HEALTHCARE
Imaging >
Global Support Operations

Technical Documentation

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1 Piece WQTSB MA1

Hardcopy Application Manual

2nd Edition

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AGFA

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1 Preface

This is the second edition of the Hardcopy Application Manual.
It replaces document DD+DIS067.98E, dated October 1998.

It was created in close cooperation between HE GSO SC (Munich; D), the Hardcopy Application Team (Mortsel, B) as well as the R&D Dry Hardcopy Team (Mortsel, B).

It treats all printers currently in production at the time of this booklet going to press (February 2004).

Goal of the Hardcopy Application Manual

Hardcopy Application means, to adapt the printer - or better, the image quality of the films printed - to the customer wishes and needs.

This is a job every field service engineer or imaging specialist has to perform at each installation, repair and maintenance of our printers.

- This manual shall assist field service engineers during printer service trainings when it comes to the topic ‘image quality’.
- It shall be a guideline for troubleshooting unsatisfactory image quality.
- For people, which know already most about 'Hardcopy Application', it shall give the latest developments in image quality adjustments with the 'new generation printer' like Drystar 4500 (M), Drystar 5500 and Drystar 5300.
- It shall be a compendium for all people, which are new to the topic ‘hardcopy application’.

Items covered in the Hardcopy Application Manual

This manual covers all hardcopy application specific items, like parameters to be adjusted, printers and their special settings or aspects for film viewing.

It does not cover the items which are described in the corresponding Technical Documentation of the printer, like Installation, Repair and Troubleshooting, Maintenance or Installation Planning.

The parameters and settings described here are based on the status of February 2004. It is possible, that settings or parameters change due to further progress in image processing, film material or printer development. For latest information refer to the technical documentation of the corresponding printer.

2 Printer Basics

The chapter 'Printer Basics' treats following topics:

Topic	Details see ...
Printing principles of the Agfa Medical printers	2.1
Spatial resolution in general	2.2
Contrast resolution in general	2.3
Color printing in general	2.4
Agfa Printers in detail	2.5

2.1 Printing principles of the Agfa Medical Printers

The table enclosed shows the printing principles of the Agfa printers, which are currently (February 2004) still in production:

The following subchapters explain the printing principles in general.

Printer	Printing Principle	Films	Details see ...
LR3300 / LR5200	Laser	'wet' films*	2.1.1
Drystar 2000	Direct thermal (B&W)	'dry' films ** (B&W)	2.1.2
	Thermo sublimation (color)	'dry' films + ribbon (color)	2.1.3
Drystar 3000	Direct thermal	'dry' films	2.1.2
Drystar 4500 (M)	Direct thermal	'dry' films	2.1.2
Drystar 5300	Direct thermal	'dry' films	2.1.2
Drystar 5500	Direct thermal	'dry' films	2.1.2

* 'wet films' means: A film processor using developer, fixer and water is required to process the films

** 'dry' films means: The film does not need a film processor, but has all required components in the film to produce the image 'on the fly', just by applying heat to the film.

2.1.1 Laser Printing on 'Wet' Films

Laser printing on ‘wet’ films can be divided in two steps:

Step 1 Expose the light sensitive film with a red laser beam:

The red laser beam is deflected by a resonant or rotating mirror.

The intensity for each pixel is adjusted by an AOM (Acousto Optical Modulator). See explanation next page.

A ‘latent’ image is created, which has to be developed.

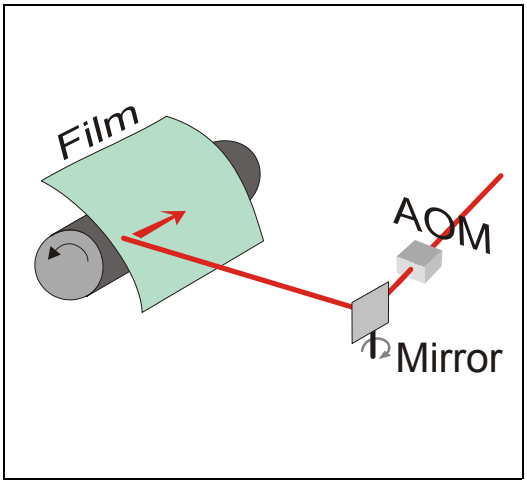


Figure 1

Step 2 Develop the film in a film processor

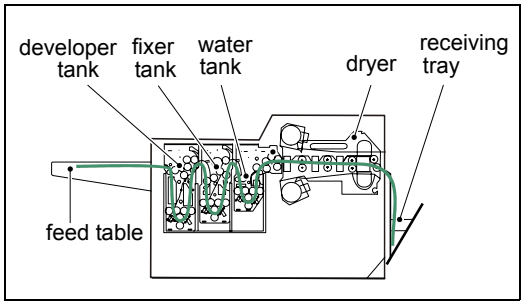


Figure 2

Advantage / Disadvantage of laser printing

Advantage	Disadvantage
+ The response time of the AOM is much less than a pixel time. Very precise and sharp images can be printed.	- Usually a 'wet' film has to be used, which causes waste (used developer, fixer)
+ Printing is done contactless: No wear of the print assembly	- The image quality of the exposed film depends on a proper working film processor.

Functional principle of an AOM

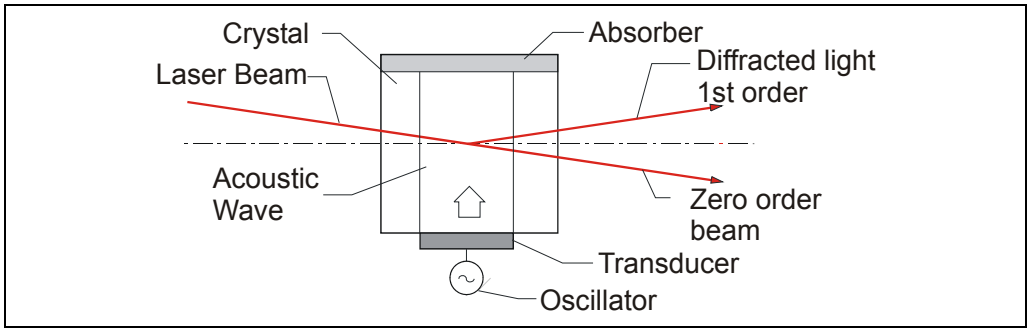


Figure 3

- The laser beam is changed in intensity according to the recorded image via an AOM (Acousto Optical Modulator)
  The AOM is a crystal, which has the effect of a grid to the laser beam. A grid causes refraction to the laser beam.
- By applying different intensities of mechanical pressure oscillations on the AOM, the intensity of the refracted beam can be varied.
  Note: The 'zero order beam' is not influenced and therefore not used.
- The mechanical variations on the AOM are created via a piezzo crystal. The piezzo crystal converts voltage to changes in dimension (used e.g. in quartz watches) and vice verse (used e.g. in electronic wedges).
- The piezzo crystal creates an acoustic wave in the crystal – variations of intensity of this wave create variations of intensity of the refracted laser beam. This is the reason why it is called 'Acousto Optical Modulator'.

2.1.2 Direct thermal printing on 'Dry' Films

Direct thermal printing on 'dry' films is made in one step:

Expose the heat sensitive film with a lot of ‘heated wires’. Each ‘wire’ is represented by a resistor in a thermal head. The number of resistors corresponds to the number of lines and so to the print resolution.
Example: Drystar 4500 (M):
20 lines per mm.

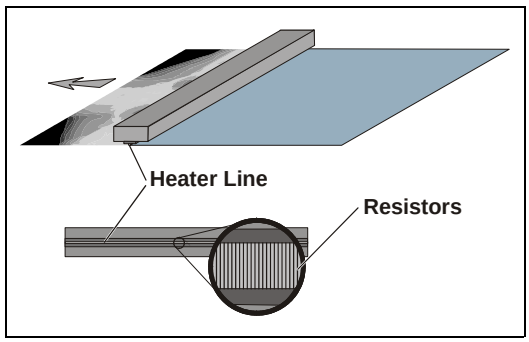


Figure 4

Advantage	Disadvantage
+ No waste like used fixer or developer + Fast access time, as it is a ‘one step’ process. + Film is not sensitive to daylight → no darkroom required → film can be loaded in daylight	- The termal head is a sensitive part, due to contact between film and heater line - Compensation required to compensate for influence of heat of neighbor pixels - Exposed film still sensitive for heat (> 70°C / 158 ° F)

- Dry film is only sensitive for heat higher approx. 70° C / 158° F.
- Dry film can be exposed by lower temperatures, too, in case the film is in hot environment for a long time.
  Example: The film is hanging for several days at a lightbox with 50°C. This can blacken the film slightly.

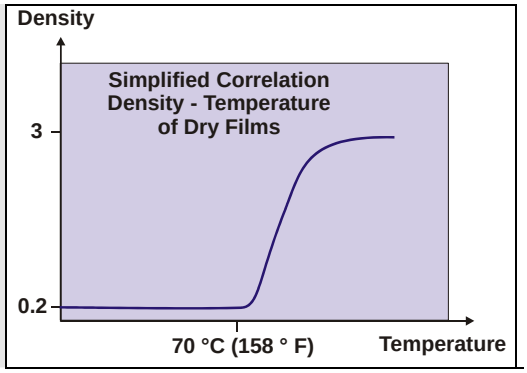


Figure 5

2.1.3 Thermosublimation color printing on 'Dry' Films

Thermosublimation color printing on 'Dry' Film is – like direct thermal printing – a one step printing process, too.
To apply the different colors, this printing process has to be repeated for each color. For the three colors yellow, magenta and cyan three printing processes are required.

