on the y axis, so that the values on the y grid will be expressed in Volts.

The following figure shows the RF pulse using <**Dec. Div.**> = 1V and <**Res. Div.**> = 2.0. The window information shows the values in Volts of the transmitted (channel A) and of the reflected power (channel B).

Receiving chain driving

A description of the process and which modules are responsible for the receiving process is shown in the following figure.

Fig. 56: Receiving channel description



The **RF signal** picked up by the reception linear coil (BRX) is sent through the cables from the RFR connectors (RFR5 and RFR7) to the magnet panel connectors (respectively MRF and MRF1).

Within RFR, the RF signal is amplified and demodulated in quadrature (removing the local oscillator signal, central frequency of magnet). Two 90 out of phase LF signals (with a 50 kHz band) are generated.

The frequency digital synthesizer (SINT module), ”SINT5” connector, sends the local oscillator (FRX) to RFR, inside the ”RFR4” connector. You can check the “SINT5”'s amplitude (1.2 Vpp), frequency (f0 of the magnet) and shape (sinusoidal) by connecting it to an oscilloscope.

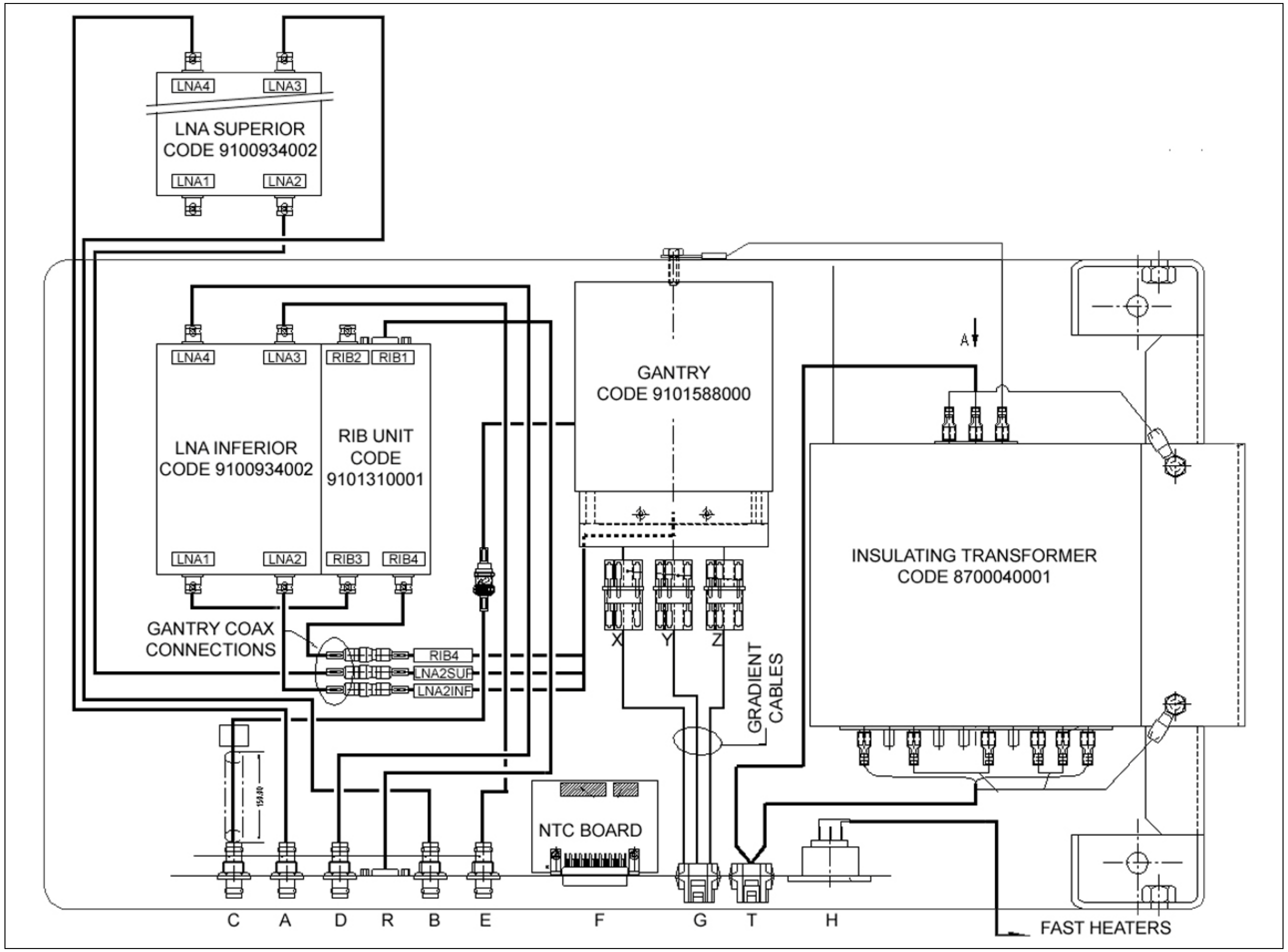
The two LF signals going out of RFR, through the ”RFR2” connector, reach ACQ (inside the PC unit)

ACQ converts the signals into digital signals and sends them, through the HSSL1 cable, to DSP (inside the PC unit). You can test the RF signal on RFR5 of the RFR module.

The RIB module is installed under the magnet; this box is the card devoted to automatic coil acknowledgement. The signal is sent to the RIB box through the cable in the “RIB4” connector, from the ”GANTRY. The signal goes out of the ”RIB1” connector to the Magnet panel connector R and reaches the DSP, inside the PC unit.

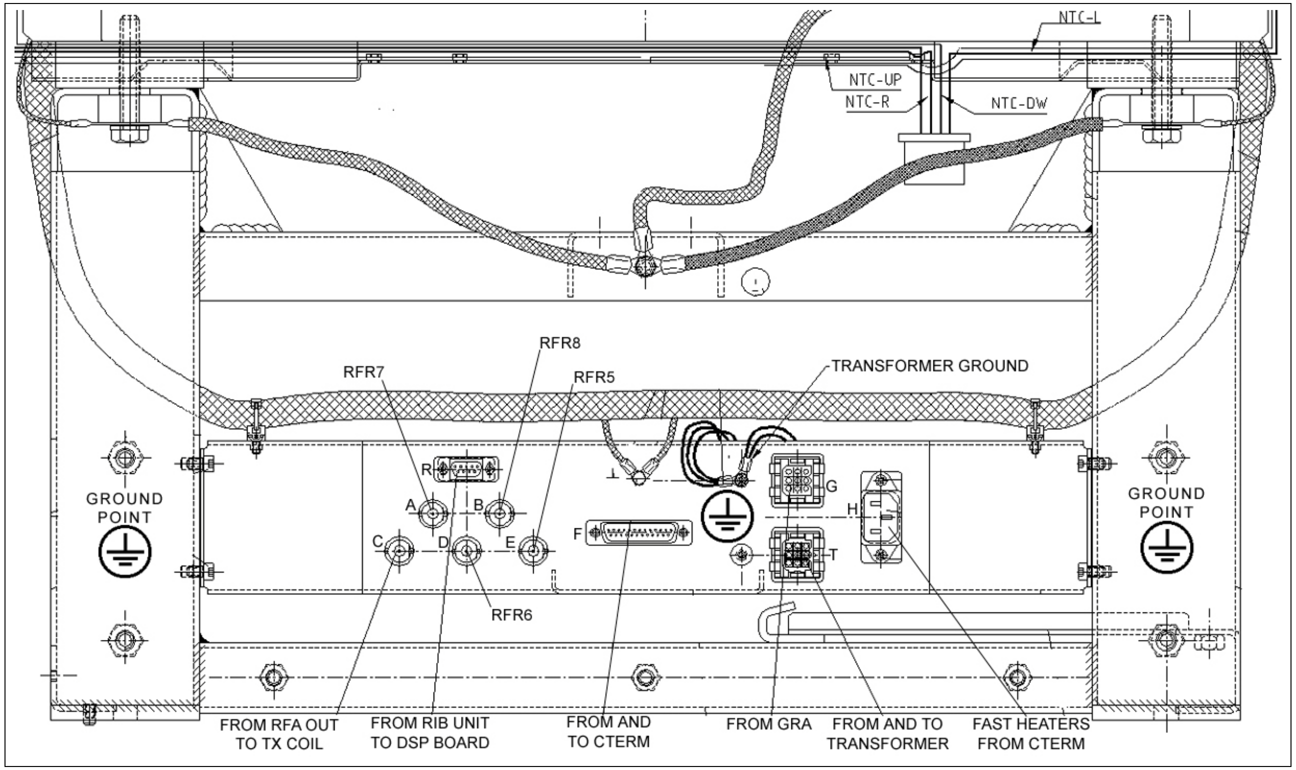
The **Varicap** driving signal in BRX (necessary for the fine-tuning of the coil) is sent from RFR to the RX coil inserted into the Magnet. The voltage can vary between 0 to 9V (center 2.1V) depending on the digital value, between 0 and 255.

Fig. 57: Magnet basement connections



This picture shows all the cable connections present between the modules contained into the magnet basement and from/to the Gantry.

Fig. 58: Magnet Panel Connectors



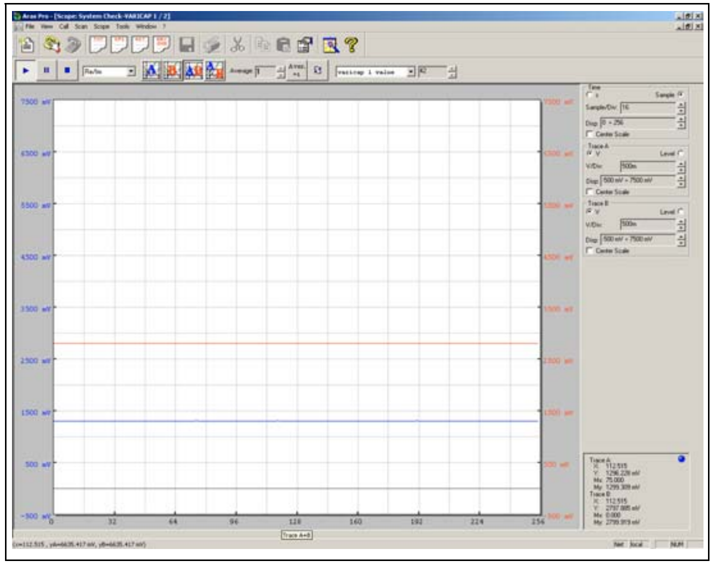
This picture shows the Magnet Panel Connector connections to the others system modules.

RFR check

Procedure

- From the ARAS program, select <**Test**> <**Hardware**> <**System Check**> <**Run**>
- Click on channel and from the drop down menu, select the Varicap channels and try to move the Varicap 1 changing its value
- If the Varicap are not present or is not possible to move the Varicap 1 the RFR module is broken

Fig. 59: Gains 1 and 2



SINT check

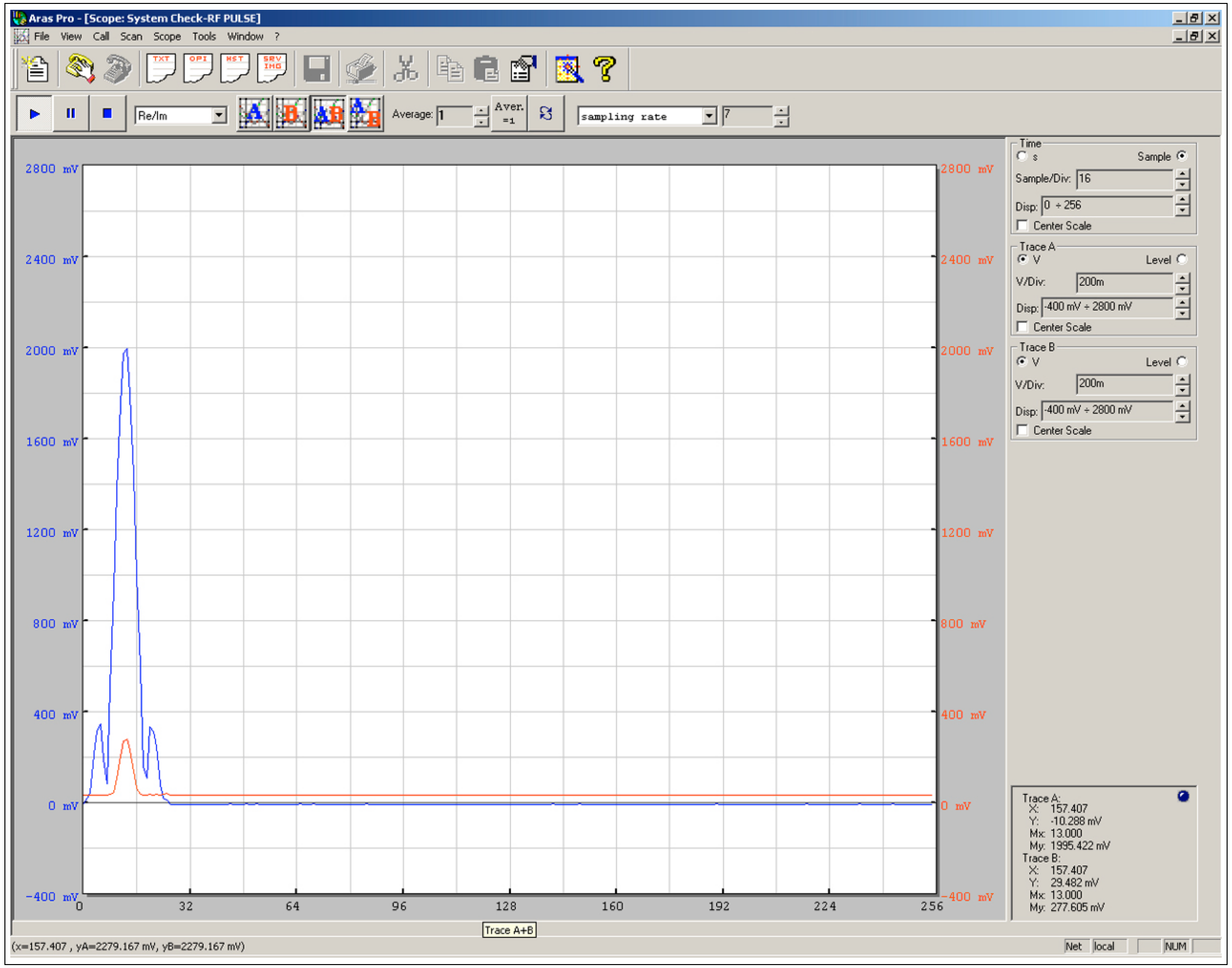
Procedure

- From the ARAS program, select <**Test**> <**Hardware**> <**System Check**> <**Run**>
- Click on channel and select the 7 channel, as shown in the next figure
- If the direct and reflected pulses are not present the SINT module does not enable the RFA module and is probably broken

Or

- Open the front console covers
- Disconnect the SINT5 BNC and connect the oscilloscope probe to the SINT5 plug
- Check if the output is a sinusoidal wave of the same frequency as the magnet (1.2Vpp). If it is not this means that the SINT module is broken

Fig. 60: System Check window



The blue trace is the direct pulse: the energy that the RFA is transmitting to the Gantry.

The red trace is energy that we are losing because the Gantry is not equal to the ideal load (50Ω). It must be lower than 20% of the direct pulse.

If the red trace is flat means that the SINT module is broken or the cable between SINT and RFA.

If the blue trace is flat disconnect the output cable and connect a dummy plug (50Ω) to the RFA output: if the trace is still flat means that the RFA is broken otherwise the Gantry or the cable are broken.

RFA check

The RFA module is the system's power amplifier. It is located inside the system console.

Procedure

- From the ARAS program, select <**Test**> <**Hardware**> <**System Check**> <**Run**>
- Click on channel and select the seventh channel, as shown in the previous figure
- The pulse values are different for every system (the displayed 90° Pulse value is obtained dividing by 2 the 180° pulse value of the system Knee Coil 2)
- Check the direct and reflected pulses: the reflected pulse (gray trace) must be lower then the fifth part of the direct pulse (white trace)
- If the reflected pulse is equal to the direct pulse something is broken in the transmission chain
- Open the Console front covers and connect a dummy load to the RFA output disconnecting the present cable
- If the reflected pulse remains equal to the direct the RFA module is broken

Transmission Coil Check

The purpose of transmission coil calibration is to check the *impedance* matching to 50Ω ± 5Ω and the tuning to the central frequency of the magnet.

The *"Diascope"* allows the display of the "*return loss*" between the transmitted and the reflected power in dB. This waveform has a peak that must be moved to the center of the X-axis, which means that the coil is tuned to the correct frequency. Besides, it is very important to check the *impedance* matching to 50Ω.

<u>**Operations:**</u>

The purpose of transmission coil calibration is to check the *impedance* matching to 50Ω ± 5Ω and the tuning to the central frequency of the magnet.