Step 1 Heat up the color ribbon with a lot of ‘heated wires’ – print the first color. Each ‘wire’ is represented by a resistor in a thermal head.
The dye in the ribbon diffuses into the film.
Step 2 Second printing process with the second color.
Step 3 Third printing process with the third color.

The temperature at the surface of the print head determines the amount of dye that is vaporized and diffused into the film.

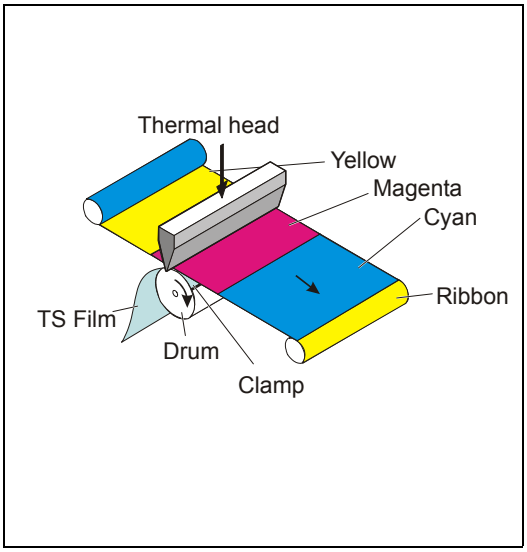


Figure 6: Color printing at Drystar 2000

Advantage	Disadvantage
+ Excellent color rendering	- Relatively slow process, as printing has to be repeated 3 times

For more info on color printing refer to document ‘Basic Principles Color’, DD+DIS109.94E.

2.2 Spatial resolution in General

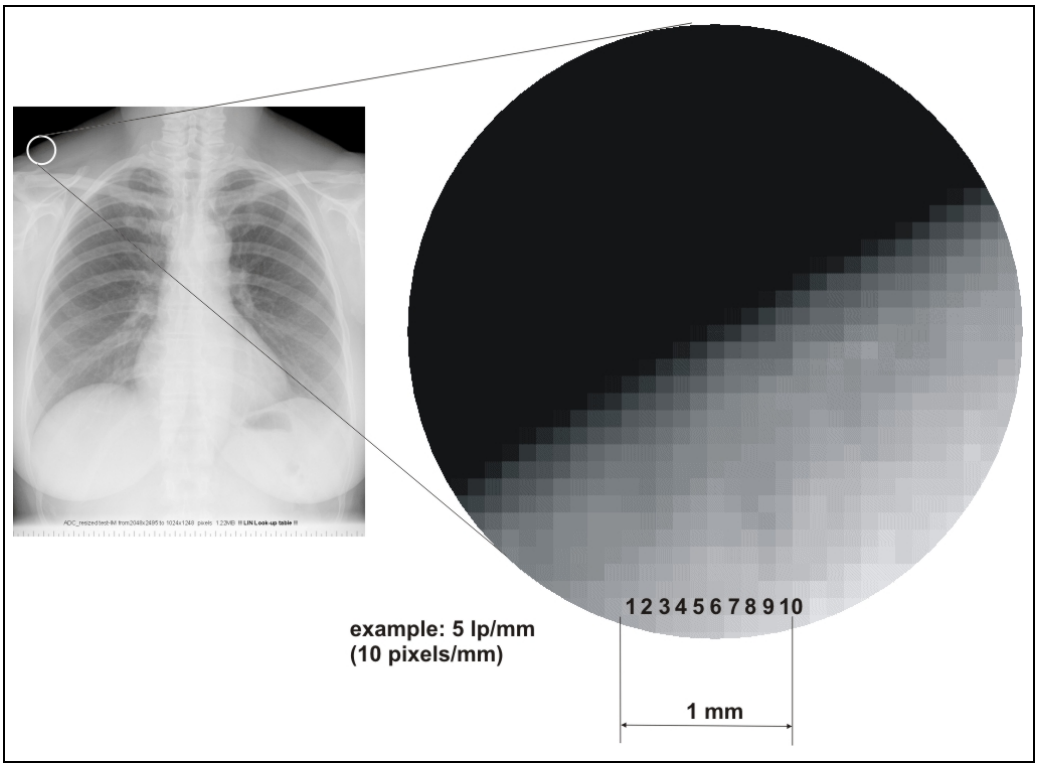


Figure 7

Spatial resolution is defined by the distance of two individual pixels. It is usually expressed in dpi (dots per inch; 1 inch = 25.4 mm).
A table with spatial resolution data of the current Agfa printers is shown below.

Printer	Spatial resolution
LR3300 (galvo)	320 dpi
LR5200 (polygon)	315 / 630 dpi (see info next page)
Drystar 2000	300 dpi
Drystar 3000	320 dpi
Drystar 4500 (M)	508 dpi
Drystar 5300	320 dpi
Drystar 5500	508 dpi

Table 1

Resolution Measurement units:
Screen Film Mammography: line pairs per mm [lp/mm]
Digital Mammography: Pixel Size in microns [µm]
Hardcopy printing: dots per inch [dpi]
Example: 10 lp / mm = pixel size 50 µm = 508 dpi

Resolution switching at Laser Imagers with Polygon

The LR5200 is designed as high resolution printer. The pixel size on film is 40 µm x 40 µm. For comparison, standard laser imagers have a pixel size of 80 µm x 80 µm. The laser spot has a gaussian profile with a diameter of 70 microns at 13% intensity. This results in a 50% overlap of neighboring scan lines which is the best compromise between suppression of scan line noise and sharpness.

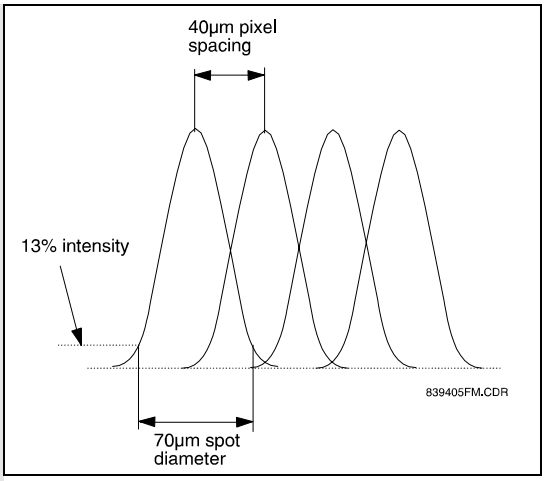


Figure 8

The LR5200 can print images in 630 dpi mode (high resolution) as well as in 315 dpi mode (standard resolution).

LR5200 Standard resolution mode

In standard resolution mode, the Controller prepares the image as it was for an 80 micron printer. The maximum page memory for 14“x17“ is 4256 x 5174 pixel which equals about 22 Mbytes of RAM.
The Controller tells the Laser Imager via AMDI-PE protocol that it must print in standard resolution. The printer takes every received pixel and replicates it in two dimensions by repeating every pixel in line direction and by repeating every line.

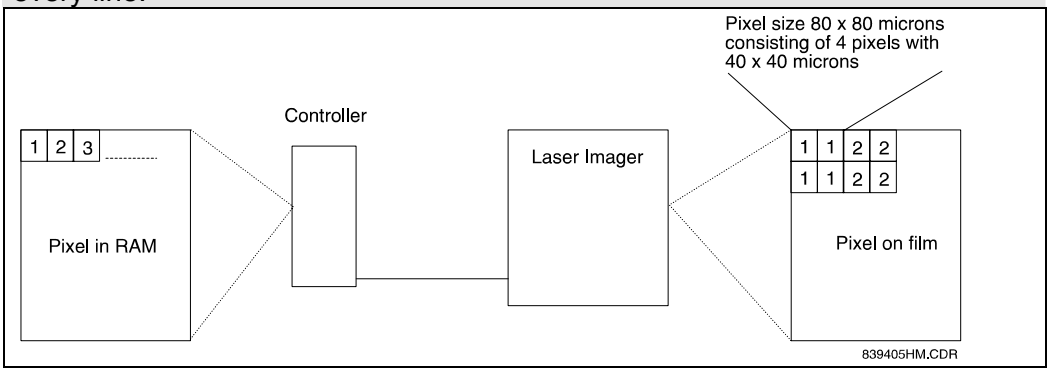


Figure 9

Film size	# pixels	# lines	page memory (MB)
8“ x 10“	2338	2972	7,09
14“x 11“	4256	3300	14,04
14“ x 14“	4256	4232	18,01
14“ x 17“	4256	5174	22,02

LR5200 High resolution mode

Printing in high resolution mode requires a lot of memory for image preparation in the Controller. For film size 14“x17“ the page memory consumes about 88 Mbyte of RAM in the Controller. This causes an increase of RAM memory as well as a reduction of throughput as the amount of data is four times as high as in standard resolution printing. Therefore the high resolution mode should only be used when it is really required.

In this mode, the size of the page memory is as big as the addressable range on film. This means that every pixel in the Controller RAM is a pixel on film.