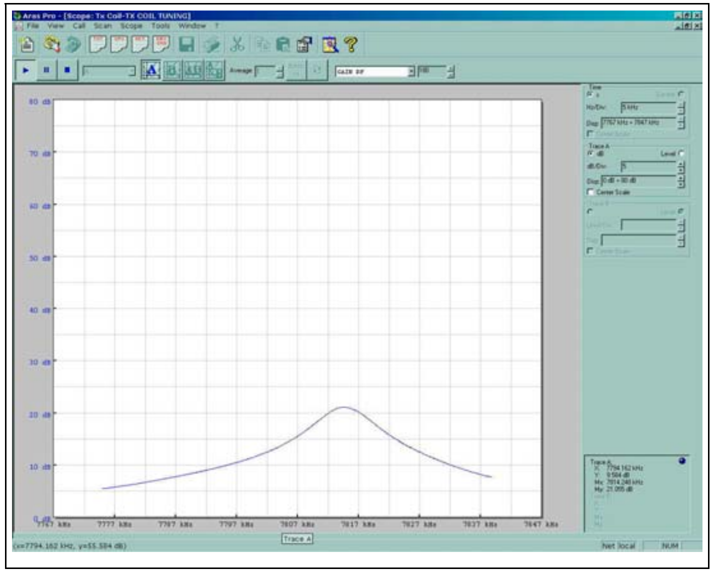
The *"Diascope"* displays the "*return loss*" between the transmitted and the reflected power in dB. This waveform has a peak that must be moved to the center of the X-axis, which means that the coil is tuned to the correct frequency. Besides, it is very important to check the *impedance* matching to 50Ω.

Using the TX Coil test, check the position and the matching of the transmission pulse:

- Insert the Coil 2 (Knee) with the homogeneous phantom into the magnet in axial position then, from ARAS, select <**Test**> <**Hardware**> <**TX Coil**> <**Run**>. The pulse is shown in the following figure
- Changing the channel, select the **SPAN STEP** field and set it to **100 Hz**

- Select the **GAIN RF** channel and set it the to 180

Fig. 61: TX Coil test



- Check if the pulse is in the central position of the screen because the magnet frequency is shown at the screen center. The maximum acceptable range is ±2.5KHz from the central frequency. Otherwise you must adjust the tuning circuit
- Check if the highest point of the peak is at least 12dB, otherwise you must adjust the matching circuit

Receiving Coils Check

Following the RX chain you can perform some checks directly on the coil connectors of the Gantry in order to test if the Varicap voltage reaches the coil and from the Coil check the cable continuities to the LNA modules and then to the RFR module.

Repair

Transmission Coil

Necessary Tools

- Non ferromagnetic screwdriver
- Kit capacitors for Transmission Coil tuning
- Solder

Operations

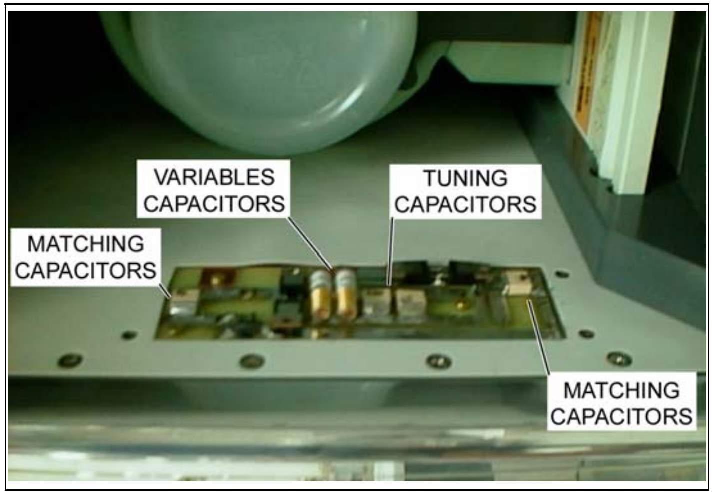
If the transmission peak is not correct, first of all remove the transmission circuits cover (removing the four screws in the cover corners) in order to access the transmission circuits.

⚠ **WARNING**	**Don't touch the TX Coil circuit when the Gain RF is set to 180 to avoid electric shock (the provided power is very high)**

Tuning

- Using the variable capacitors present on the tuning circuit you can move the pulse at maximum **100**KHz (f0 ± **50**KHz). The variable capacitor position is shown in the following figure
- Turn the variable capacitors by the same value (Example: two turns for each capacitor) and see directly on the monitor if you are moving the pulse in the right direction

Fig. 62: TX Coil Circuit



- If the variable capacitors are not sufficient to reach the correct frequency you can solder another capacitor (if it's necessary to increase the capacitance) in the close to the already soldered capacitors or over them or change the their values

Fig. 63: Example of transmission peaks

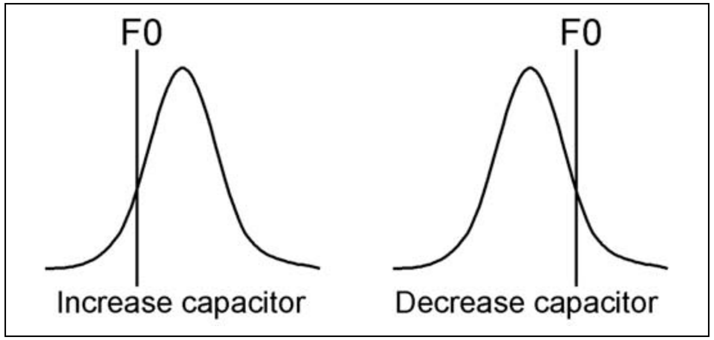
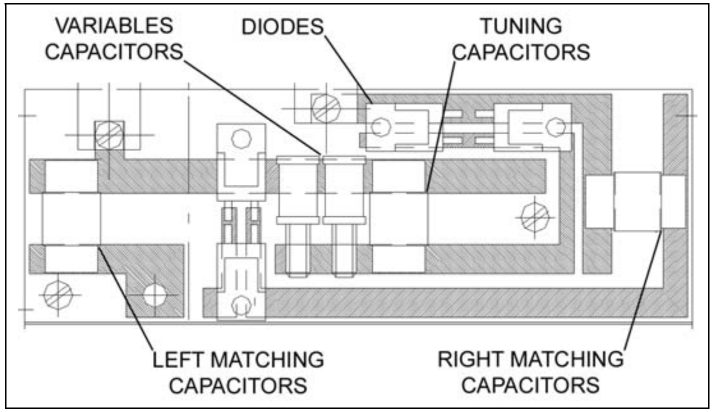


Fig. 64: TX Coil Circuit Layout



Matching

- If the pulse is lower than 12dB you must increase the matching of the transmission coil.
- In this case change the value of the fixed matching capacitors. Remember that the sum of the left side matching capacitors must be equal to the sum of the right side matching capacitors
- Touch the TX Coil with your hand close to the circuit to find out if you have to increase or decrease the capacitance value to obtain the correct matching value
  - If the value of the matching increases you must decrease the capacitance
  - If it decreases you must increase the capacitance
- Decrease or increase the capacitors by a small amount, then repeat the test checking if the deepness of the peak is at least 12dB. You must change at least two capacitors at a time

Receiving coil

Introduction

This chapter describes the Service coils tuning procedure. This procedure allows the Service technician to tune the RX coil in the field, using the special capacitors kit and RX coils prepared for this purpose.

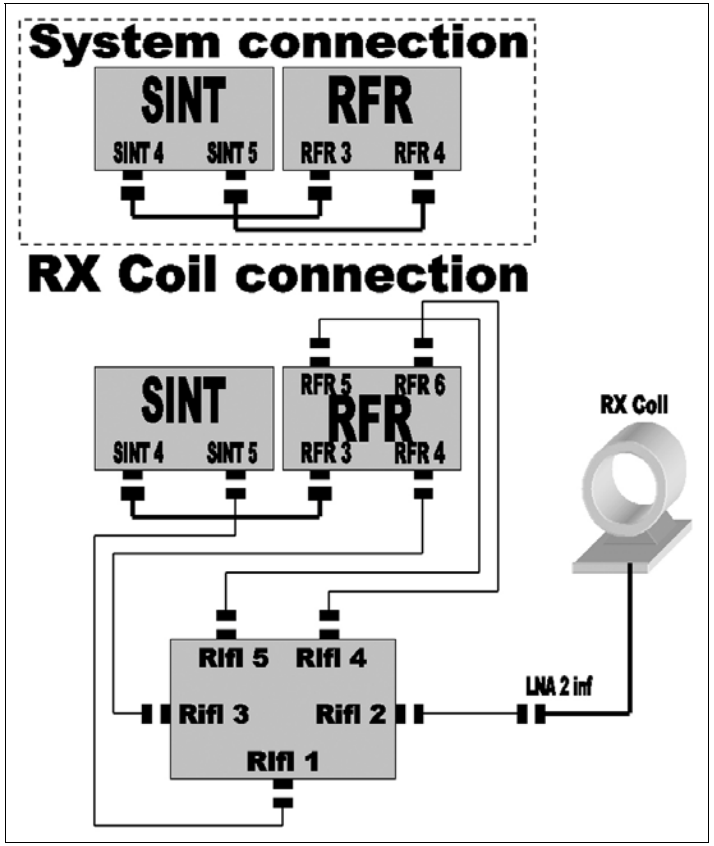
Necessary Tools

- RX Coil tuning kit
- Soldering
- Flat screwdriver medium tip
- Pincers and nippers

Hardware Connections

- Open the rear and front covers of the Electronic Unit left side (patient view)
- Open the Magnet cover not patient side
- Disconnect the cable between SINT5 and RFR4
- Connect the RIFL1 to SINT5, RIFL3 to RFR4, RIFL5 to RFR5 and RIFL4 to RFR6 (like shown in the next figure)
- Disconnect the BNC connects to LNA2 inf and connect it to an extension cable but don't connect the extension to the RIFL2 till now

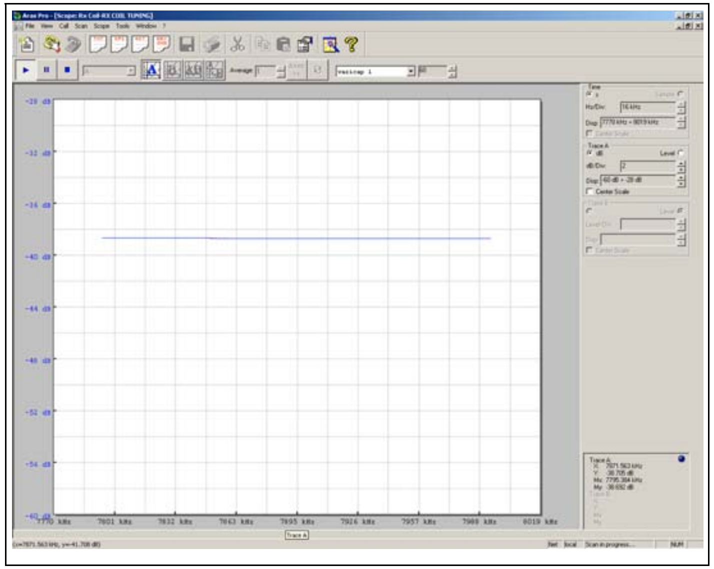
Fig. 65: RX Coil hardware connections



Check Procedure

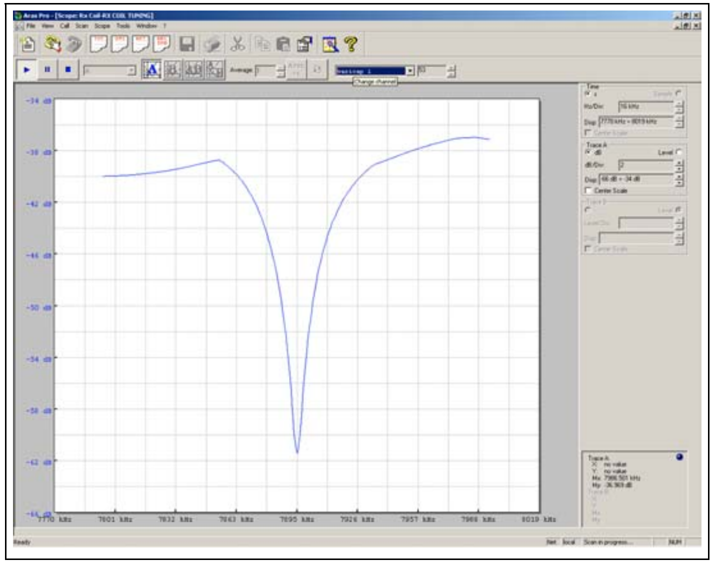
- From the ARAS program, select <**Test**> <**Hardware**> <**RX Coil**> <**Run**>
- Wait for the system diascope (like shown in the next figure). Only when the diascope appears the system has set the RFR gains (1 and 2) to 255 (maximum value)

Fig. 66: RX Coil diascope



- Now connect the extension cable to RIFL2 and check the peak position and deep

Fig. 67: RX Coil peak

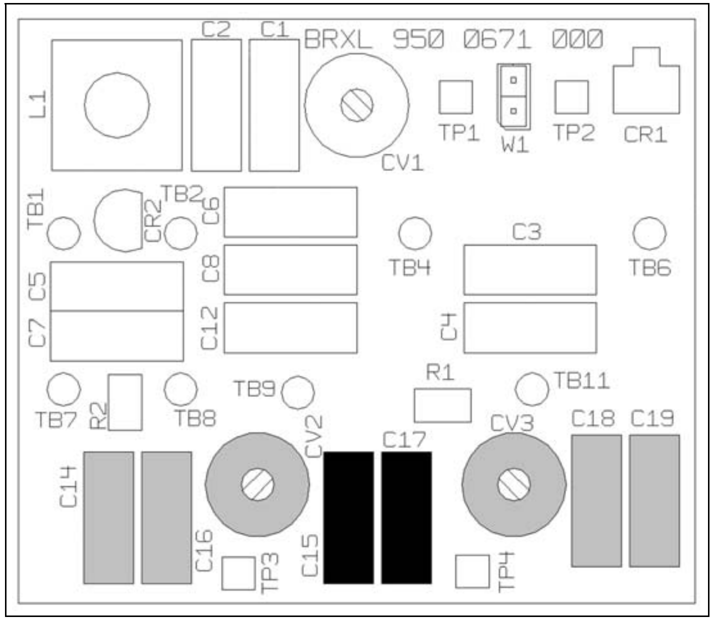


- In the center of the screen the Magnet central frequency is automatically set:
  - move the Varicap value and check if it's possible to set the coil peak to the magnet central frequency, if no refer to the Tuning part
  - check the deep peak, it has to be at least 20dB when the peak is set to the Magnet central frequency, if no refer to the Matching part

Tuning & Matching

- Remove the Coil and open the Coil base to have access to the circuit
- Change the central capacitors to tune the coil, change the lateral capacitors (at least two per time) to reach the correct peak match. Refer to the following figure for the capacitor positions

Fig. 68: Coil 1, 2 and 3 Circuits



- To adjust the coil tuning, change the capacitors C15 and/or C17 (in black in the figure): increase them means decrease the coil frequency tuning
- To adjust the matching, act on the variable capacitors CV2 and CV3 of the same amount. They reach the maximum and the minimum values in one turn. If the variable capacitors are not enough, set them to the middle values and then change the capacitors C14, C16, C18 and C19 (in gray in the figure) but remember: the total value C14 + C16 must be equal to the total value C18 + C19

Tab. 8: Test and adjustment

MODULE	**TEST**	**ADJUSTMENT**
RFR	Try to acquire some images	Phase and Quadrature Channels inside <**Test**> <**Manual**> <**RX chain**> and the Gain Channel inside <**Test**> <**Manual**> <**Gain Channel**>
SINT	Carry out automatically 180° pulse inside <**Test**> <**Automatic**> <**180 pulse**>. Check TX coils	Save for every coil <**Test**> <**Automatic**> <**180 pulse**> manually
RFA	Go to <**Test**> <**Hardware**> <**System check**> and check if direct and reflect pulses are present.	Save 180° pulse for every coil manually and calibrate the Transmission coil <**Test**> <**Hardware**> <**TX coil**>
COIL	Carry out automatically varicap and 180° pulse inside <**Test**> <**Automatic**> <**Varicap**> <**180° pulse**>	Tune the Coil to Magnet frequency, save the new varicap and 180° pulse value manually
GANTRY	Go to <**Test**> <**Hardware**> <**System check**> and check if direct and reflect pulses are present	Go to <**Test**> <**Hardware**> <**TX coil**> and set the gantry tuning and matching to the system frequency

Part 8 Patient Handling

Trouble shooting strategy

In this chapter you will find test strategies encompassing Patient Handling.

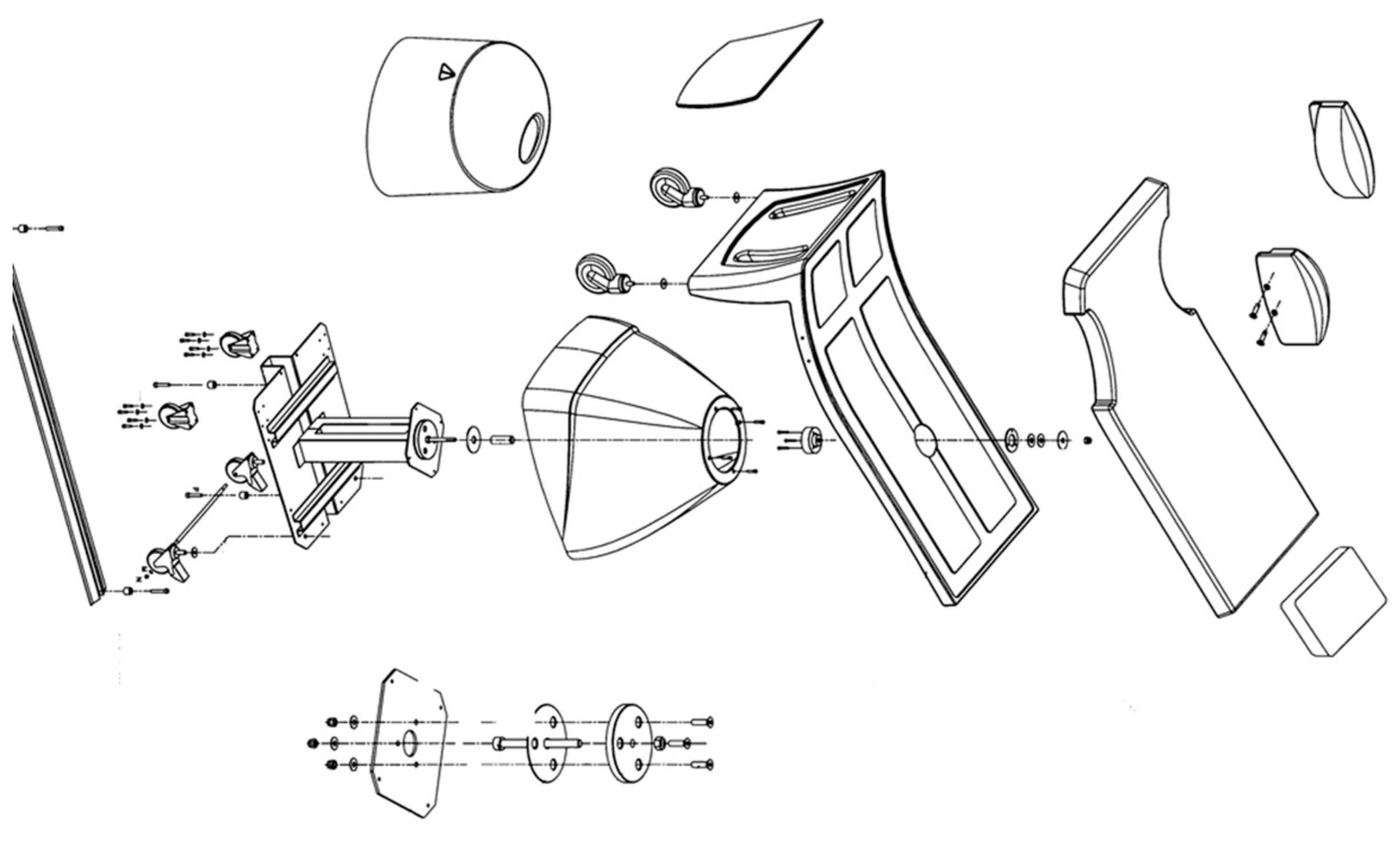
Refer to the Functional Description manual Patient Handling chapter for more information.

Procedure

- Check all the possible positions of the patient seat
- Check the patient seat stability

Use the following scheme in case of adjustment or repair.

Fig. 69: Seat Composition Draw



Part 9 Gradient

Trouble shooting strategy

In this section you will find test strategies, procedures and repair instructions encompassing the complete gradient system.

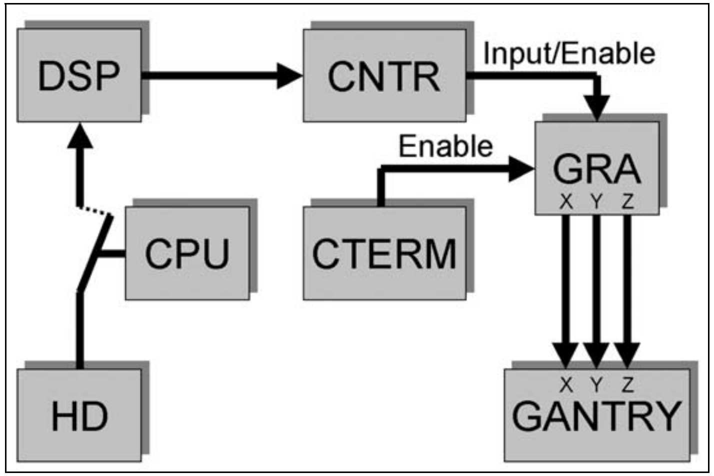
For more information refer to the Functional Description manual Gradient chapter.

Procedure

Gradient driving transmitting chain

A description of the process and which modules are responsible for the transmission process is shown in the following figure.

Fig. 70: Transmission chain description (gradient driving)



Use of the System Check

Select <**Test**> <**Hardware**> <**System check**> and wait for the diascope, then click on the <**Channel**> button and from the drop down list you can select the three channel Gradient output (X, Y and Z). When you select channel 0, the first line at the top right corner of the monitor shows the label "**X Grad**"; channels 1 represents the "**Y GRAD**" and channel 2 the "**Z GRAD**".

The blue trace (real component) is the driving voltage of the gradient amplifier's X channel (GRA module), measured at the output of the CNTR module, located in the control box unit.

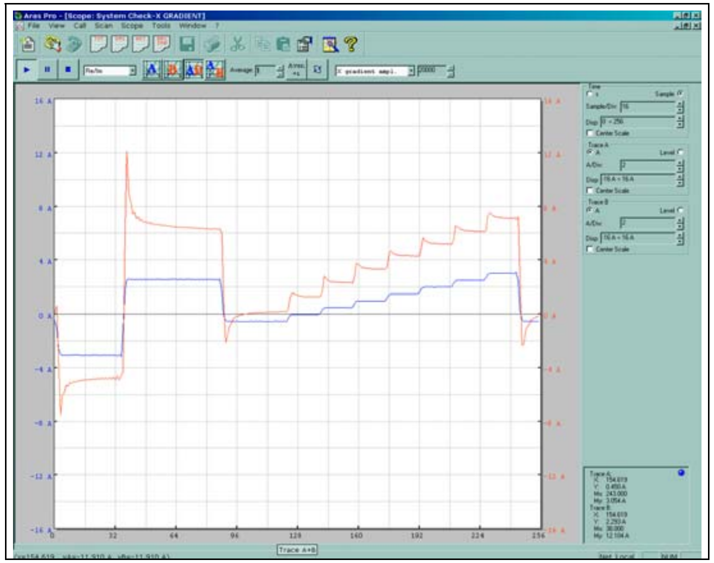
The red trace (imaginary component) is the output current of the GRA X channel, measured by shunting a part of it from the corresponding final stage.

The sequence used by <**System Check**> is designed specifically to examine the variables concerned (X gradient, Y gradient or Z gradient).

If the coil relative to the Y gradient is driven correctly, the monitor will display this waveform (use the <**Res. Div.**> and <**Dec Div**> commands to display the optimal dimensions) for both channels (A and B).

Please note that the GRA drive voltage (blue trace) must have a rather square shape since it is driven directly by the D/A (except for gains and offset). Whilst the output current (red trace), besides the different gain value, shows overshoots and undershoots generated by the eddy current compensation circuit located at GRA input.

Fig. 71: Gradient waveforms



If the blue track (GRA input) is correct, but the red (GRA output) is not, there is probably a problem is related to the gradient amplifier.

If the blue track is not correct as well, probably the problem is related to the CNTR module (or DSP, which programs CNTR).

Obviously, using the apparatus as an oscilloscope assumes that the acquisition subsystem (consisting of the DSP and ACQ modules) is operating correctly. Any problems with this subsystem must be identified if, for instance, the oscilloscope behaves incorrectly regardless of the selected channel. In this respect, note that channels 3, 4, 5 and 6 have special significance since the values being displayed are generated internally by the acquisition subsystem.

Repair

GRA replacement

The GRA module (gradient amplifier) is placed into the electronic unit at the right magnet side (patient view). Follow this procedure to replace it.

- Open the front and rear electronic unit covers (left side)
- Disconnect the GRA power plug (rear side)
- Disconnect all the cables (front side)
- Take out the broken module and insert the new one replacing all the cables

GRA gradient check

Necessary tools

- Gradient Tuning Kit
- Allen key 4 mm
- Screwdriver, small and big standard tip

Cables connection

- Switch off the system
- Open the left electronic unit cover patient side
- Disconnect **RFR3** cable from the RFR module; use the nine pin flat cable to connect **RFR3** connector to **RF3** cable and **P1** connector on the AINT box (next figure)
- Put the BNC cable between **SINT2** (on SINT02 module) and **GATE IN** (AINT box)
- Insert the Pick-up coil support into the Gantry and lock it like a normal coil
- Connect the Pick-up coil to the to the **COIL IN** connector (AINT box)
- Put the AINT box switch on **DC** mode and set its counter to **000**

NOTICE	No other counter settings are allowed

- Disconnect the **RFR2** cable from the **RFR2** connector on the RFR module and connect it to the **J1** connector on the AINT box using the 9 pin flat cable
- Switch on the system

Fig. 72: Cable connection (the thinner cables are the kit cables)

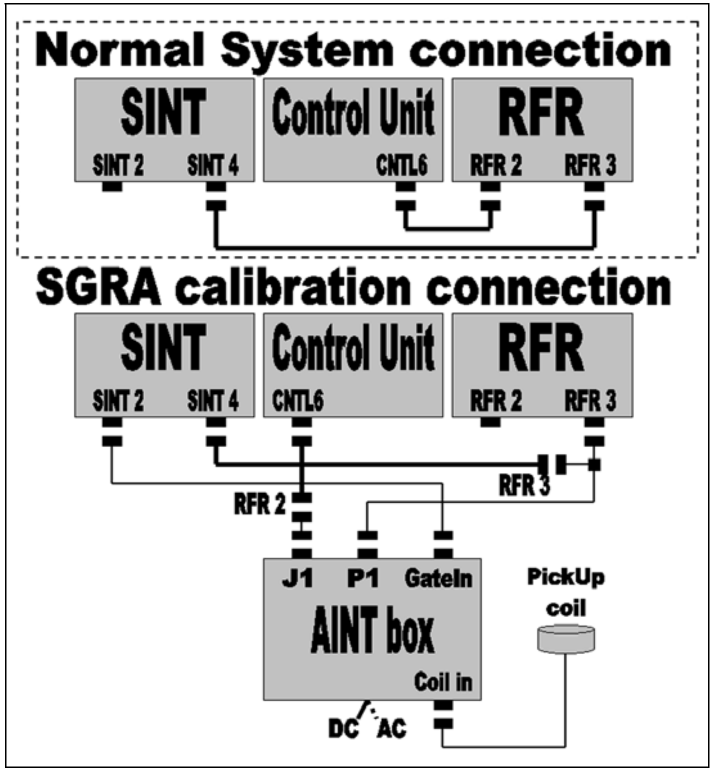
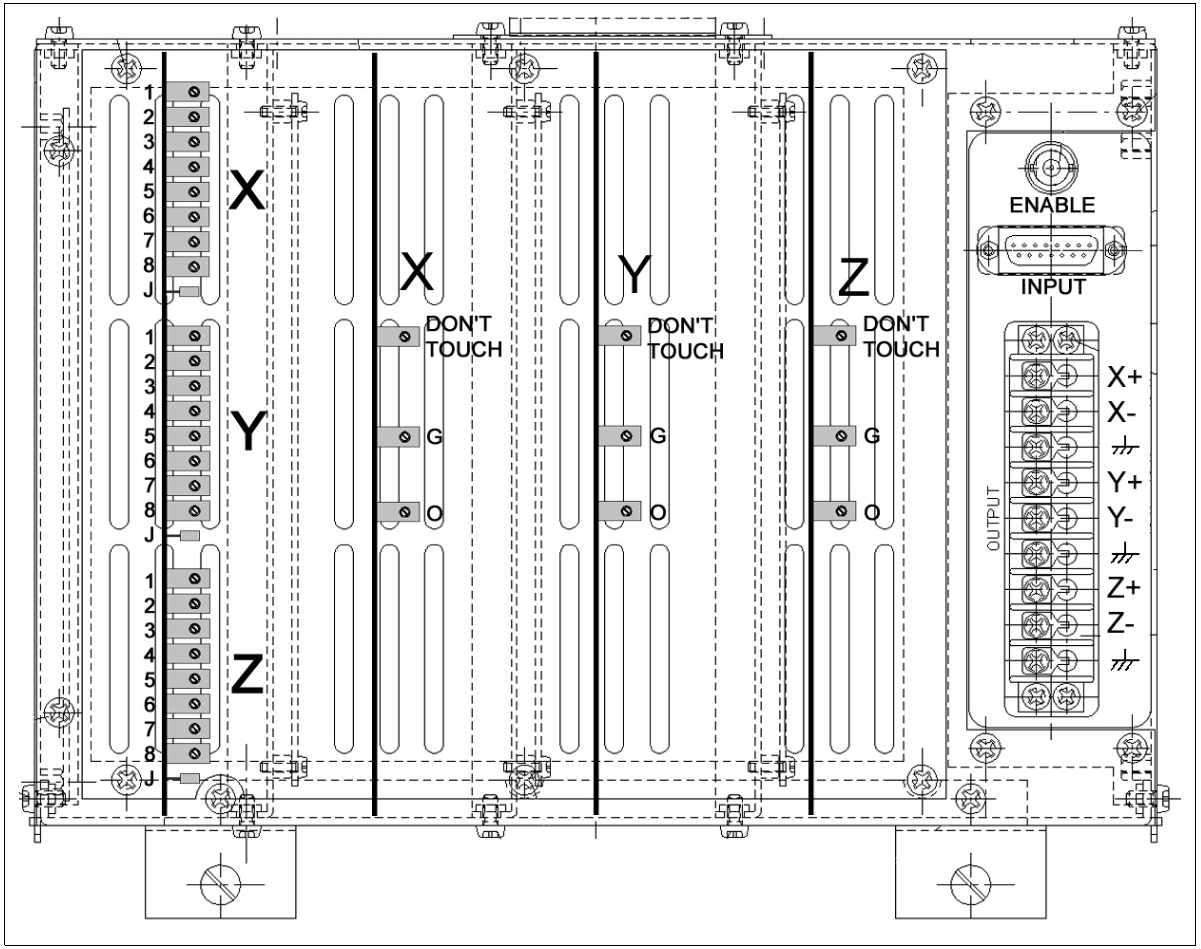


Fig. 73: Pick-up coil support

Fig. 74: GRA module



As you can see, every channel (X, Y and Z) have the same trimmers in the same positions.

From the top the first six trimmers are dedicated to the gradient output waveform adjustment, the trimmer number seven is the geometrical distortion trimmer, the number eight is the hardware offset and the jumper is the output en-able (if you remove it the GRA output is disabled).