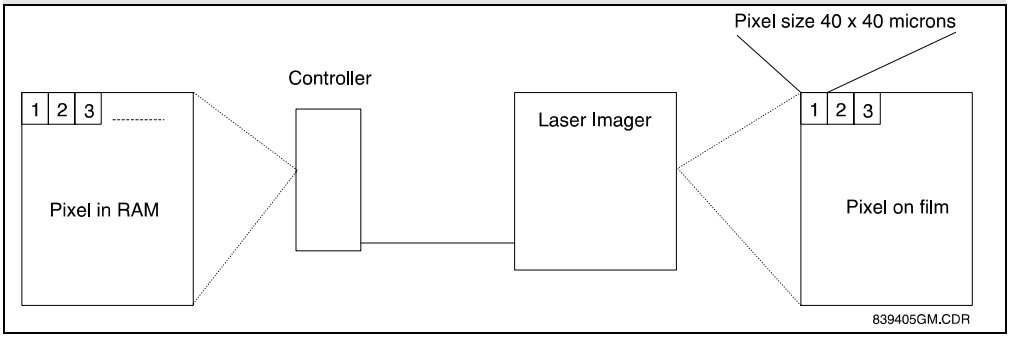


Figure 10

Film size	# pixels	# lines	page memory (MByte)
8“ x 10“	4776	5944	28,39
14“x 11“	8512	6600	56,18
14“ x 14“	8512	8464	72,05
14“ x 17“	8512	10348	88,08

Additionally the operating system of the MG3000 Controller needs up to 14 Mbytes. That means that a 128 Mbytes memory board is needed in the Controller for high resolution printing on 14“x17“ film.

2.3 Contrast resolution in General

Contrast resolution is defined by the number of possible grey steps on the printed medium. It is usually represented in bits.
A table with typical contrast resolution data is shown below.

Figure 11

Printer	Contrast resolution	# of grey steps
LR3300	8 bit	256
LR5200	8 or 12 bit (configurable)	256 / 4096
Drystar 3000	8 bit	256
Drystar 2000	8 bit	256
Drystar 4500 (M)	12 bit	4096
Drystar 5500	12 bit	4096
Drystar 5300	12 bit	4096

Table 2

At a paper laser printer the parameter 'contrast resolution' never appears in the list of technical data, as a laser (or ink jet) printer only is capable to print either a black or a white pixel.
In the figure enclosed a magnified part of a grey wedge of a laser or ink jet printer is shown. This way of creating grey steps is called ‘dithering’.

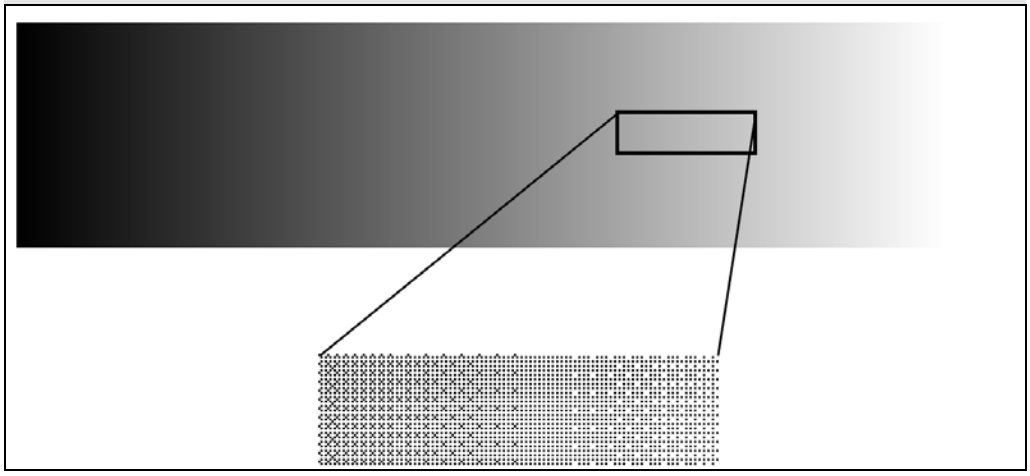
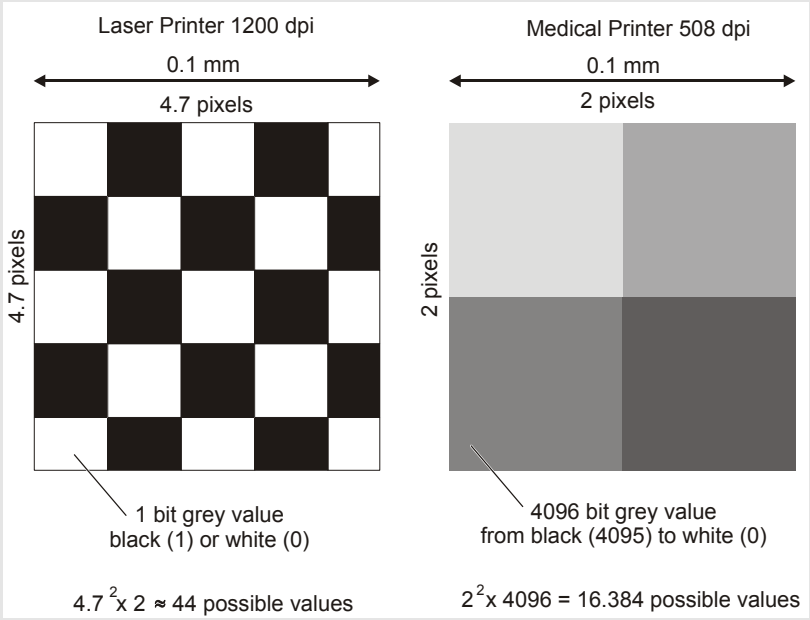


Figure 12

Often the contrast resolution is mixed with the number of bits per pixel that are used for internal image processing.
The Agfa Drystar 3000 printer is using for example 12 bit for internal image processing (e.g. for applying a taste look-up-table). Before printing, the data is re-calculated to 8 bit. This means, on film a maximum of 256 different grey steps could be measured, what corresponds to 8 bit.

To judge the printer capabilities both, the spatial resolution and the contrast resolution have to be taken into account.
Example:



A medical printer with spatial resolution of 508 dpi and 12 bit contrast resolution is able to display approx. 372 times as much information as a 1200 dpi laser printer on the same surface.

2.4 Color printing in General

At ink jet and color laser printers colors are made by placing yellow, magenta and cyan pixels in a certain relation on a certain surface to achieve the corresponding color impression.
Black pixels are created with the black ink cartridge or the black toner cartridge respectively.
Each pixel is either yellow, magenta, cyan or black.
Green is made for example by placing several yellow and cyan pixels close to each other.

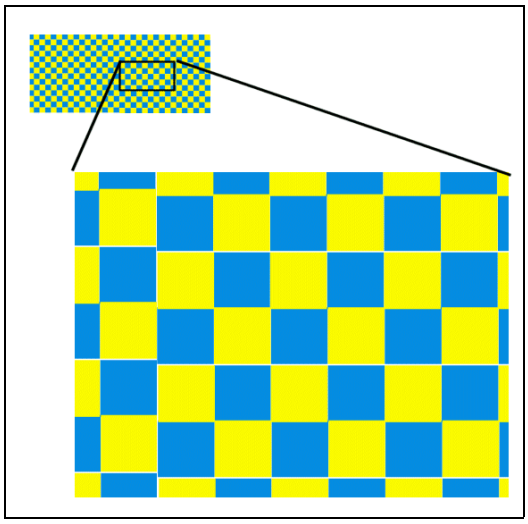


Figure 13

At medical printers colors are made by mixing yellow, magenta and cyan color in one pixel in a certain relation to achieve the corresponding color.
A white pixel is made by printing nothing.
Black is made by printing all three colors over each other.
Green is made for example by placing a yellow and cyan pixel over each other.

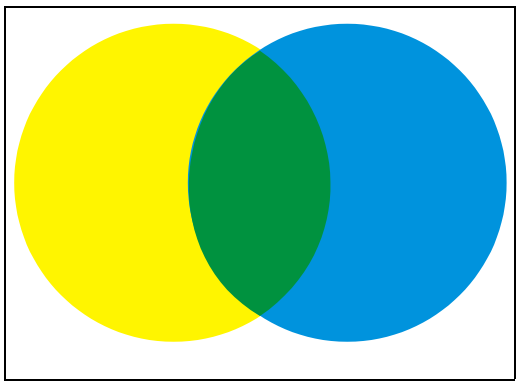


Figure 14

For more info on color printing refer to document ‘Basic Principles Color, DD+DIS109.94E.

2.5 Agfa Printers in detail

The table enclosed shows the printing principles of the Agfa printers, which are currently (February 2004) in production

The following subchapters describe the printers in greater detail.

Printer	Production since	Details see ...
LR3300	1992	2.5.1
Drystar 2000	1994	2.5.2
Drystar 3000	1997	2.5.3
LR5200	1997	2.5.4
Drystar 4500 (M)	2001	2.5.5
Drystar 5500	2003	2.5.6
Drystar 5300	2004	2.5.7

The figures for maximum printed density presented in the subchapters 2.5.1 to 2.5.7 depend on

- Proper film storage condition; age of the film
- Proper calibration of the printer
- Densitometer for measurement.

Additional info on the different parameters is available in following chapters:
Film storage: → chapters 3.2 and 3.3
Calibration: → chapter 5.1
Density Measurement: → chapter 8.2.1

2.5.1 LR3300

- The LR3300 was available in many different versions, like standalone version, parallel docking or serial docking with a Curix HT530 film processor.
- At the time of the booklet going to press, only the S (standalone) and P (Processor on top) versions are available.
- The most successful product is the P-Version.
- For image processing the LR3300 either requires an MG3000 (also called 'Laser Imager Controller) or a LR DICOM Controller.