Check the Gradients

- Place the pick-up coil in the "**X**" position of the support
- Select <**Test**> <**Hardware**> <**X gradient**> then <**Exec**> and wait for the system diascope
- Click on the <**Channel**> and select <**Coarse offset**> channel
- Click on the <**Coarse offset**> vertical arrows to transfer the gray trace to the center of the screen. This operation allows eliminating the offset created by the AINT box. Then change the channel and select <**Fine offset**> to set the AINT box offset to zero using smaller step than <**Coarse offset**>

NOTICE	During the whole calibration procedure, the offset must be zero

NOTICE	To better visualize both traces they have two different zero levels: the AINT box offset zero level is in the middle of the screen

Fig. 75: Not correct AINT offset

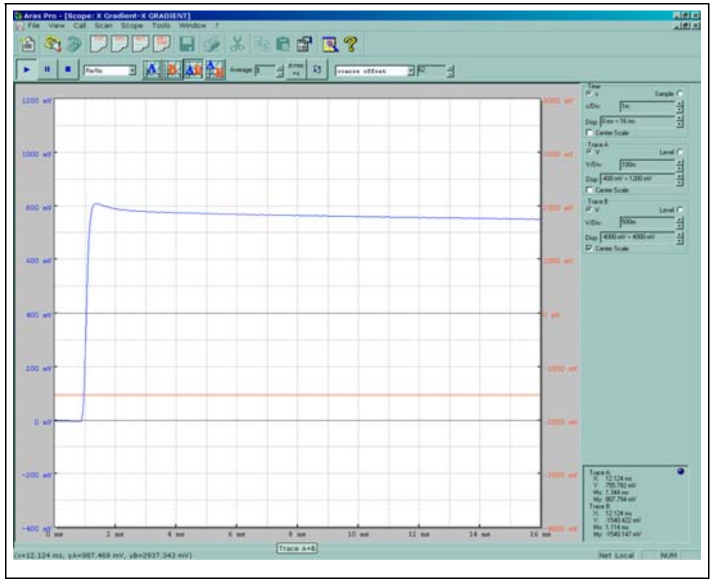
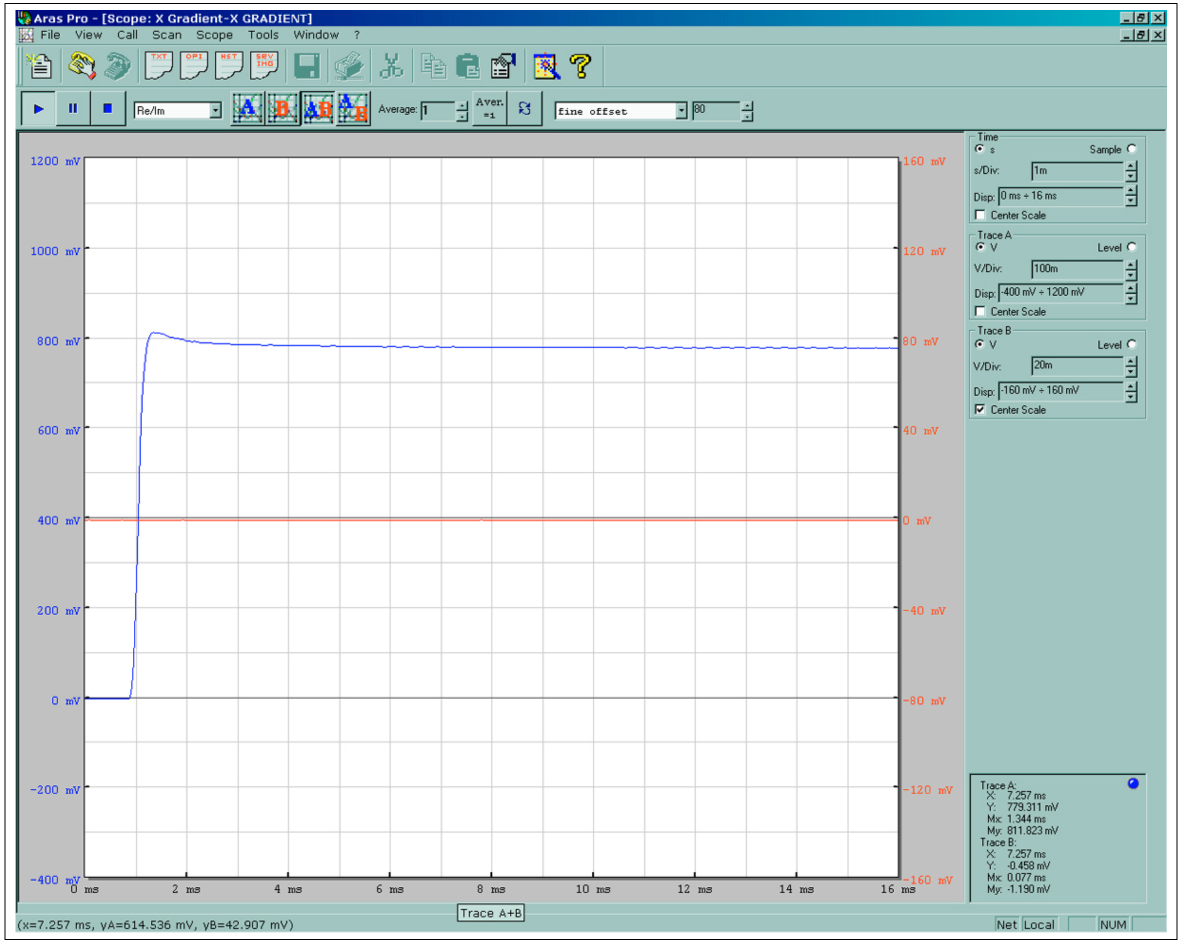


Fig. 76: Correct AINT offset



The AINT offset must be set to zero along the entire calibration.

If the offset is not to zero, the gradient waveform is not correctly visualized and seems that its linearity is not perfectly flat.

In this example, the rise time is a bit too fast and it generates an overshoot on the gradient waveform: it will be compensated, before the measurements, decreasing the trimmer 1 and increasing the trimmers 2 and 3.

- To check the gradient linearity, change the TIME visualization scale till to visualize the entire waveform. In the previous figure the TIME scale is set to 1 msec, in the next figures is set to 2 msec and 10 msec

Fig. 77: TIME scale set to 2 msec

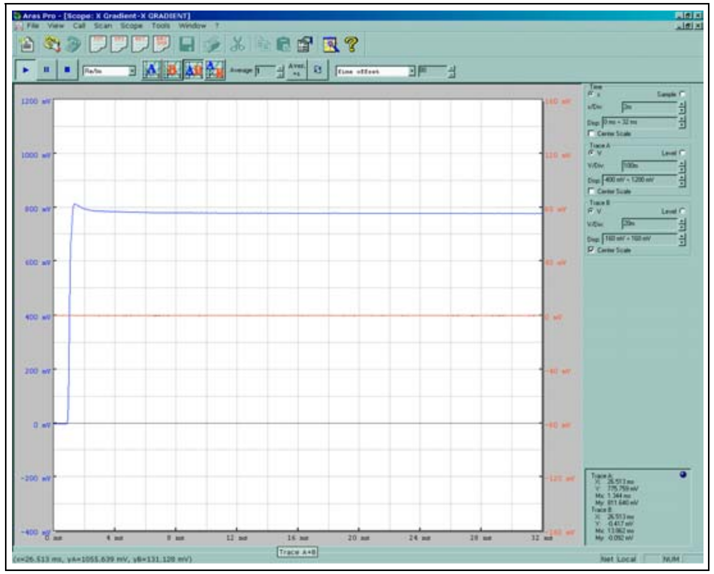
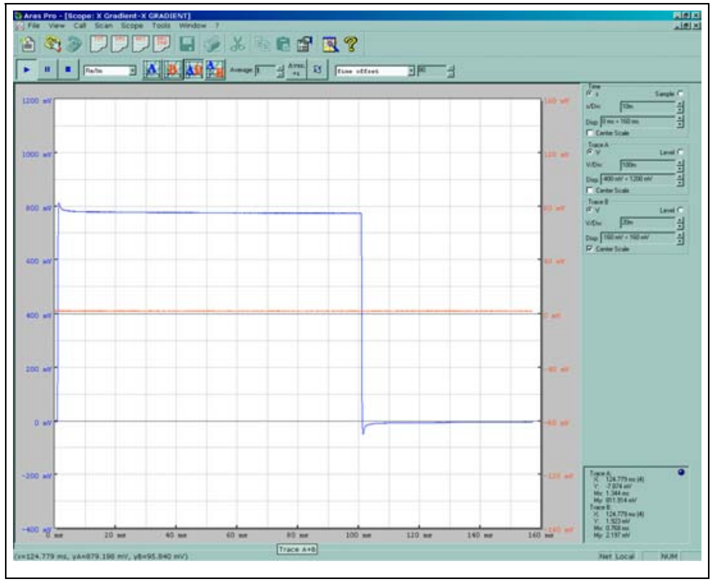
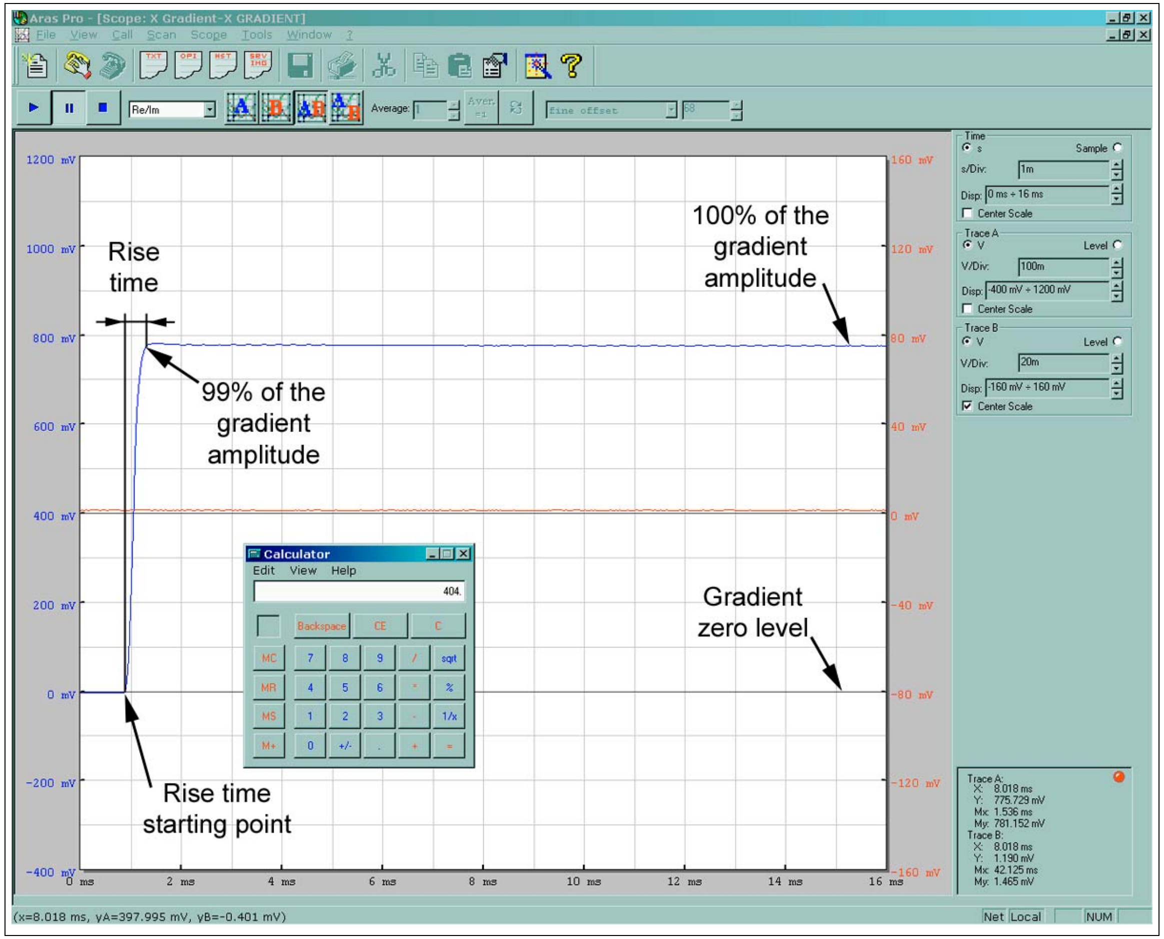


Fig. 78: TIME scale set to 10 msec



- Put the Diascope on pause
- Check the gradient waveform measuring the rise time and the gradient linearity. For the rise time, you must use the mouse arrow and measure when the signal moves up and when the gradient is in the final condition. Calculate 99% of the value obtained and put the second marker on the result value. It corresponds to the raise time and must be < 500 µs
- The next figure is an real example of gradient waveform

Fig. 79: Rise time measurement



The most important parameter of the gradient waveforms is the rise time. It is the time that the gradient takes to reach the 99% of its maximum amplitude value.

To measure it, put the test on pause, move the cursor on the waveform and read the measured values in the small panel on the right bottom corner.

Use the WINWOS calculator to compute the values (START, Programs, Accessories and Calculator).

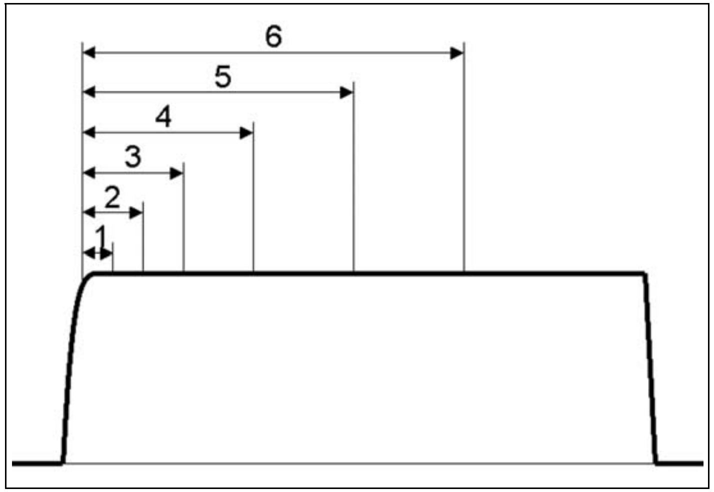
In this example the TIME scale is set to 1 msec.

- If this condition is not satisfied adjust it using the T1, T2 and T3 trimmers looking for the better compromise between the rise time and the gradient linearity. To have an idea how the trimmers work see the next figure

NOTICE	If any gradient adjustment is necessary remove the pause function

NOTICE	The higher trimmer acts also on the previous portion of the gradient waveform

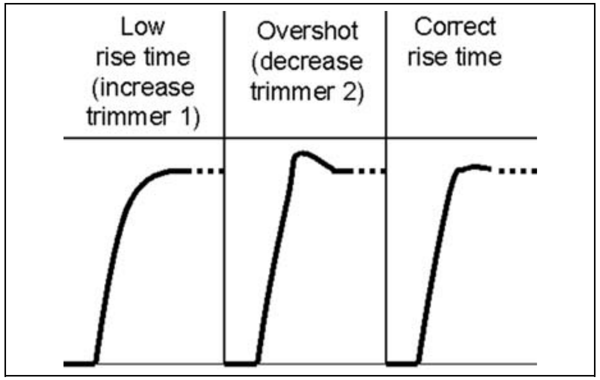
Fig. 80: Trimmers working area



- In the next figure it's possible to see the most common cases of incorrect gradient wave form:
  - Low rise time: rotate the T1 clock wise
  - Overshoot: rise time too fast, decrease the T2 (counter clock wise)
  - Correct rise time: good compromise between overshoot and rise time

NOTICE	Gradient rise time: 99% < 500 µs. Don't set the rise time under 400 µs: very fast rise time don't increase the image quality

Fig. 81: Example of rise time correction



- Repeat the same procedure for the Y and Z gradient moving the pick up coil to the correct position and selecting <**Y gradient**> and <**Z gradient**> from the <**Hardware**> menu

Gain gradient calibration (Geometrical distortion test)

Introduction

In order to check the image quality from the point of view of dimensional accuracy; use the pins fitted for this purpose in the geometrical phantom.

The distance between the pins of the various squares, as recorded in the calibration protocol, may be measured with the <**Distance**> tool in the OPI toolbar (**Slash** icon), zooming in the images if necessary, in order to reduce any measurement errors.

When moving the phantom, it is recommended that the scout be repeated so as to ensure its exact position.

If errors exceeding the maximum permitted value occur, it is also necessary to check that there are no shimming problems, perhaps due to any ferrous objects placed inadvertently in the gantry.

Necessary Tools

- Geometrical Phantom and its supports
- L-key 4 mm
- Screwdriver, small and big standard tip
- Screwdriver, medium Philips tip

Operations

- Position the Knee Coil 2 with the geometrical phantom placed in an axial position, using the suitable support
- Perform one scout to check the phantom position and calibrate the system to the phantom load
- Click on the OPI <**Protocol list**>, on <**Geometrical Distortion Measurements**> and then select the sequence <**GRY Gain transverse**>
- Display the reconstructed image in format 1. Zoom in the image if necessary
- Select <**Distance**> icon and measure from the left pin to the right pin (horizontally from edge to edge) between the pins at 60 mm
- If the measurement has an error exceeding 1% of the ideal value, calibrate the gain of the Y gradient rotating the Y trimmer 7 (one turn = 0.4 mm)