Figure 15

Printing principle:

- A resonant mirror (648 Hz) deflects the red helium laser beam (633 nm, 7 mW)
- The beam is manipulated by the AOM, using the acousto optical effect
- Internally the laser imager uses 16 bit for image manipulation. It prints either in 8 or 12 bit mode, depending on the configuration of the controller (MG3000 or LR DICOM Controller).
- The maximum laser power on the film (approx. 1.5 mW) is adjusted via a calibration sensor and a polarizer filter.
- During printing the film is continuously driven by a scan drum

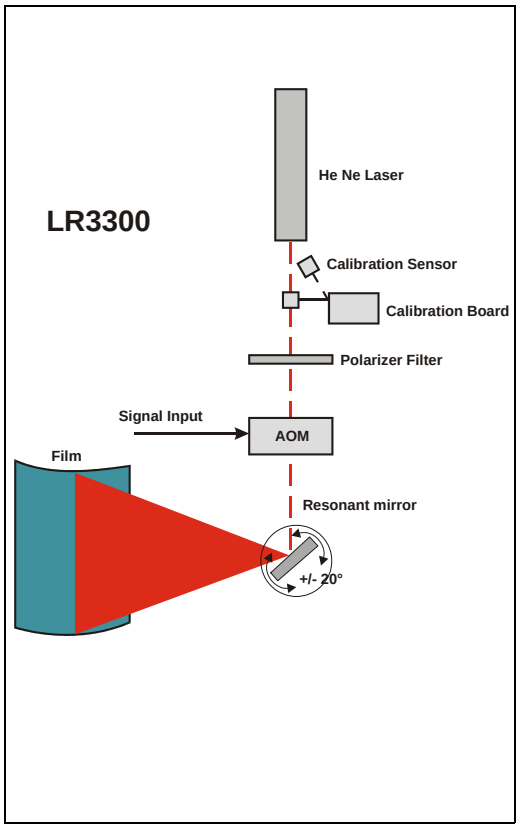


Figure 16

Main technical data of the LR3300:

Parameter	Value	Comment
Spatial resolution	315 dpi	--
Contrast resolution	8 or 12 bit	Depends on configuration of the controller (MG3000)
Max. density	3.8 O.D.	--
Max. image width	14 "	--
Printing time max.	8 sec.	--
Access time min.	Approx. 1 min.	Throughput up to 240 films/h (8x10”)
Film sizes	8x10”, 11x14”, 14x17”	--
Number of film trays	2	--

The LR3300 was initially only available with resonant mirror (‘galvo’). In 1997 the LR5200 with polygon mirror was introduced.

Due to marketing reasons, this distinction was given up – some printers with polygon mirror also got the name 'LR3300'.

An overview of which laser printer has which type of printing principle, depending on the serial number, is available in chapter 1 of the LR5200 technical documentation.

2.5.2 Drystar 2000

- The Drystar 2000 is the only color printer in the assortment of Agfa Healthcare.
- It is also capable to print black & white images.
- Its main application is Ultrasound and Nuclear Medicine.

Figure 17

Printing principle color:

- The film is clamped on the drum
- The thermal head with 2880 resistor elements heats up the ribbon.
- Dye (cyan / magenta / yellow) diffuses into the film.
- The film makes 3 turns: For each color one.
- The higher the temperature at the individual resistor element the more color will diffuse to the film.

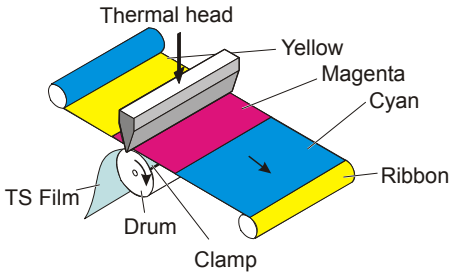


Figure 18

Printing principle black & white:

- The film is clamped on the drum
- The thermal head with 2880 resistor elements heats up the thermo-sensitive film
- The higher the temperature at the individual resistor element the higher will be the density of this pixel.

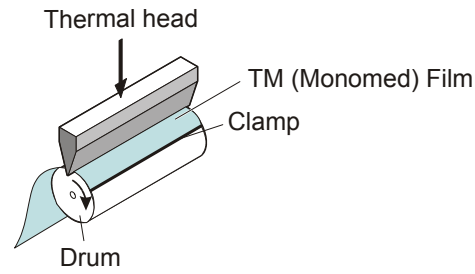


Figure 19

Main technical data of the Drystar 2000:

Parameter	Value	Comment
Spatial resolution	300 dpi	--
Contrast resolution	8 bit	--
Max. density	3.0 O.D.	For color printing 2.0 O.D.
Max. image width	8 "	--
Printing time max.	3 min.	For color printing
Access time min.	Approx. 1 min.	For black & white printing
Film sizes	8x10”	--
Number of film trays	1	--

The Drystar 2000 was initially available with black & white or color ribbon.

Later on (in 1997), as the so-called 'Monomed' film was available, the black & white ribbon was not required anymore. The Drystar 2000 was able now to print its black & white images directly on the film, without ribbon.

The maximum density raised from 2.0 with black & white ribbon to 3.0 for Monomed films.

2.5.3 Drystar 3000

- The Drystar 3000 is currently the most successful printer of Agfa Healthcare: It is sold more than 10.000 times.
- It can be used for all kinds of applications, except mammography applications

Figure 20

Printing principle:

- The film is driven upwards by the drum and some rollers
- The thermal head with 4352 resistor elements heats up the thermo-sensitive film.
- The higher the temperature at the individual resistor element the higher will be the density of this pixel.

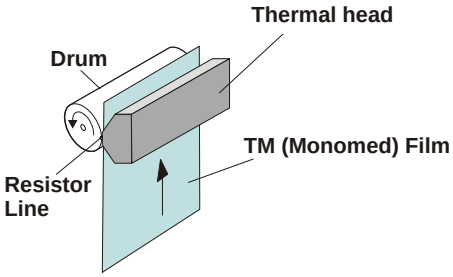


Figure 21

Main technical data of the Drystar 3000:

Parameter	Value	Comment
Spatial resolution	320 dpi	--
Contrast resolution	8 bit	--
Max. density	3.0 O.D.	--
Max. image width	14 "	--
Printing time max.	60 sec.	--
Access time min.	Approx. 1.5 min.	1st film 14x17": approx. 120 secs.
Film sizes	11x14", 14x17"	--
Number of film trays	1	--

2.5.4 LR5200

- The LR5200 is available as S- (Standalone) or P-Version (Processor on top)
- The most successful product is the P-Version.
- Due to its wide range of image formats (8 x 10" to 14 x17") as well as its wide range of optical density (up to 3.8 O.D.) it is used for all applications.
- For image processing the LR3300 either requires an MG3000 (also called 'Laser Imager Controller) or a LR DICOM Controller.
- Nowadays it is more and more superseded by the Drystar printers – its image quality however is still unbeatable, especially for mammography applications.

Figure 22

Printing principle:

- A 10 facet polygon mirror (5256 rpm) deflects the red helium laser beam (633 nm, 7 maw)
- The beam is manipulated by the AOM, using the acousto optical effect.
- Internally the laser imager uses 16 bit for image manipulation. It prints either in 8 or 12 bit mode, depending on the configuration of the controller (MG3000).
- The maximum laser power on the film (approx. 1.5 mW) is adjusted via a calibration sensor and a polarizer filter.
- During printing the film is continuously driven by a scan drum

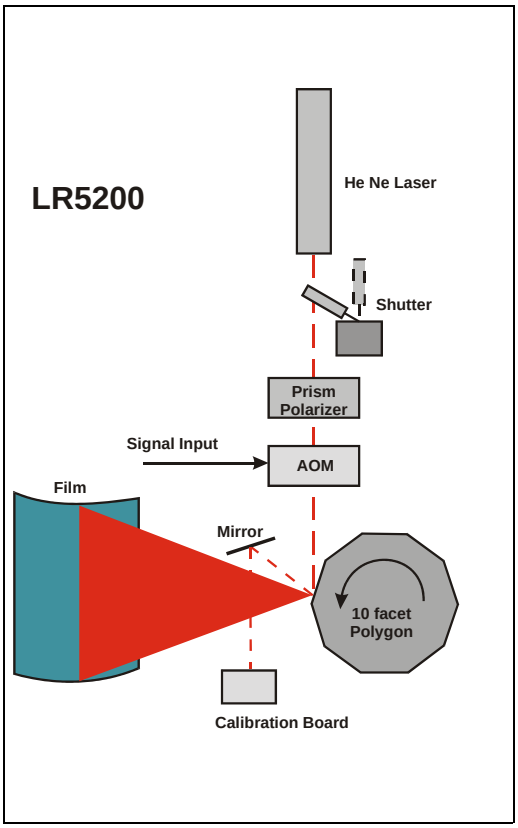


Figure 23

Main technical data of the LR5200:

Parameter	Value	Comment
Spatial resolution	630 dpi	--
Contrast resolution	8 or 12 bit	Depends on configuration of the controller (MG3000)
Max. density	3.8 O.D.	--
Max. image width	14 "	--
Printing time max.	12 sec.	--
Access time min.	Approx. 1 min.	Throughput up to 240 films/h (8x10”)
Film sizes	8x10”, 11x14”, 14x17”	--
Number of film trays	2	--

The LR3300 was initially only available with resonant mirror. In 1997 the LR5200 was introduced, with polygon mirror.

Due to marketing reasons, this distinction was given up – some printers with polygon mirror also got the name 'LR3300'.

An overview of which laser printer has which type of printing principle, depending on the serial number, is available in chapter 1 of the LR5200 technical documentation.

2.5.5 Drystar 4500 / Drystar 4500 M

- Drystar 4500 (M) belongs to the 'new generation' of Agfa printers: It is quite simple to set-up and only offers network input.
- It is available as Drystar 4500 (maximum density 3.1) and Drystar 4500 M (maximum density > 3.5 O.D).
- The **Drystar 4500** can be used for all applications, except Mammography.
  The **Drystar 4500 M** can be used for all applications including digital Mammography.

Figure 24

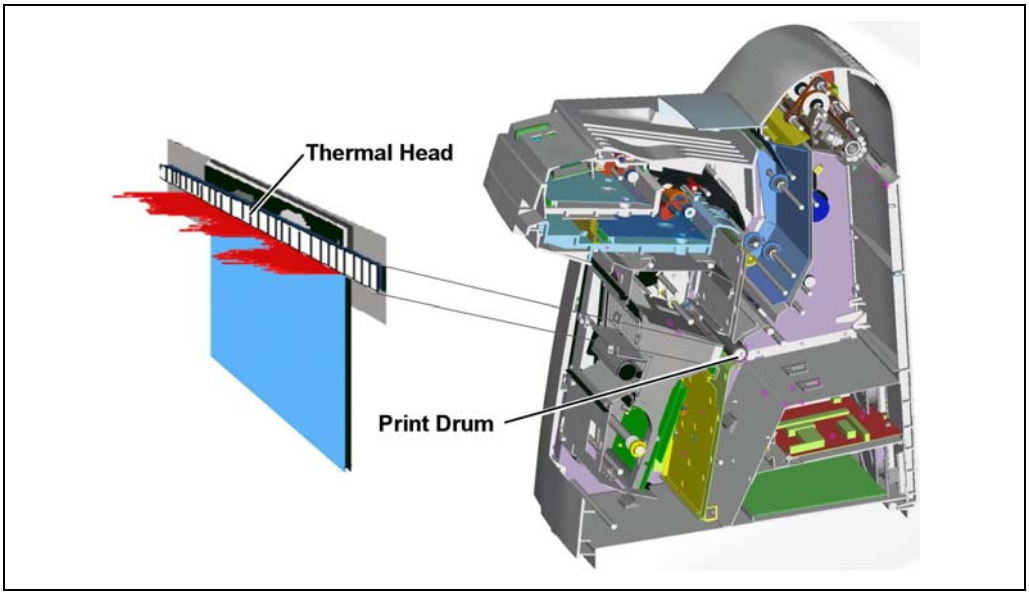


Figure 25

Printing principle:

- The film is driven upwards by the drum
- The thermal head with 4992 resistor elements heats up the thermo-sensitive film.
- The higher the temperature at the individual resistor element the higher will be the density of this pixel.

Main technical data of the Drystar 4500 / Drystar 4500 M:

Parameter	Value	Comment
Spatial resolution	508 dpi	
Contrast resolution	12 bit	
Max. density	> 3.5 O.D.	Drystar 4500: 3.1 O.D: Drystar 4500 M: > 3.5 O.D.
Max. image width	10 "	--
Printing time max.	60 sec.	--
Access time min.	45 secs.	1st film 10x12": approx. 120 secs.
Film sizes	8x10", 12x10"	--
Number of film trays	2	--

2.5.6 Drystar 5500

- Drystar 5500 belongs to the 'new generation' of Agfa printers: It is quite simple to set-up and only offers network input.
- The Drystar 5500 can be used for all applications, except Mammography.
- It offers 2 input trays for film formats 8x10", 10x12", 11x14", 14x14" and 14x17"
- A sorter with 4 output trays allows fast identifying of the printed images.

Figure 26

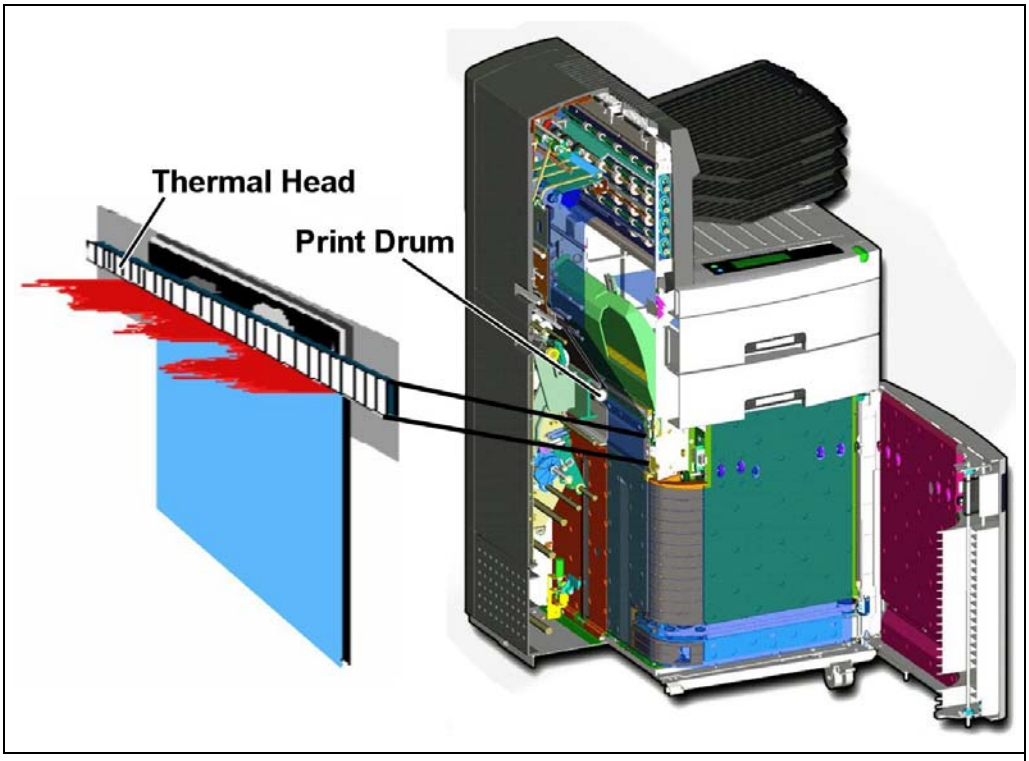


Figure 27

Printing principle:

- The film is driven upwards by the drum
- The thermal head with 7104 resistor elements heats up the thermo-sensitive film.
- The higher the temperature at the individual resistor element the higher will be the density of this pixel.

Main technical data of the Drystar 5500:

Parameter	Value	Comment
Spatial resolution	508 dpi	--
Contrast resolution	12 bit	--
Max. density	3.2 O.D.	--
Max. image width	14 "	--
Printing time max.	36 sec.	--
Access time min.	Approx 40 secs.	1st film 14x17": approx. 76 secs.
Film sizes	8x10", 10x12", 11x14", 14x14", 14x17"	--
Number of film trays	2	--
Number of output trays	4	--

2.5.7 Drystar 5300

- The Drystar 5300 belongs to the 'new generation' of Agfa printers: It can be installed by the customer. Due to its modular design defective parts can be exchanged very simple. It only offers network input.
- The Drystar 5300 can be used for all applications, except Mammography.
- It offers one film tray for 14x17” or 11x14” films.
- Allows next to application imaging because of its table top design.

Figure 28

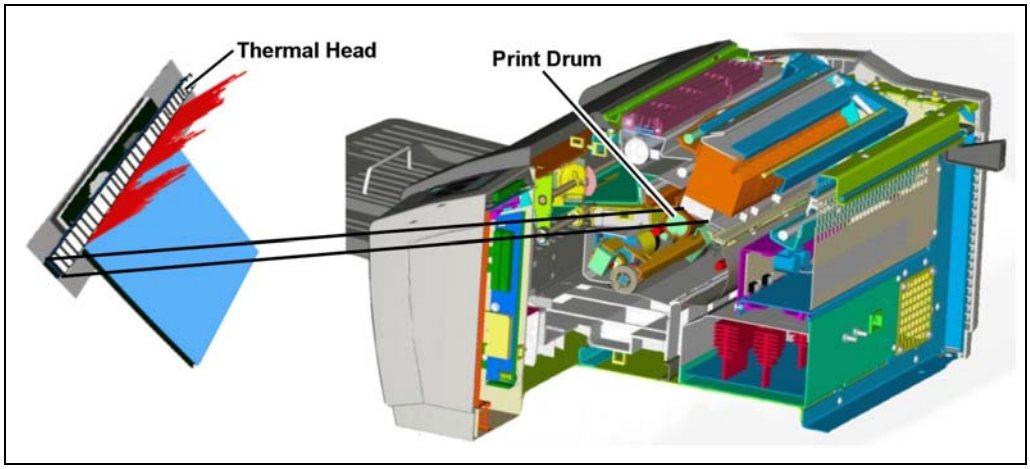


Figure 29

Printing principle:

- The film is driven upwards by the drum
- The thermal head with 4352 resistor elements heats up the thermo-sensitive film.
- The higher the temperature at the individual resistor element the higher will be the density of this pixel.

Main technical data of the Drystar 5300:

Parameter	Value	Comment
Spatial resolution	320 dpi	--
Contrast resolution	12 bit	--
Max. density	3.2 O.D.	--
Max. image width	14 "	--
Printing time max.	Approx. 1 min.	--
Access time min.	< 1.5 min.	1st film 14x17": approx. 90 secs.
Film sizes	11x14", 14x14"	--
Number of film trays	1	--

3 Film material Basics

The Agfa Healthcare printers are printing on different film material, depending on the printing principle and the application.
The next subchapters shall give an overview of the film material basics.
The table enclosed lists the different topics:

Topic	Refer to ….
Hardcopy Film Composition in General	3.1
'Wet' Film Material	3.2
'Dry' Film Material	3.3
RF-Tag and Film Info Area	3.4
Emulsion Side Recognition	3.5

The figures for maximum film density presented in the subchapters 3.2 and 3.3 depend on

- Proper film storage condition; age of the film
- Proper calibration of the printer
- Suitable densitometer for measurement.