NOTICE	The reference values for the pins at 60mm are: 59.4 mm ÷ 60.6 mm

Fig. 82: Acquired image displayed in 1 format

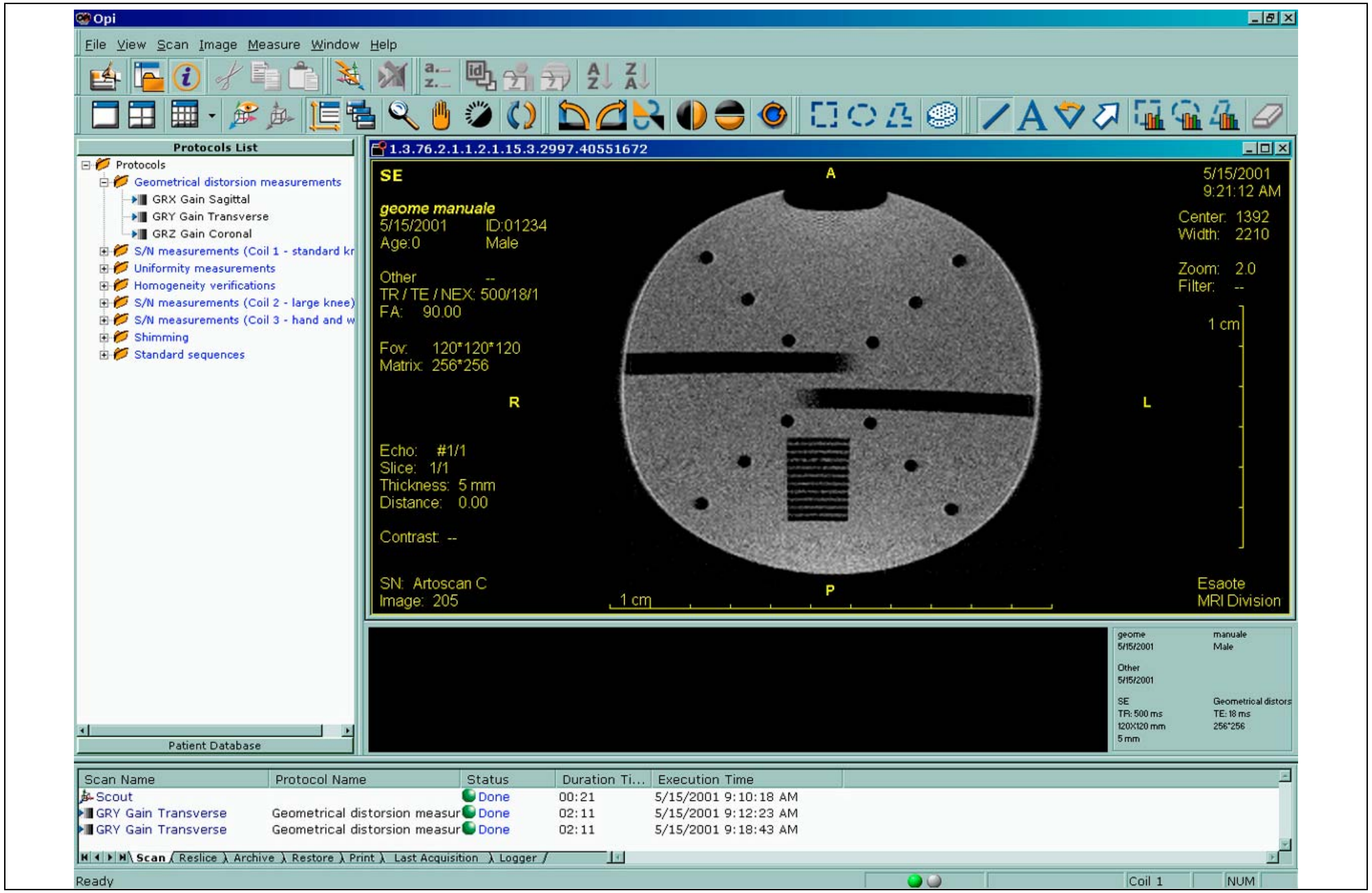
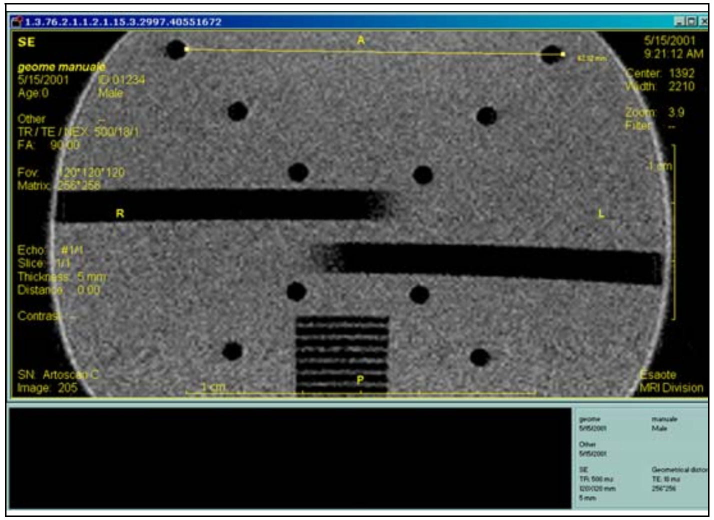


Fig. 83: Zoom the image to reduce the measurement errors



- Position the Knee Coil 2 with the geometrical phantom placed in an sagittal position, using the suitable support and perform a Scout
- Click on the OPI <**Protocol list**>, on <**Geometrical Distortion Measurements**> and then select the sequence <**GRX Gain transverse**>
- Display the reconstructed image in format 1. Zoom in the image if necessary
- Select <**Distance**> icon and measure from the left pin to the right pin (horizontally from edge to edge) between the pins at 60 mm
- If the measurement has an error exceeding 1% of the ideal value, calibrate the gain of the X gradient rotating the X trimmer 7 (one turn = 0.4 mm)

NOTICE	The reference values for the pins at 60mm are: 59.4 mm ÷ 60.6 mm

- Position the Knee Coil 2 with the geometrical phantom placed in an coronal position, using the suitable support and perform a Scout
- Click on the OPI <**Protocol list**>, on <**Geometrical Distortion Measurements**> and then select the sequence <**GRZ Gain transverse**>
- Display the reconstructed image in format 1. Zoom in the image if necessary
- Select <**Distance**> icon and measure from the upper pin to the lower pin (vertically from edge to edge) between the pins 60 mm
- If the measurement has an error exceeding 1% of the ideal value, calibrate the gain of the Z gradient rotating the Z trimmer 7 (one turn = 0.4 mm)

NOTICE	The reference values for the pins at 60mm are: 59.4 mm ÷ 60.6 mm

NOTICE	In the event of gain adjustment repeat the Homogeneity and gradient offsets check

Test and adjustment table

MODULE	TEST	ADJUSTMENT
Gantry	Select <**Test**> <**Hardware**> <**System check**> and see if the output signals from the GRA (gradients) are present.	Check the gradient rise time and the geometrical distortion test for every channel, then calibrate the system (homogeneity, sequences, etc)
GRA	Select <**Test**> <**Hardware**> <**System check**> and see if the output signals from the GRA (gradients) are present.	Check the gradient rise time and the geometrical distortion test for every channel , then calibrate the system (homogeneity, sequences, etc)

Part 10 Magnet

Trouble Shooting Strategy

You will find test strategies, procedures and repair instructions encompassing the complete Magnet System in this section.

For more information refer to the Functional Description manual Magnet chapter.

⚠ WARNING	**Make sure you use only non-ferromagnetic tools near the magnet. Do not place any other ferromagnetic objects near the magnet (e.g. the metal support for the transportation of the magnet).** **Be careful that screws, etc. or other foreign metallic bodies do not fall into the equipment, because they could cause a short circuit.** **Be careful with the cables coming from the unit: they should be positioned so that they do not represent an obstacle otherwise they could break, causing damage to the unit and could be hazardous for both the patient and operator.**

Procedure

Thermal Control Check

The magnet must always be at the correct temperature, to achieve this result two dedicated modules have been fitted to the system.

The first one is the CTERM module that provides for the magnet to keep the desired temperature. It is installed on the electronic unit, between the RFR and the SINT modules and connected to the magnet through the NTC board.

The CTERM, through CTERM2 connector is connected to ACQ module, it sends the reference signal, concerns the power output and temperature errors on the four sides of the magnet.

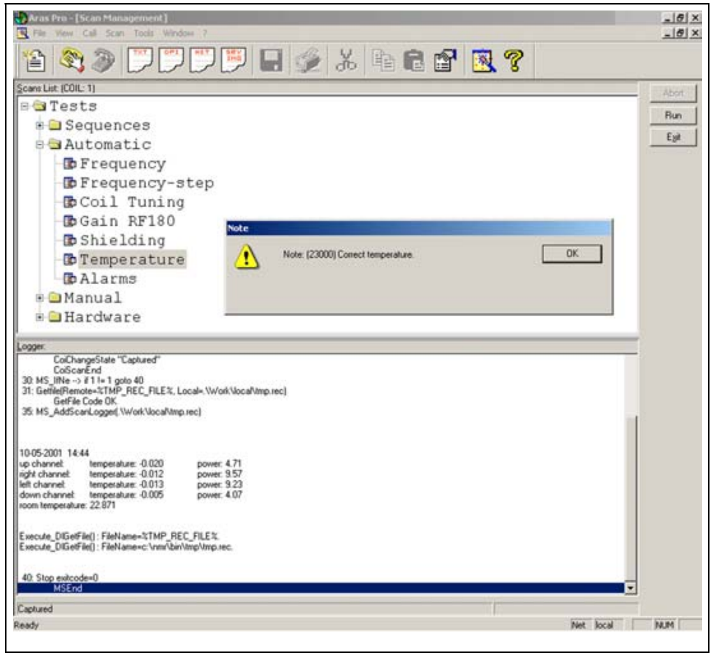
CTERM can disable SGRA by sending on the GROFF cable, connected between the CTERM1 connector and the ENABLE of GRA. Its function is to protect the gantry: if the temperature on at least one side of the magnet is higher than 0.5° C compared with the normal magnet operating temperature or if the magnet temperature is too low, it switches the heaters and SGRA off.

The second is NTC board that is installed on the magnet basement, right beyond the magnet connection panel, **F** connector. Resistors are fitted to the board and their values are calculated by taking note of the value of the thermal sensors in the magnet. This means that every magnet has its own NTC board.

To check if the magnet is at the correct temperature, perform the automatic temperature test present in the ARAS program under <**Test**> <**Automatic**> <**Temperature**>.

This test will give some information shown in the following figure.

Fig. 84: Automatic temperature test



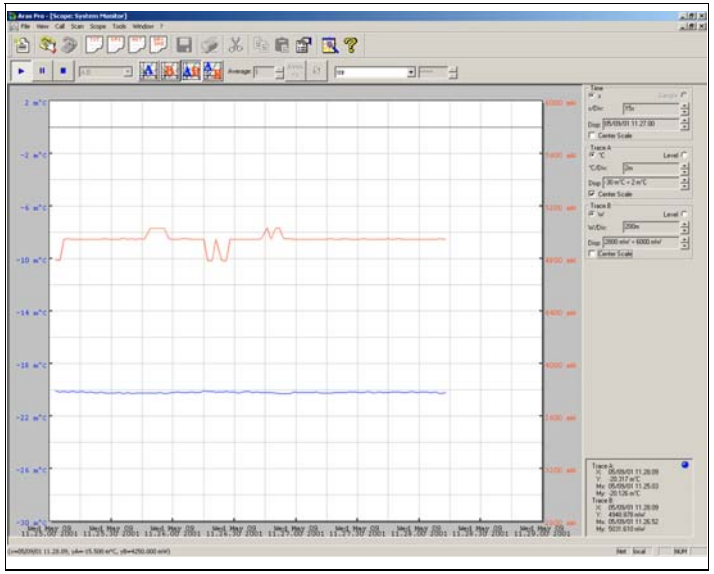
If you want to visualize the temperature in real time, to evaluate any kind of temperature instability, another test is available. This test is called **System monitor** and is under <**Test**> <**Hardware**>. This test allows you to follow the magnet temperature and power in real time for every channel.

Each channel displays the power output to the heaters (gray track) and the temperature error detected by the two sensors (white track) located on the side being monitored.

No value may be changed since the thermal subsystem is independent from the personal computer (it also works when the computer is off).

If the behavior is correct, we should be able to see straight lines that either do not change in time or change very slowly. The System monitor test visualizes a flat line if the temperature error is higher then 0.7°C (depending of the CTERM offset) with respect to the ideal value. As for the numerical values, the temperature error must have an absolute value smaller than a few m °C and the power output to the heaters, always positive, must be lower than 20 Watts for every channel.

Fig. 85 System Monitor Test:



Sensors and Heaters Check

It is possible to measure the resistance values of the Sensors and Heaters present into the magnet, doing that you can understand if one channel is correct or if is a open or shirt circuit.

Disconnect the **CTEMA** cable from the CTERM module connector, and measure the resistance between pins of the cable connector against the specification written in the following table.

Tab. 9: Heaters and sensors values

PIN	PIN	TYPE	MINIMUM VALUE	MAXIMUM VALUE
1	5	Heater up	90Ω	110Ω
2	5	Heater right	90Ω	110Ω
3	5	Heater down	90Ω	110Ω
4	5	Heater left	90Ω	110Ω
10	22	Sensor up	19KΩ	27KΩ
11	22	Sensor right	18KΩ	24KΩ
12	22	Sensor down	19KΩ	27KΩ
13	22	Sensor left	18KΩ	24KΩ

Consider the reference values for the sensors above reported are indicative when the magnet is cold. To do a data evaluation when the magnet is warm, it is necessary to know that the value of sensors at 36° C is 13.8 KΩ and that a variation of about 500Ohms corresponds to 1° C, opposite in sign with respect to temperature.

Fig. 86: Magnet Heater positions

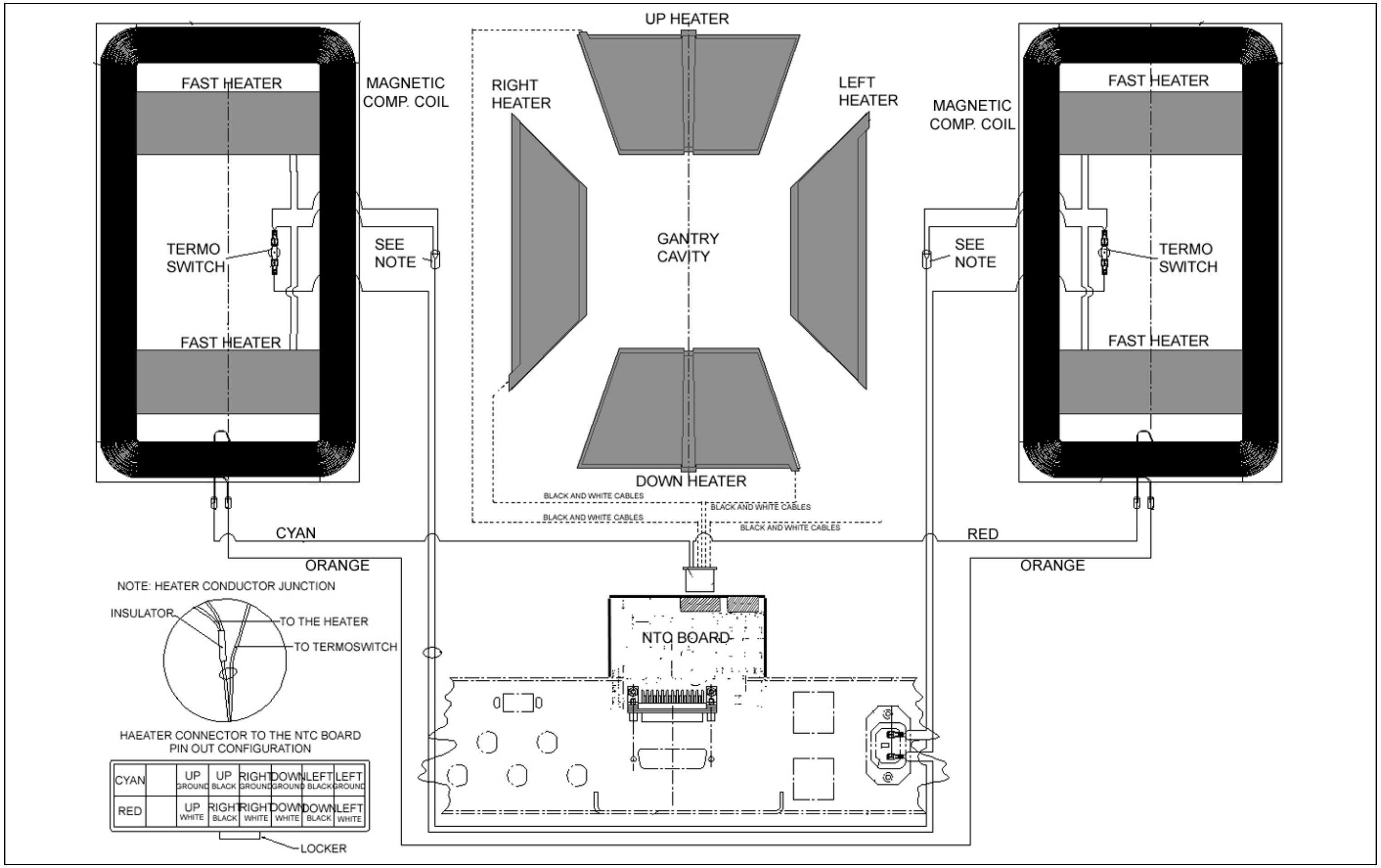
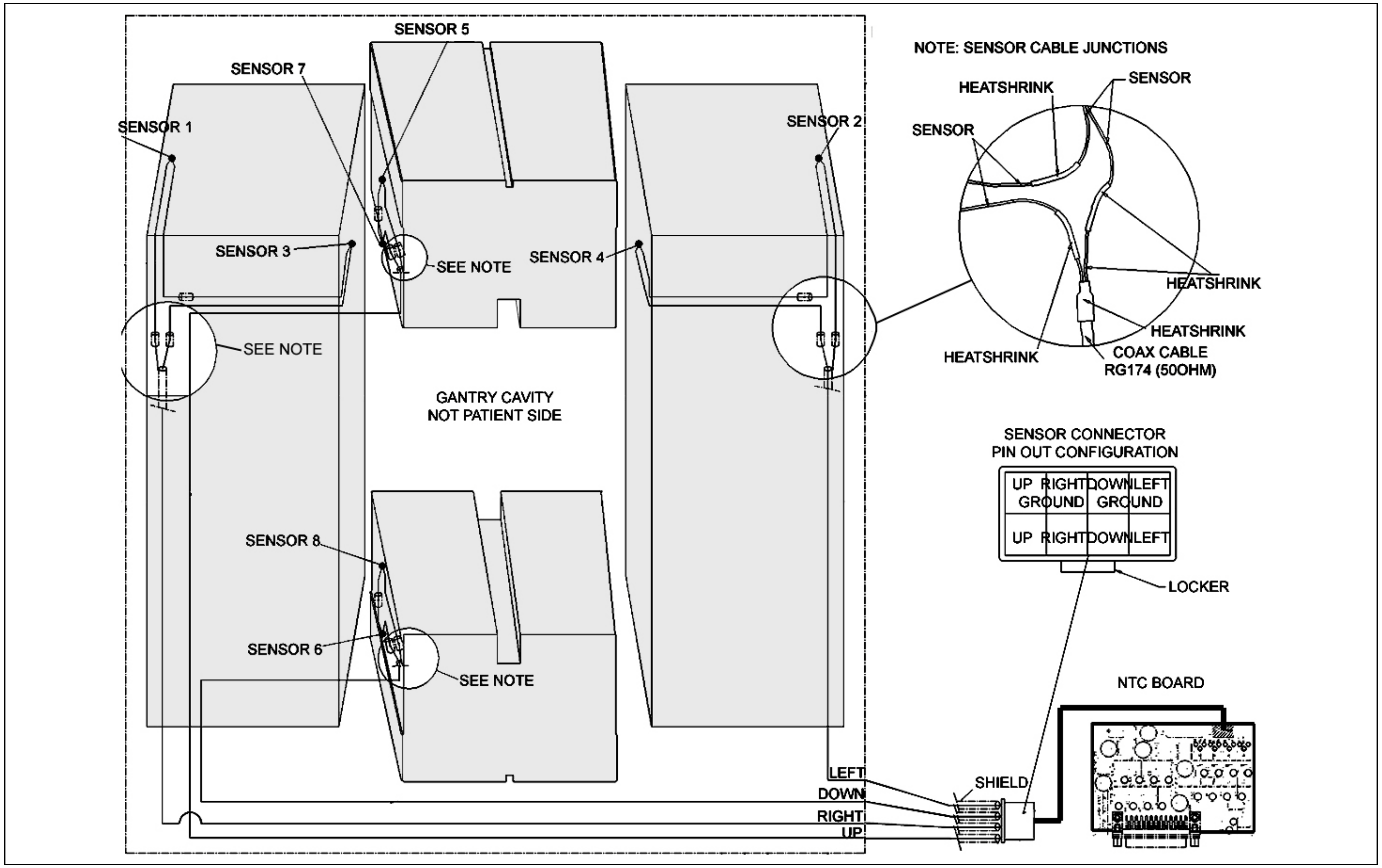
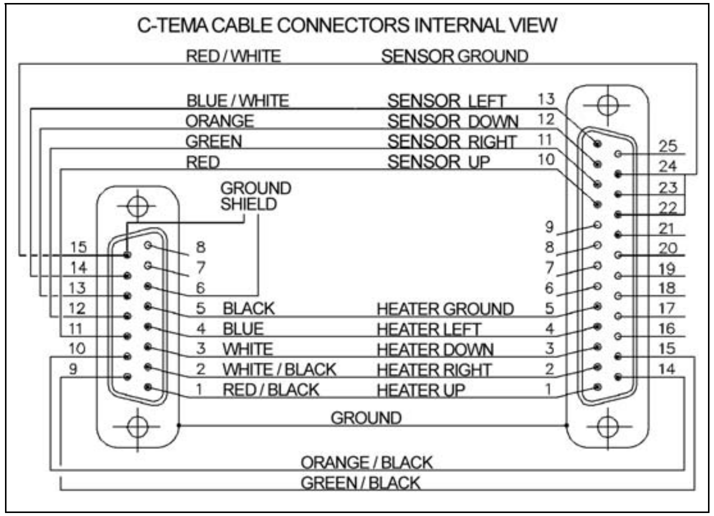


Fig. 87: Magnet Sensor positions



To check the CTEMA cable, use the following figure.

Fig. 88: CTEMA Cable pin out



Operations

- From the ARAS program, select <**Test**> <**Hardware**> and <**System Monitor**> then <**Run**>
- Use the arrow to set the logical channels 0, 1, 2, 3 to display the parameters on the four sides of the magnet,
- Click on the <**Channel A**> icon to display only the temperature error or on the <**Channel B**> icon to display the power output to the heaters, or on the <**Dual**> button to display them together
- Press <**Scale Div**.> to set the correct value of the scale on the Y axis (for example: 1m°C for the temperature error and 15 Watt for the power output to the heaters)
- Then, with the mouse cursor, click on the signal trace to obtain some information about it in the information window

Environment temperature control

The <**System Monitor**> environment makes it possible to also display external temperature.

As a matter of fact, a particular probe is placed outside the system to check the external temperature, so that you can understand if something has changed in the external conditions. To check this parameter, you must enter <**System monitor**> and set the logical channel 4.

⚠ **WARNING**	**Before performing this test check if the correct CTERM offset values are inserted under <SERVICE> <TOOLS> <SYS PARAMETERS>**

The correct temperature value can be monitored, but you must probably change the scale on the Y-axis with the <**Scale Div**.> Button in °C and the <**Displacement**> button to improve the signal display.

At this point, you can find out the exact external temperature value by clicking with the mouse on the signal trace.

Operations:

- Enter the service software ARAS and select <**Test**> <**Hardware**> and <**System Monitor**> button
- Use the arrow to set the logical channel 4 to display the external temperature. Press <**Scale Div.**> to set the correct value for the scale on the Y-axis (usually 1°C or 5°C)
- Then, with the mouse cursor, click on the signal trace to obtain some information about it in the information window

Shimming Check

Good homogeneity of the static field of the magnet is a necessary condition if you want to obtain good quality images. The shimming procedure carried out in the factory guarantees that magnetic field homogeneity is within specification when the magnet comes out from the factory.

However, due to several factors (transportation, storage etc.), the magnetic field may change, and the service operator might find that, on site, the homogeneity is not within specification anymore: this is due to the fact that some field coefficients (notably the second order coefficients) have increased.

The aim of this procedure is to detect and (if necessary) correct on site the second order coefficients of the magnetic field.

The flow chart (shown below) illustrates the logical sequence of the steps to be performed to check and, whenever necessary, to correct the static magnetic field and, in particular, the above-mentioned parameters.

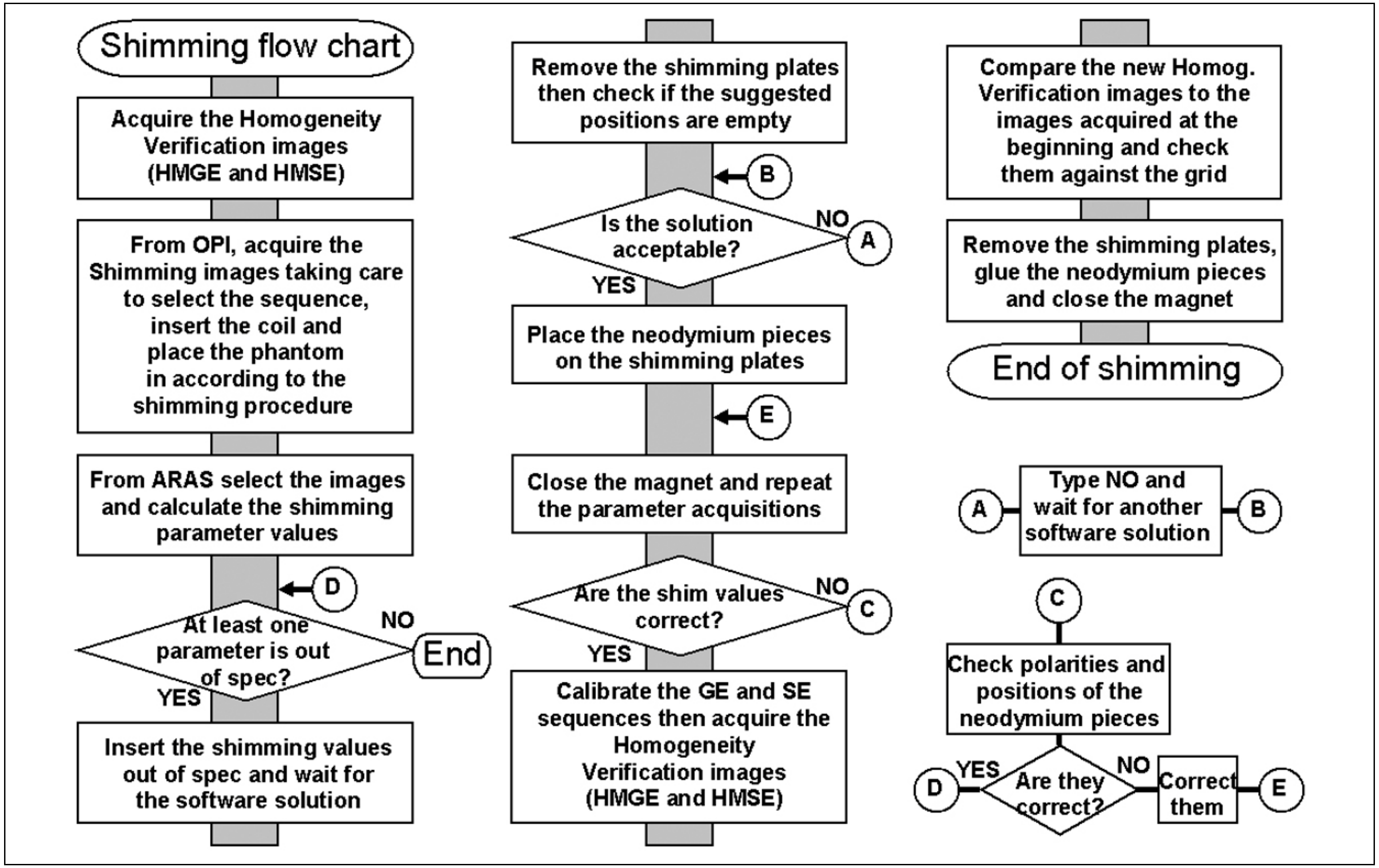
The chronological order of these steps is very important, because the various parameters affect each other, so that correcting one of them might cause the undesired change of the other magnetic field parameters. Therefore, it is recommended to perform all the required steps and, in particular, the correction procedure, with the utmost care.

NOTICE	Open the magnet, remove the shimming plates, leave them outside for 5 minutes then insert them back before to perform this procedure

Necessary tools

- Shimming Kit
- Allen key 4 mm
- Screwdrivers flat and Philips
- Geometrical Phantom and its support
- Coils 1, 2 and 3

Fig. 89: Shimming Flowchart



Shimming Parameter Acquisitions

2.0 Cos

- Place the vial in coil 3 (upper limbs) along the magnet's axis using its suitable support and make sure the partition is in vertical position

Fig. 90: Correct vial position

- From OPI, perform a Scout scan and set the anatomical area as "other", then check its position
- Click on <**Protocol list**> then select the <**Shimming Test 2.0 Cos**> sequence

2.1 Cos

- Place the geometrical phantom on the suitable support in the Knee coil 1 in Coronal position
- From OPI, perform a Scout scan and set the anatomical area as "other", then check its position
- Click on <**Protocol list**> then select the <**Shimming Test 2.1 Cos**> sequence

2.2 Sin

- Place the geometrical phantom in the Knee coil 1 in Axial position, using its suitable support
- From OPI, perform a Scout scan and set the anatomical area as "other", then check its position
- Click on <**Protocol list**> then select the <**Shimming Test 2.2 Sin**> sequence

2.2 Cos

- Place the vial in Large Knee coil 2, by using its special support, in vertical position and make sure the partition is in horizontal direction

Fig. 91: Correct vial position

- Perform a <**Scout**> and set the anatomical area as “knee”, then check its position
- From OPI, perform a Scout scan and set the anatomical area as “other“, then check its position
- Click on <**Protocol list**> then select the <**Shimming Test 2.2 Cos**> sequence

Shimming Parameter Calculations

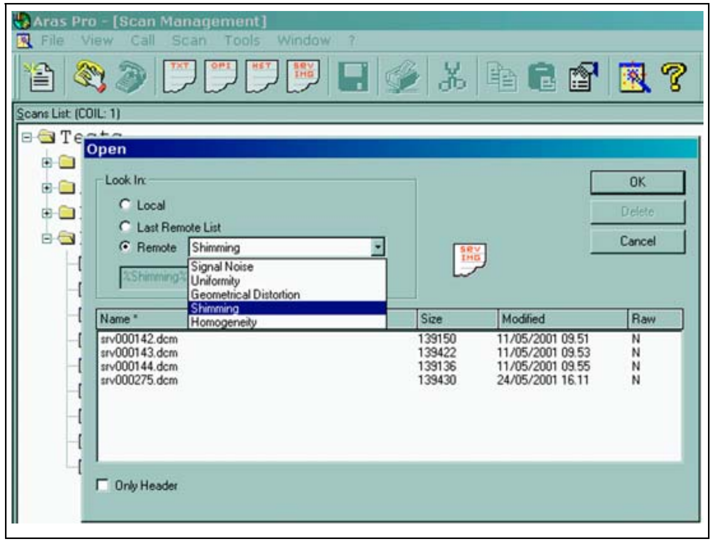
Image Selection

- To load the correct image from ARAS, select the <**Open Service Img File**> icon (as shown)

Fig. 92: Open the service image files

- Select the **Remote** option then **Shimming** from the shown list and the system will show you only the shimming images
- Select the image corresponding to the shimming parameter has to be calculated

Fig. 93: Select the shimming images

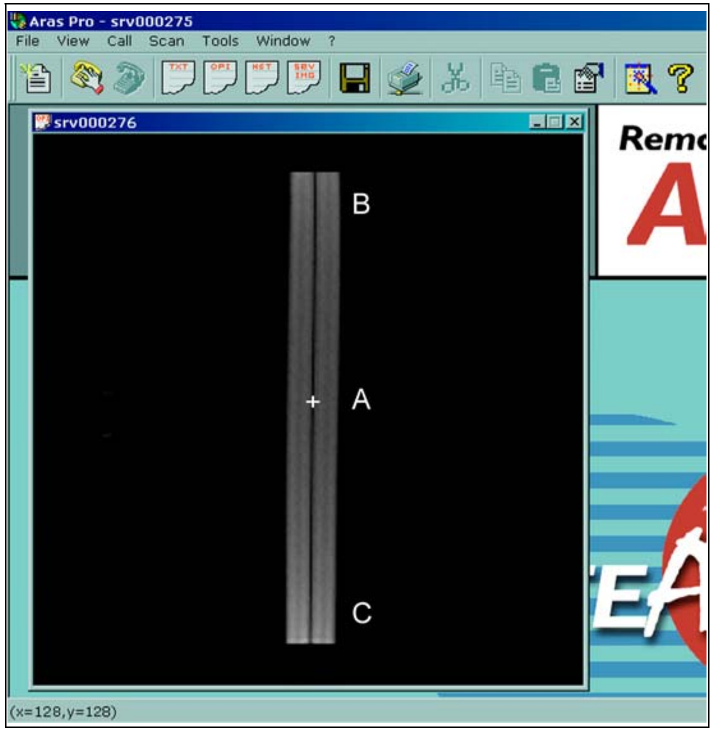


2.0 Cos

- Identify the co-ordinates of three points on the vial's partition, one at the center and two at a distance of 70 pixels vertically (A, B and C). To do that, move the mouse prompt on the image and on system will show the coordinates on the left bottom corner or type the right mouse button when the mouse prompt is on the selected images and the drop down menu will appear then select the Distance option:
  - **A** is at the center of the partition and its co-ordinates are **(A,128)**
  - **B** is above, at a distance of 70 pixels vertically and a few pixels offset horizontally, depending on the in-homogeneity. Its co-ordinates are **(B,58)**
  - **C**, opposite to **B**, is below. Its co-ordinates are **(C ,198)**
- Calculate: **E=[(B –A)+(C – A)] / 2**
- Calculate: **ppm (20cos)= 113.63 x E / F0 / 4**