Additional info on the different parameters is available in following chapters:
Film storage: → chapters 3.2 and 3.3
Calibration: → chapter 5.1
Density Measurement: → chapter 8.2.1

3.1 Hardcopy Film Composition in General

- In a simplified cross-section, hardcopy film consists of three layers:
  1) Protective layer
  2) Emulsion
  3) Polyester base
  4) Backing Layer
- The emulsion layer is either light (for Laser Imagers) or heat sensitive (for dry imagers).
- The polyester base is either blue tinted ('blue based film') or clear ('clear based film').
  Most often blue based film is used.
- Film for conventional X-Ray diagnostics in general consists of two emulsion layers (with some exceptions).
  Hardcopy film always consists of one layer.
- For hardcopy printing it is important, that the film is inserted the right way, i.e. that the film is printed on the emulsion side.

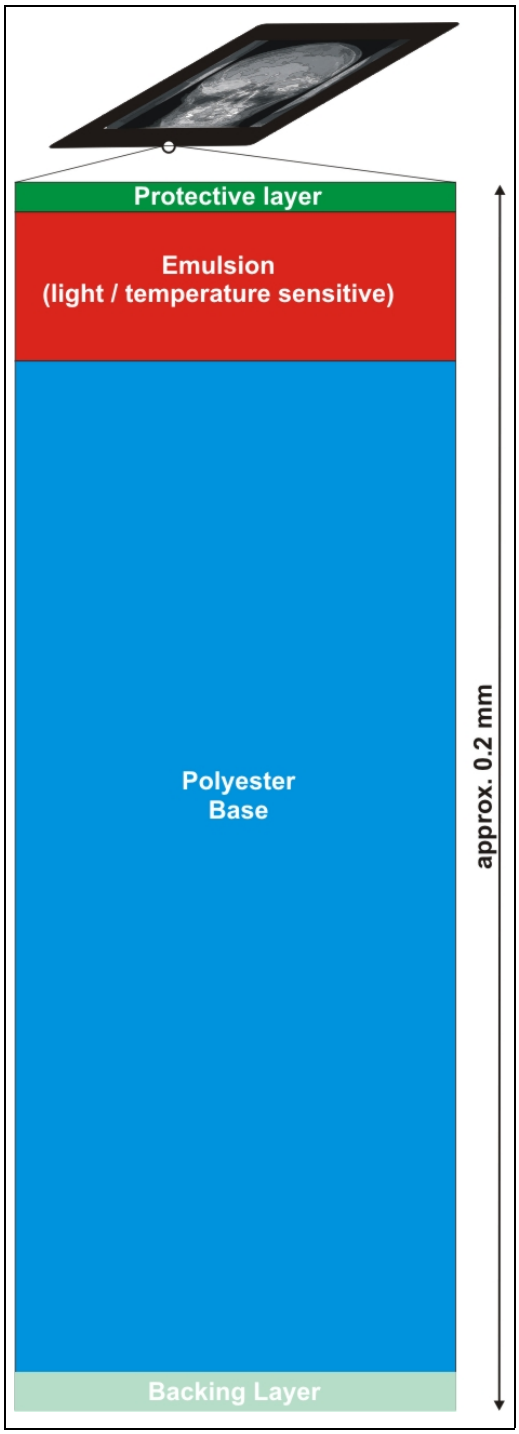


Figure 30

Printing of a wrong inserted film at a laser imager results in very low densities (approx. 1 instead of 3 O.D.)
Printing of a wrong inserted film at a dry imager results in a contaminated thermal head and very, very low densities, just above fog level.

3.2 'Wet' Film Material

Agfa offers a wide variety of 'wet' films for medical imaging.
Many of them can be used in 'non-Agfa printers' as well.
The table enclosed lists only these films which are used in the Agfa Laser Imager LR3300 / LR5200.

Film	Used in ….	Refer to ….
Scopix LT 2 B / C	LR3300 / LR5200	3.2.1
Scopix Laser 2 B	LR3300 / LR5200	3.2.2
Mamoray LT 3 B	LR3300 / LR5200	3.2.3
Scopix DR 3	LR3300 / LR5200	3.2.4

Cross section through a wet laser film:

- Wet laser film, like dry film material, is a 'single emulsion film': In opposite to conventional film, which has two emulsion layers in general.
- Wet laser films have to be processed in a film processor. Typical processing times are 60 to 90 seconds.

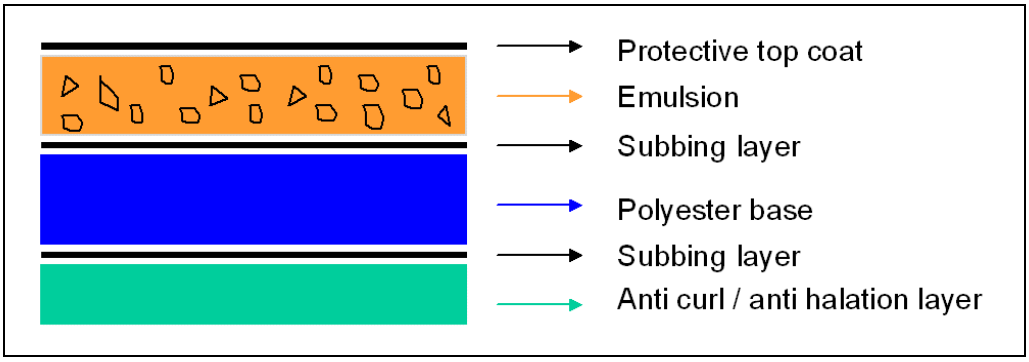


Figure 31

Black and white film uses small silver chloride crystals suspended in an emulsion, coated on a transparent backing (In the early days of photography, glass plates were used as the transparent backing). Photons striking the AgCl in a crystal grain cause ionisation into Ag^+ and Cl^-. The greater the amount of light impinging on a grain, the more Ag^+ ions are produced. Those crystals that have been exposed to light have their chlorine ions removed by the "Developer", leaving behind the Ag^+ now reduced to the metallic state as black silver crystals. After development the "Fixer" removes any silver chloride that was not light-activated. The small silver crystals form opaque areas on the film. This means that when one looks at the film, illuminated from behind, those parts that are exposed to light are dark (hence the term negative). The more light, the more silver gets left behind on the film, up to the maximum density of the film.

Wet laser films are sensitive to daylight. Enclosed is a graph which shows the sensitivity versus wave length
Example: Scopix LT 2 films:

Note: The Agfa Scopix LT 2 can perfectly be used with a green safelight.

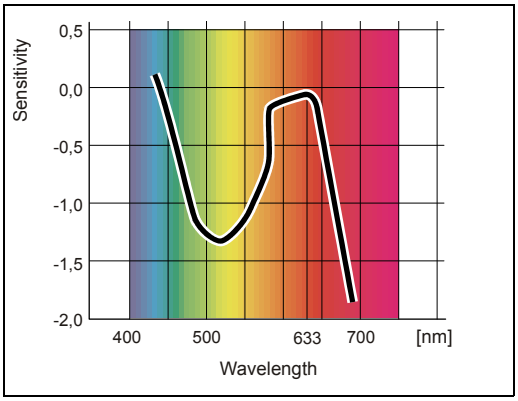


Figure 32

3.2.1 Basic facts to Scopix LT 2 B / C films

The Scopix LT 2 B / LT2 C is the film most often used in the Laser Imagers LR3300 / LR5200.
In the table enclosed some basic facts to the film:

Film name	Scopix LT 2 B or Scopix LT 2 C
Meaning of the Abbreviations	LT = Laser Technology 2 = 2nd generation B = Blue based / C = Clear based
Maximum Density	3.6 O.D.
Applications	All applications except Mammography
Shelf life	18 months at 5 to 21° C
Archivability	20 years

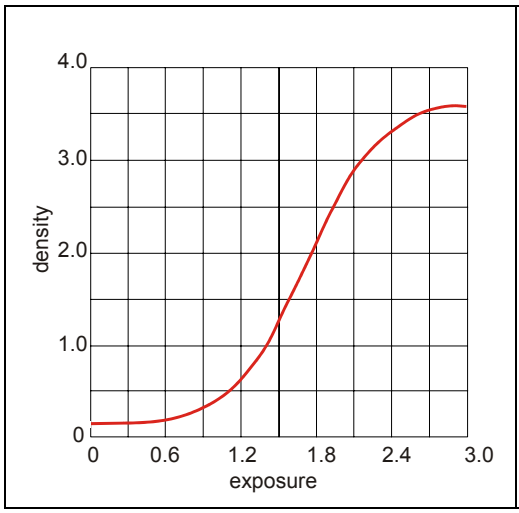


Figure 33

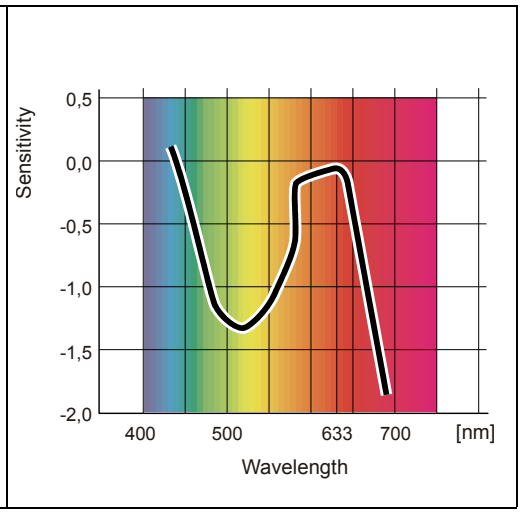


Figure 34

The sensitometric curve of Scopix LT 2 film is ideally shaped to meet the specific requirements of HeNe laser imagers. It features intentionally low contrast in low density image zones, which minimizes eye-distracting scanning noise, yet without loss of detail information. On the other hand it shows high contrast in the higher density zones, thereby offering the right exposure latitude for sharp and crisp images.

3.2.2 Basic facts to Scopix Laser 2 B / C films

Laser 2 B is the high end product of the Scopix LT 2 B family.
Laser 2 B film is especially designed for the German market, with the most stringent tolerances for sensitometry.
For the basic data to Scopix Laser 2 B / C films refer to 3.2.1.

3.2.3 Basic facts to Mamoray LT 3 B films

Mamoray LT3B film is a special film for digital Mammography applications in the LR3300 / LR5200.
In the table enclosed some basic facts to the film:

Film name	Mamoray LT 3 B
Meaning of the Abbreviations	LT = Laser Technology 3 = 3rd generation B = Blue based
Maximum Density	4.0 O.D.
Applications	Digital Mammography
Shelf life	18 months at 5 to 21° C
Archivability	20 years

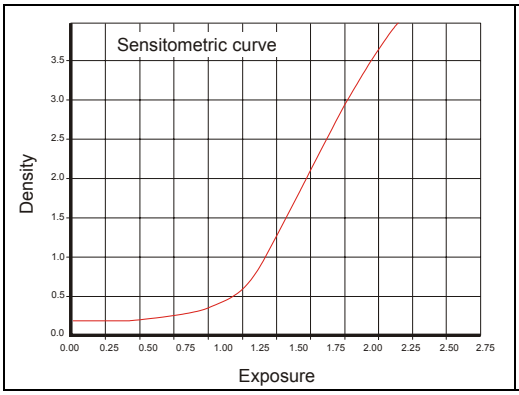


Figure 35

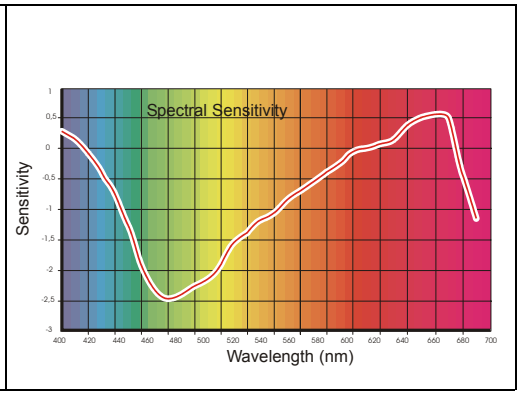


Figure 36

The MAMORAY LT 3 Helium-Neon sensitive laser film offers the dedicated hardcopy approach which Full Field Digital Mammography requires. The non-glossy film surface makes the images pleasing to view. Furthermore, MAMORAY LT 3 offers the high optical densities demanded by mammography.

3.2.4 Basic facts to Scopix DR 3 films

The Scopix DR3 film is a special film for Digital applications for Laser Imagers LR3300 / LR5200. Special feature is the non-glossy film surface.
In the table enclosed some basic facts to the film:

Film name	Scopix DR 3
Meaning of the Abbreviations	DR = Digital Radiography 3 = 3rd generation
Maximum Density	3.6 O.D.
Applications	Digital Radiography
Shelf life	18 months at 5 to 21° C
Archivability	20 years

Scopix DR 3 features a well balanced contrast, high maximum density and a low fog level which guarantees flawless image quality for digital radiography.
Especially the higher contrast in the higher density areas enhances detail perception.

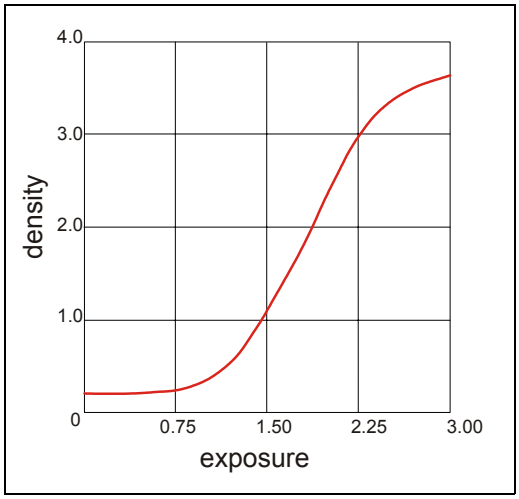


Figure 37

3.3 'Dry' Film Material

The table enclosed lists all currently (February 2004) available 'dry' Agfa films.

Film	Used in	Refer to ....
Drystar TS 2	Drystar 2000 (Color)	3.3.1
Drystar DT 1 B / C	Drystar 3000 / Drystar 2000, Drystar 4500 / 4500 M	3.3.2
Drystar Mammo	Drystar 4500 M	3.3.3
Drystar DT 2 B / C	Drystar 5500 / Drystar 5300	3.3.4

Cross section through a 'dry' color TS2 film / ribbon combination:

- The ribbon has a thermal protective layer for protection against the heat transmitted by the thermal print head.
- The sublimation of dye influenced by heat begins at a temperature of 70° C.
- The nominal temperature reached during printing at the contact surface between donor and acceptor is 150° C. At this temperature the dye sublimates and diffuses into the acceptor layer of the acceptor sheet.

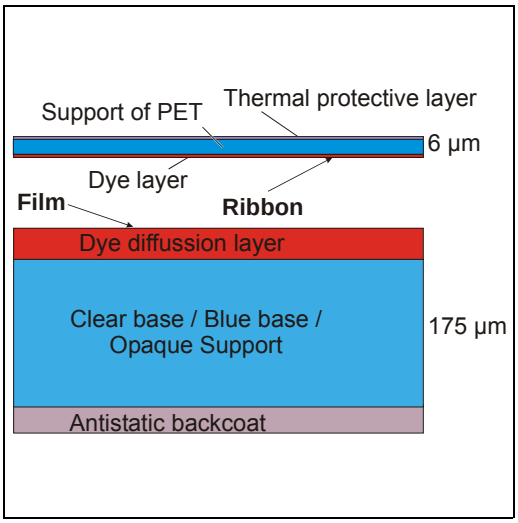


Figure 38: TS film with ribbon

Cross section through a 'dry' black & white film:

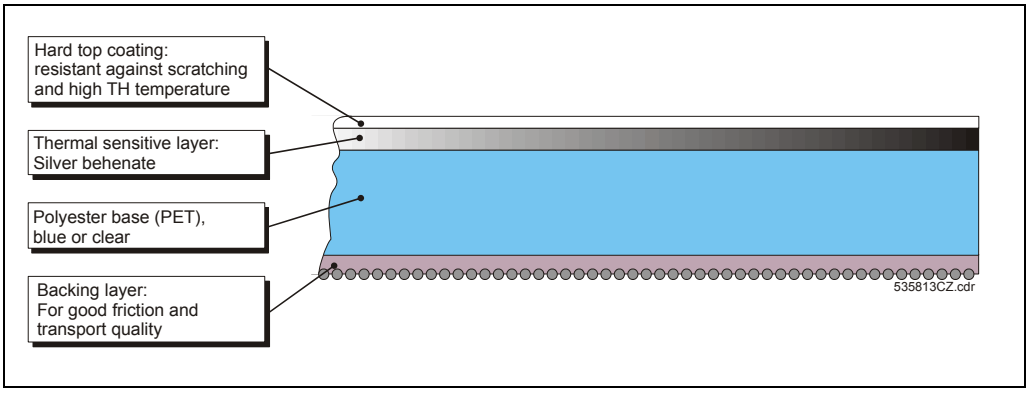


Figure 39: TM film

The image forming layer of AgOS is heat sensitive but not light sensitive.
By influence of heat (100° - 200° C) the silver (Ag) is reduced from AgOS:

Dry films are on short term not sensitive to daylight. They are only sensitive to heat.
Dry films do not require additional processing. The image processing happens internally on the fly.

If exposed to sunlight behind a window or other sources of heat dry film material can be blackened also after the film has been printed. Example:

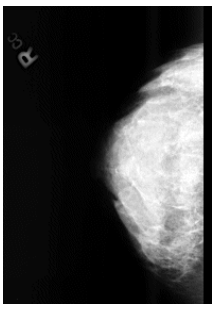
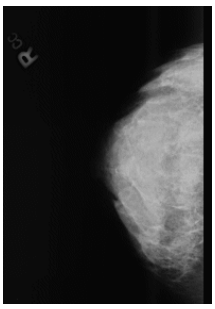
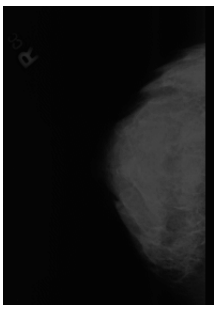
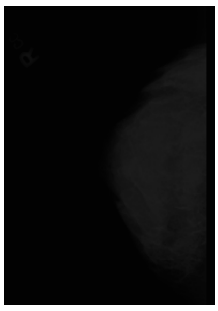
			
original image	2 h in T > 60 °C	4 h in T > 60 °C	8 h in T > 60 °C

Figure 40:

Dry film material is a single emulsion film. It can only be printed at the emulsion side.