NOTICE	F0 is the central frequency of the magnet in MHz

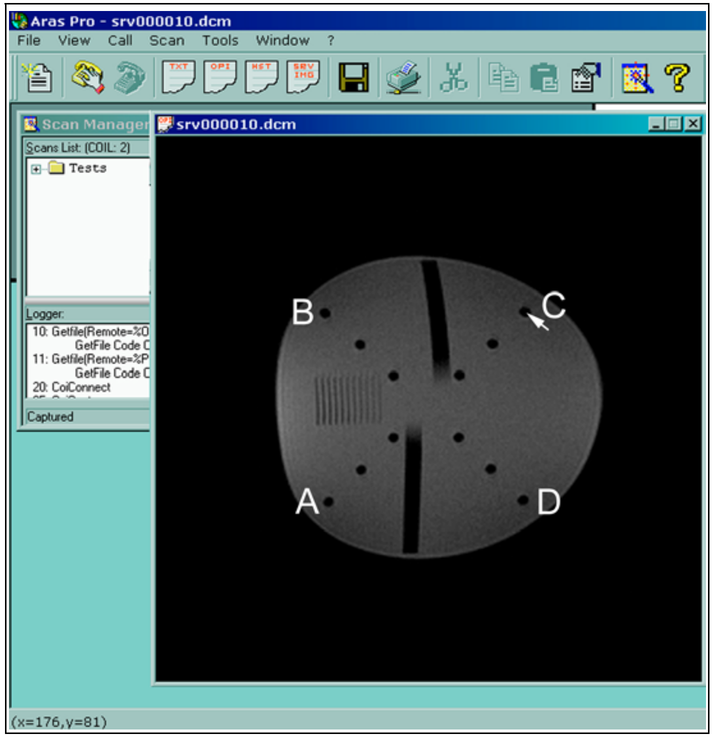
Fig. 94: 2.0 Cos calculation



2.1 Cos

- Load the correct image from ARAS

Fig. 95: 2.1 Cos Calculation



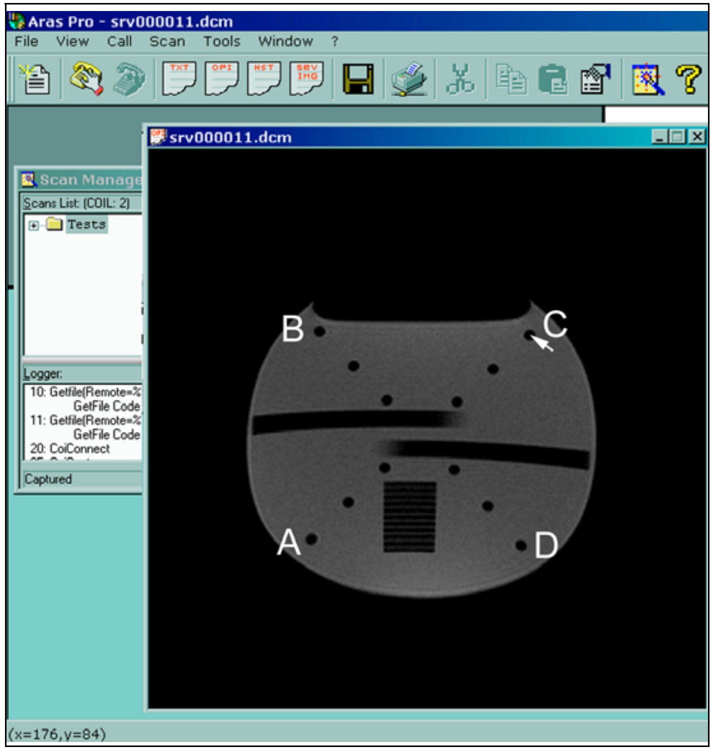
- Identify the co-ordinates of the four points corresponding to the pins of the geometrical phantom located at a distance of 48 pixels from the center, (C, B, A and D in figure). To do that, move the mouse prompt on the image and on system will show the co-ordinates on the left bottom corner:
  - **C** is the top right pin. Its co-ordinates are **(176, C)** where **C** must be measured by putting the mouse cursor exactly at the center of the black pin
  - **B** is the top left pin. Its co-ordinates are **(80, B)** where **B** must be measured by putting the mouse cursor exactly at the center of the black pin
  - **A**, opposite to **B**, is below. Its co-ordinates are **(80, A)** and **A** must be measured by putting the mouse cursor exactly at the center of the black pin
  - **D**, opposite to **C**, is below. It co-ordinates **(176, D)** and **D** must be measured by putting the mouse cursor exactly at the center of the black pin
- Calculate: **E=[(A – B) + (C – D)] / 8**
- Calculate: **ppm (21cos)= 212.68 x E / F0**

NOTICE	F0 is the central frequency of the magnet in MHz

2.2 Sin

- Load the correct image from ARAS

Fig. 96: 2.2 Sin Calculation



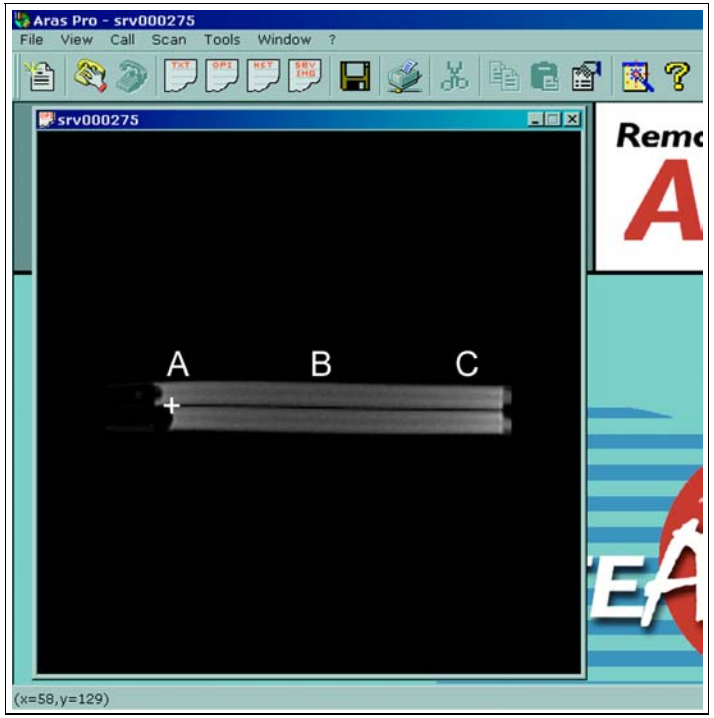
- Identify the co-ordinates of four points corresponding to the pins of the geometrical phantom located at a distance of 48 pixels from the center (A, B, C and D in figure). To do that, move the mouse prompt on the image and on system will show the coordinates on the left bottom corner:
  - **A** is in the bottom left part. Its co-ordinates are **(80, A)** and **A** must be measured by putting the mouse cursor exactly at the center of the black pin
  - **B** is the top left pin. Its co-ordinates are **(80, B)** where **B** must be measured by putting the mouse cursor exactly at the center of the black pin
  - **C** is the top right pin. Its co-ordinates are **(176, C)** where **C** must be measured by putting the mouse cursor exactly at the center of the black pin
  - **D** is in the bottom right part. Its co-ordinates **(176, D)** and **D** must be measured by putting the mouse cursor exactly at the center of the black pin
- Calculate: **E=[(C – B) – (D – A)] / 8**
- Calculate: **ppm (21sin)= 159.51 x E / F0**

NOTICE	F0 is the central frequency of the magnet in MHz

2.2 Cos

- Load the correct image from ARAS

Fig. 97: 2.2 Cos calculation



- Identify the co-ordinates of three points on the vial's partition, one at the center and two at a distance of 70 pixels horizontally.

To do that, move the mouse prompt on the image and on system will show the coordinates on the left bottom corner:

- **B** is at the center of the partition. Its co-ordinates are **(128, B)**
- **A** is at the left side of the screen, at a distance of 70 pixels horizontally and a few pixels offset vertically, depending on the in-homogeneity. Its co-ordinates are **(58, A)**
- **C**, opposite to **B**, is at the right side. Its co-ordinates are **(198, C)**

- Calculate: **D = [(A – B) + (C – B)] / 2**
- Calculate: **ppm (22cos)= 75.01 x D / F0 – ppm (20cos)**

NOTICE	F0 is the central frequency of the magnet in MHz

Access to the shimming plates

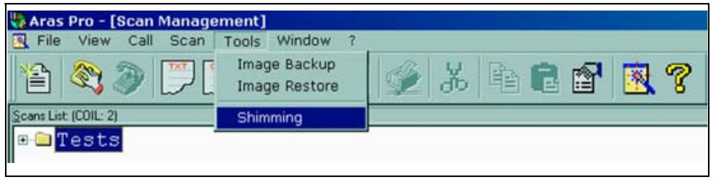
WARNING **The GRA must be disabled while disconnecting the gradient cables**

- Disable the GRA disconnecting the power cable (rear side)
- Remove the magnet covers Leg Lock Motion Device (LLMD) side
- Remove the LLMD taking out the for bolts placed under it
- Take out all the screws from the Gantry edges (operator and patient side)
- Remove the metallic cover operator side taking out all the screws
- Disconnect all the gantry cables
- Place one hand inside the Gantry and slide it out
- Remove the shimming plates (left and right):
  - Slide one hand between the shimming plate and the iron pole till to reach the other side shimming plate edge
  - Move the shimming plate to the magnet center then slide it out
  - Repeat this procedure to the other shimming plate
- Insert again the Gantry and place the metallic cover to avoid thermal instability

Shimming parameters correction

- From ARAS, select the <**Tools**> menu and the <**Shimming**> button

Fig. 98: Shimming Menu

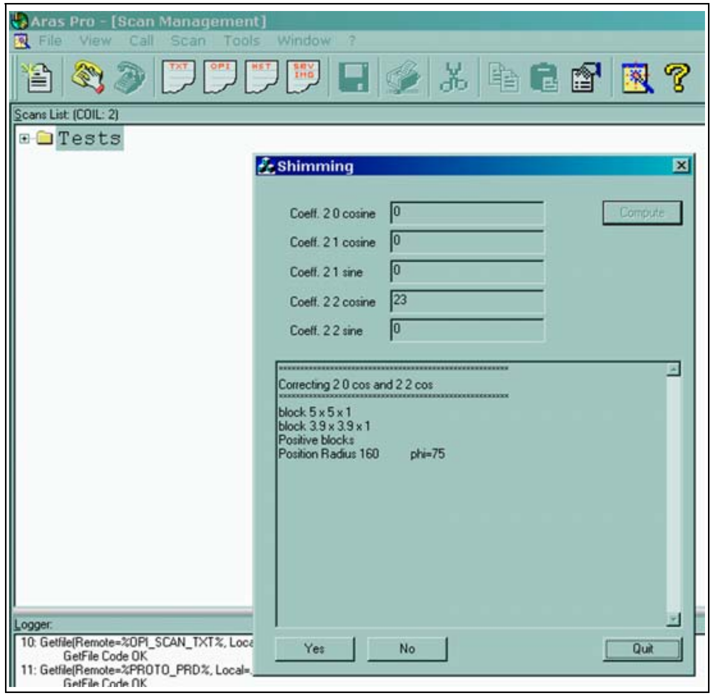


- Insert zero for the correct parameters (also if their value is not zero) and the real value of the parameter/s must be corrected (like shown in the next figure)
- Check if the inserted parameters are correct, then click on the <**Compute**> button and the system will show a possible solution

NOTICE The specification range is ppm = ± 10. Only one parameter can be ppm = ± 15

NOTICE In the position for 2.1 sin coefficient you must insert value zero because we don't measure it

Fig. 99: Parameter insertions



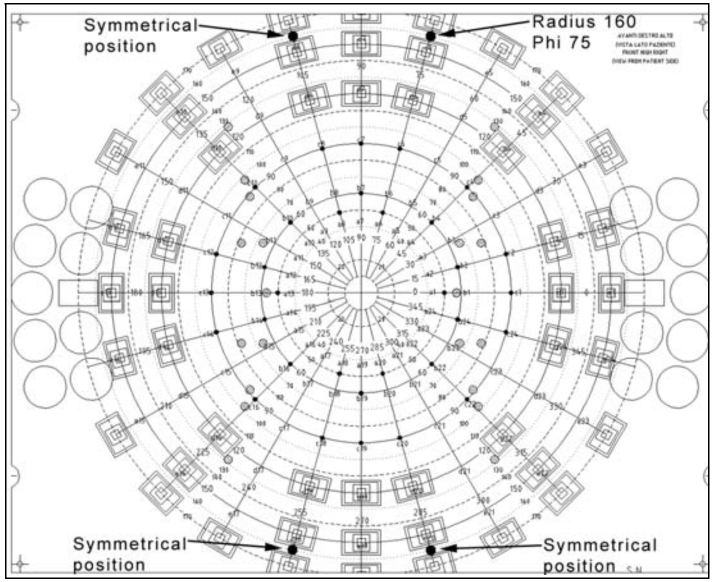
Example:

Real values are	Inserted values will be
2.0 cosine = 8 (in specification)	2.0 cosine=**0**
2.1 cosine = -7 (in specification)	2.1 cosine = **0**
2.1 sine = 0 (as default)	2.1 sine = **0** (as default)
2.2 cosine = 23 (out of specification)	2.2 cosine = **23** (out of specification)
2.2 sine = -5 (in specification)	2.2 sine =**0**

- Check if the suggested positions are empty and only in this case accept the solution clicking on the <**Yes**> button. If there are not empty click on the <**No**> button and the system will provide you another solution. The solution is compound by:
  - **First line:** parameter/s need to be adjusted
  - **Second line (on if the blocks are more than one):** block dimension of neodymium necessary to compensate the above in-homogeneity parameter/s
  - **Third line:** polarity of the blocks (positive or negative)
  - **Fourth line:** the co-ordinates (radius and phi) of the blocks on the shimming plates
- Every position has other three symmetrical positions. Only the positions on the horizontal or vertical shimming plate axis have just one symmetrical position. Remember that all the pieces are glued symmetrically: it's enough to check one position to be sure that also the others are empty. The silver coins glued laterally always have a positive polarity: use them to check the polarity of the neodymium pieces that you have to place and don't forget that positive polarity on the left plate means negative polarity on the right plate

NOTICE You only need to check one position because the neodymium pieces are glued on symmetrical positions

Fig. 100: Shimming plate (the shown positions refer to the written example)



- If you type <**Yes**> the system will show the entire solution: follow it step by step to avoid errors
- Place the neodymium pieces on the shimming plates making sure about their positions, dimensions and polarities comply with the software indications. Regarding polarity, use the lateral neodymium coins as a reference: their polarity is always positive in every magnet. Use double-sided tape and paper tape to fix the pieces, do not use glue for the moment

NOTICE	Positive for the right shimming plate means negative for the left shimming plate and vice versa

Fig. 101: Complete Shimming Solution

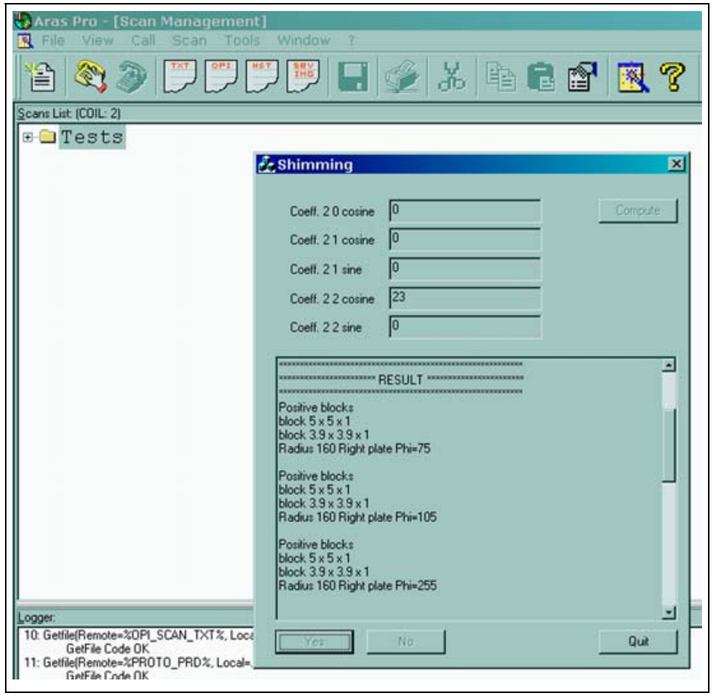
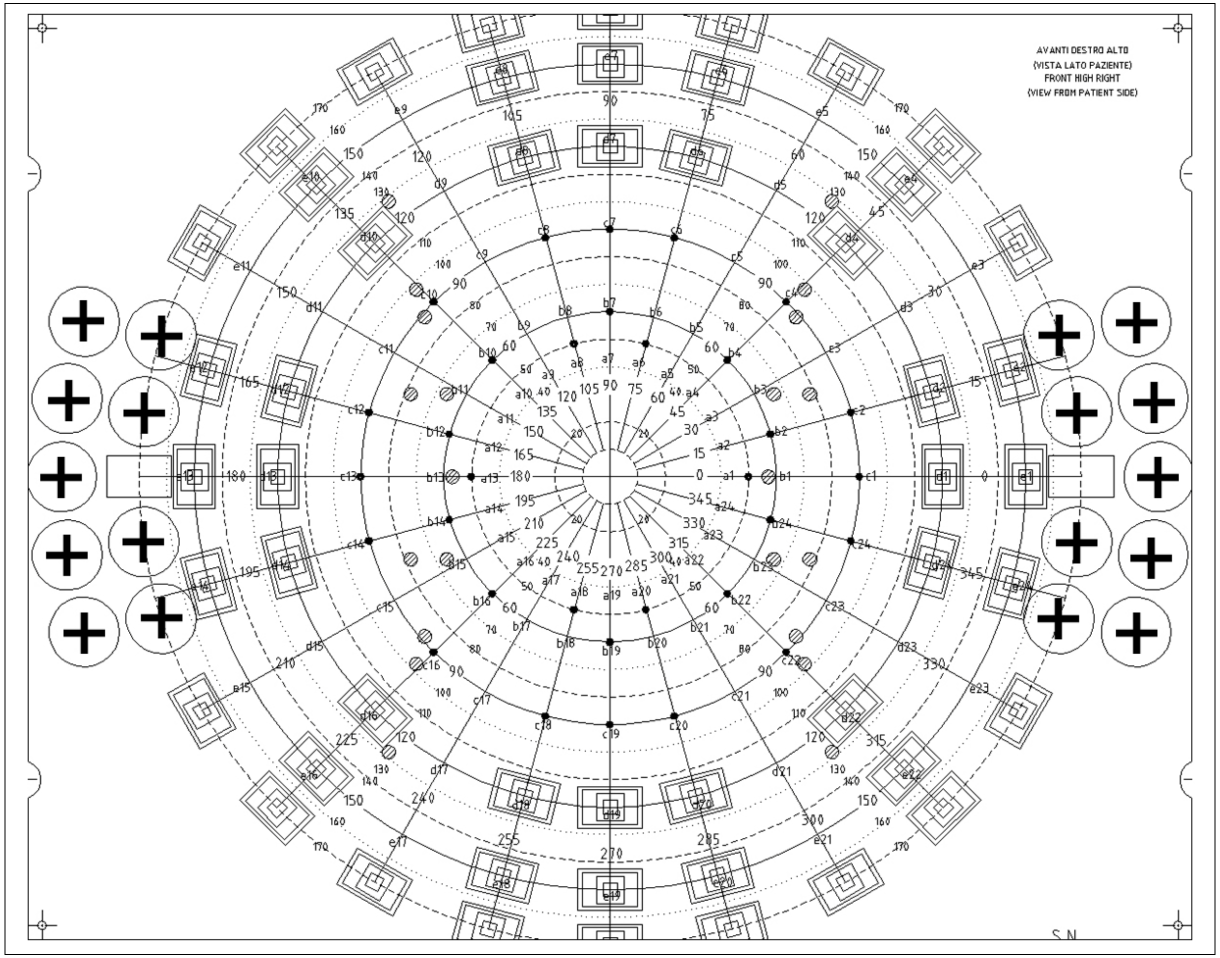


Fig. 102: Shimming Plate Reference Polarity



The silver coins placed laterally on the shimming plate are always positive, but positive is a relative concept related to that shimming plate.

Remember that positive is a relative concept: what is positive on the right shimming plate is negative on the left shimming plate and vice-versa.

Test on the right coins what has to be placed on the right shimming plate and do the same on the left shimming plate.

Stack the neodymium pieces only if the software solution told you that.

- Remove the Gantry and insert the shimming plates: the four pivots present on both the iron poles must fit the four holes present on both the shimming plates. Insert the plates carefully because the attraction between them and the magnet is very strong
- Insert the Gantry and reconnect all the cables then place the metallic cover
- Enable the GRA module re-connecting the ENABLE cable
- Calibrate the Homogeneity test and the SE and GE sequences
- Repeat the shimming parameters procedure from the beginning
  - If the parameters are now correct fix the neodymium pieces with glue using this procedure to have access to the shimming plates
  - If the parameters are not correct remove the shimming plates and check the polarities, dimensions and positions of the shimming pieces placed to correct the wrong parameters. If everything is correct proceed with another correction using this procedure

Test and adjustment table

MODULE	TEST	ADJUSTMENT
CTERM	Check if the new module is working automatically, monitoring the power inside <**Test**> <**Automatic**> <**Temperature**>. After several hours check the temperature in the same way. Or check the power and the temperature inside <**Test**> <**Hardware**> <**System Monitor**>	Read on the CTERM label the new offsets and insert them into the Internet Explorer. Repeat all the tests as during the installation.
MAGNET SHIMMING	Perform the **Homogeneity and gradient offset check**	Calibrate the system and fill in the Quality Form

Part 11 Power Distribution

Introduction

In this section you will find the strategies for trouble shooting on the power distribution

Strategy

This chapter describes the test strategy for the Power Distribution

CAUTION	**Voltage continues to be present at the line voltage transformer even after the MR system has been switched off. The line power Distributor must be switched off for service work and the on-site circuit breakers must be set to OFF**

The green Power Light is located on the left side of the console.

If it goes off there is a problem in the main line or the light bulb.

Fig. 103: System Power Led and Power Cable connection

- Check if the feeder circuit breaker is switched off
- Check if the main system fuse is interrupted
- Check if the secondary system fuse is interrupted
- Check if the insulation transformer input and output are correctly set

Repair

Checking the line voltage

- Lock all emergency shutdown buttons
  - Prior to switch-on, several adaptations to the line voltage must be made
- Ask your project manager about the on-site line voltage and perform your own measurement

The on-site line voltage is:	**V AC**

NOTICE	Switch off the on-site power supply and secure it with a lock to prevent anyone from inadvertently switching it on

Adapting transformer to the line voltage

Check if the primary stage of the insulation transformer is correctly set for the main supply voltage of the country where the system is installed. Refer to the figure for transformer settings.

Use the cables supplied for the additional bridge if necessary.

The insulation transformer is inside the Magnet basement, beyond the Magnet Connection Panel as shown in the next figure.

Fig. 104: Insulating system transformer

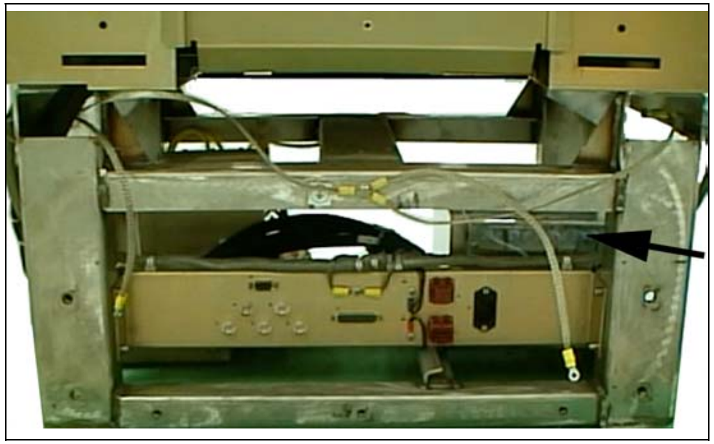
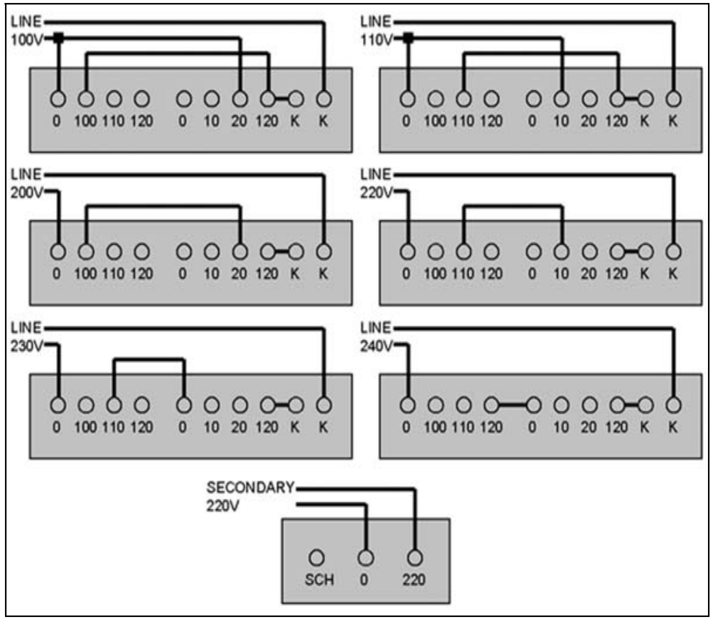


Fig. 105: Possible transformer input voltages



NOTICE The secondary voltage from the console transformer is 220V

Check if the main fuse has the correct value (depending on the country main power supply) and check if it's interrupted:

- Fuse 15A for 100÷110VAC supply voltage, Ch T
- Fuse 6.3A for 220÷240VAC supply voltage, Ch T

The secondary fuse already inserted in the secondary stage of the transformer is:

- Fuse 6.3A for 220 out put voltage, Ch T

Other kinds of fuses are used in the system: the position of some of them is shown in the following figure.

They are accessible without removing or opening the modules. Remove the small cover on the main power plug of these system modules to change their fuse or check that they work. Their values are indicated in the next table.

Other fuses are present in the system modules and their values are indicated in the following table.

Tab. 10: Fuses values and position

Module	**Fuse value**			**Ch**
GRA	6.3 A	10 A	4 A	T
SRFA	3.15 A			T
SINT	0.16 A	2 A	0.8 A	T
SRIB	1 A			T
CTERM	1.6 A	4A		T

These fuses are present in the spare part installation kit.

The equipment must be permanently connected to the mains Power supply: 100/110/220/230/240 VAC ±10%, 50/60 ±10%Hz, 1.3kW (refer to the Site Planning Guide).

NOTICE A TWO POLE SEPARATING SWITCH MUST ALWAYS BE INSTALLED BETWEEN THE MAINS AND THE SYSTEM

Grounding is required. An electric wire with a minimum nominal cross-section of 1.5 mm^2 must be used to ground the equipment (according to EN 60601-1).

If the mains is equipped with a feeder circuit breaker, the system must be connected to a standard two-pole separating switch.

If the mains is not equipped with a feeder circuit breaker, the system must be connected to a 16 A feeder circuit breaker.

These switches must have been approved according to the international and/or national and/or federal and/or local regulations in force and they must be installed in a wall-mounted sheltered box near the unit.

Wiring between the system and the switches must be via the three-wire cable supplied with the system itself. It must be cut to the appropriate length and cable end sleeves must be inserted before inserting them into the terminal connection.

This cable is 10 m long and the nominal cross-section of each of its wires is 1.5 mm^2. This wiring will be permanent; therefore the cable can be removed only by means of a special tool (e.g. a screwdriver).

The yellow-green wire is the grounding wire: it must be connected to the ground terminal on the main line.

The brown wire is the phase wire: it must be connected to the phase terminal on the separating switch.

The blue wire is the neutral wire: it must be connected to the neutral terminal on the separating switch.

⚠ **WARNING**	**Be sure to correctly identify the phase and neutral wires when connecting the equipment or when wiring the separating switch**

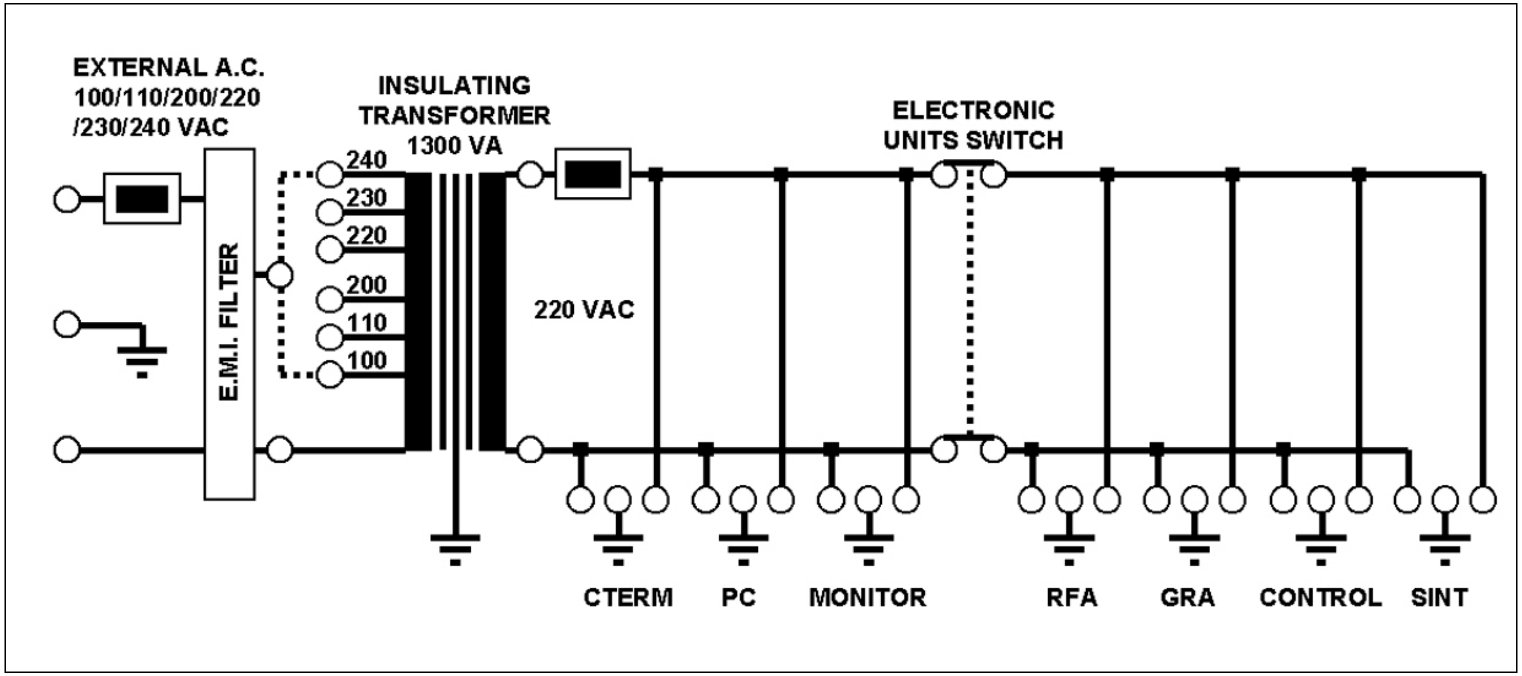
If additional optional lights are installed in the pavilion, you must install a dedicated separating switch and insert the power cables into a dedicated duct to avoid electric shocks.

The dedicated plug for the optional lights is located on the filter panel and has the following characteristics: 250V MAX and 5A MAX.

No dimmer or fluorescent lights may be used.

⚠ **WARNING**	**All the main power cables and the cables from the console to the filter panel and from the filter panel to the magnet must be inserted under the floor or into the delivered duct that must be fixed to the floor**

Fig. 106: Power distribution Scheme



Part 12 Maintenance Instructions

Maintenance Plan

The system maintenance does not require any critical or difficult operations, but some periodic controls are summarized in the following table.

NOTICE	At the end of maintenance procedure, take a copy of the table that has been filled in and file it in the Logbook

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Tab. 11: Maintenance instructions period six months and year

Performed by | **System Ser/N** | **Customer** | **Date**

DESCRIPTION	TOOLS & FORMS	PROCEDURE	FREQUENCY	DONE	N/A	OK	NOK
System calibration control	Quality Form	See the Installation Guide calibration chapter	every six months	☐	☐	☐	☐
TX signal control for transmission coil		See the Installation Guide calibration chapter	every six months	☐	☐	☐	☐
Power cord check		Visual inspection of the integrity of the external sheath		☐	☐	☐	☐
Power light check		Visual inspection of the green light, and of the switch placed in the left cover of the Electronic box	every six months	☐	☐	☐	☐
Cleaning the gantry	brush (or compressed air spray)	Extract the coil possibly present in the gantry and clean the TX coil using the brush to remove any dust	every six months	☐	☐	☐	☐

DESCRIPTION	TOOLS & FORMS	PROCEDURE	FREQUENCY	DONE	N/A	OK	NOK
Electronic Unit and PC internal dust cleaning	Screwdrivers Philips tip medium size, standard tip, Allen key 4mm, brush	Following the standard procedure shut down the system. Open the Electronic Unit covers and open the PC unit. Using the brush remove any dust from the boards (removing them from their places if needed). At the end of the cleaning procedure connect everything again and check for proper functioning.	every six months	☐	☐	☐	☐
Cleaning and functional check of the cooling fan (with the exception of the CTERM ones)	Screwdriver standard tip , Allen key n. 4, brush (or compressed air spray)	Following the standard procedure shut down the system. Open the electronic unit covers not patient side to get access to the fan and remove any dust. Be careful of the two smaller fans (for CTERM module) which are still in function. At the end restart the system and check fan functionality, then close the metallic cover and check for functionality of the cover fan. Close the plastic cover.	every six months	☐	☐	☐	☐
Cleaning of the RX coils and functionality test of insertion in the gantry	soft cloth, water, neutral detergent	Extract the RX coils and remove any dust using the soft cloth and the neutral detergent. Allow the detergent residuals to evaporate, then mount the coil in place and check functionality.	every six months	☐	☐	☐	☐
Patient seat control		Check the wheel and brake functionality, if necessary lubricate the wheel bearings	every six months	☐	☐	☐	☐

DESCRIPTION	TOOLS & FORMS	PROCEDURE	FREQUENCY	DONE	N/A	OK	NOK
Check for integrity and number of cushions		For the number of cushions required, refer to the relevant chapter in the User Manual	every six months	☐	☐	☐	☐
RX coils tuning check	Quality Form	Check varicap and 180° pulse for every coils	every six months	☐	☐	☐	☐
Check of the following: ground screws, cables, connector caps both of the Magnet and of the Electronic units	Screwdrivers Philips tips , standard tips, Allen keys or adjustable spanners	Remove the Electronic Unit and Magnet Unit covers to gain access to the cables and connectors: after checking and screwing all the covers until they are closed	every six months	☐	☐	☐	☐
Check of the safety labels		Inspect the labels on the Magnet and on the Site door to make sure they are legible	every six months	☐	☐	☐	☐
Shimming parameters check	Shimming kit	Check and eventually correct the Magnet shimming parameters	every year	☐	☐	☐	☐
Protective Conductor Measurements		Check the System insulation	every year	☐	☐	☐	☐

Part 13 Index

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