The emulsion side is slightly smoother than the backing layer. This can be felt with the finger nail.

If printed on the wrong side,

- The image is hardly visible on the film
- The thermal head can be contaminated

To avoid that the film is positioned the wrong way in the film tray, DT2 films have one edge with a smaller radius than the other edges. Refer to 3.3.4. and 3.5.

3.3.1 Basic facts to Drystar TS 2 films

Drystar TS films are available in a choice of base tints, TS 2 B (blue-base), TS 2 C (clear-base), and TS 2 0 (opaque-base); providing the perfect film for every application. Clear and blue base films are ideal for diagnosis on a viewing box, opaque material is ideal for referral.
In the table enclosed some basic facts to the film:

Film name	Drystar TS 2 B/C/O
Meaning of the Abbreviations	TS = Thermosublimation 2 = 2nd generation B = Blue based / C = Clear based / O = Opaque (non transparent)
Maximum Density	2.0 O.D.
Applications	US, NM
Shelf life	18 months
Storage temperature	Max. 18 °C
Used in printers	Drystar 2000
Archivability	20 years

3.3.2 Basic facts to Drystar DT 1 films

DT1 films are the successor of TM1 films.
In the table enclosed some basic facts to the film:

Film name	Drystar DT 1 B/C
Meaning of the Abbreviations	DT = Direct Thermal 1 = 1st generation B = Blue based / C = Clear based
Maximum Density	3.2 O.D.
Applications	All applications except Mammography
Shelf life	18 months
Storage temperature	5 – 25 ° C
Archivability	20 years
Used in printers	Drystar 2000, Drystar 3000, Drystar 4500 (M)
Available	Year 2002 and further

3.3.3 Basic facts to Drystar Mammo films

Drystar Mammo film was especially made for the Drystar 4500 M.
This is a film with very high maximum density (> 3.5 O.D.).
In the table enclosed some basic facts to the film:

Film name	Drystar Mammo
Meaning of the Abbreviations	Mammo = Mammography
Maximum Density	> 3.6 O.D.
Applications	Digital Mammography
Shelf life	18 months
Storage temperature	5 – 25 ° C
Archivability	20 years
Used in printers	Drystar 4500 M
Available	Year 2002 and further

3.3.4 Basic facts to Drystar DT 2 films

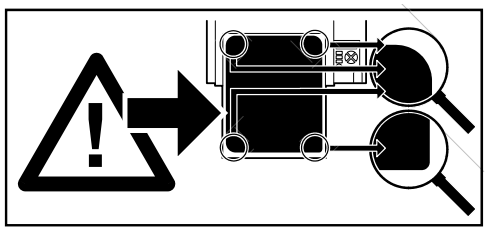
DT2 films are special high throughput films for Drystar 5500 and Drystar 5300.
In the table enclosed some basic facts to the film:

Film name	Drystar DT 2 B/C films
Meaning of the Abbreviations	DT = Direct Thermal 2 = 2nd generation B = Blue based / C = Clear based
Maximum Density	3.2 O.D.
Applications	All applications except Mammography
Shelf life	18 months
Storage temperature	5 – 25 ° C
Archivability	20 years
Used in printers	Drystar 5500, Drystar 5300
Available	Year 2003 and further

Mispositioning of individual unprinted sheets in input tray results in heavy, persistent thermal head contamination.

To avoid this, DT2 film contains one ‘small corner’

A pictogram demonstrates in which corner the ‘small corner’ should be positioned.
See also 3.4 RF-Tag and Film Info Area and 3.5 Emulsion Side Recognition.



DT2 films have following main improvements, compared to DT1 films:

- Evaporation of white powder is avoided
- withstand high instantaneous printing power
- fine tune image hue at higher printing speed
- improved resistance against temperature peaks after printing (storage in cars,…)
- improved curl at the lightbox

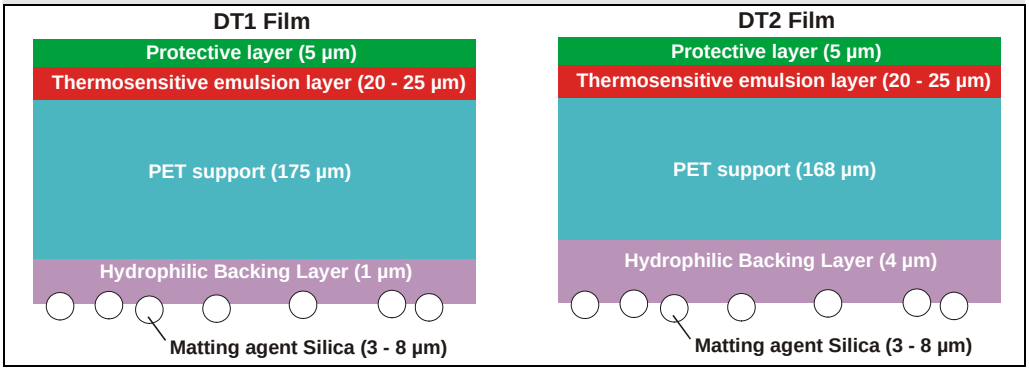


Figure 41

3.4 RF-Tag and Film Info Area

DT2 films used in Drystar 5300 and Drystar 5500 have a film identification chip named 'RF tag' (RF = radio frequency) in the protection sheet. This chip is read out whenever a new film package is inserted. It contains amongst other information following encrypted data:

- Film type (e.g. BB, CB)
- Film Format
- Emulsion number
- Order number / pack no.

Refer to table next page for details.

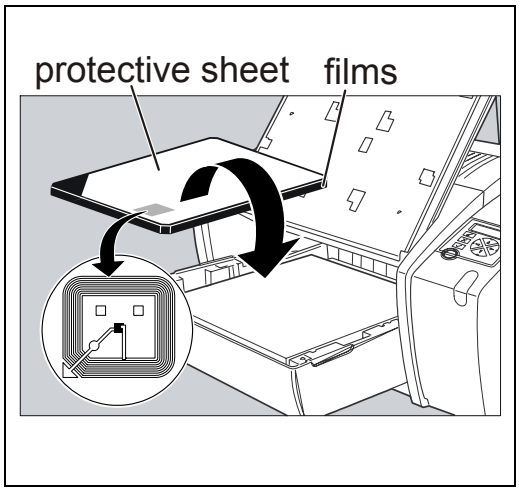


Figure 42: RF tag location

The printer reads this info

- to control the film specific settings of the printer
- to print this info in small characters (< 1 mm) in 'system info area' in the black border, thereby improving traceability in case of image quality problems / complaints.
- to go to SAFE MODE in case film identification contains inconsistent information (e.g. DT1 films inserted) → the maximum print power is reduced and density is limited to 2.00

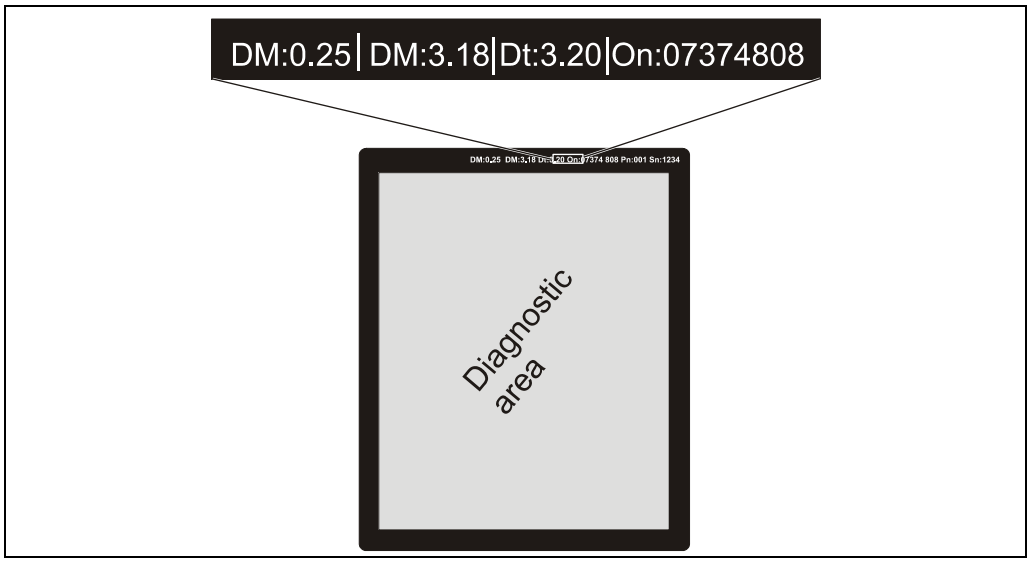


Figure 43: System info on the film

Table with System Info explanation for Drystar 5300:
(refer to Figure 43: System info on the film).

Abbreviation	Meaning	Comment
Part one : printer info		
Dm	System Dmin	Dmin after calibration
Dt	Dmax target	--
DM	System Dmax	Dmax after calibration
On	Order no	--
Pn	Pack no	--
Sn	SN printer	--
TFC	Total film count	… of installed thermal head
FCC	Film count after the previous / next TPH cleaning	divided by slash '/'
FCP	Film count after the previous / next TPH profile calibration	divided by slash '/'
Sw	SW version	--
Ma	Remaining maintenance actions	Yes or No
Aa	Active alert status	Yes or No
FCI	Film calibration initiation (auto)	ON/OFF + Frequency(*)
Part two : controller info Condition is given for the first image of a job		
Src	Image source	IP-address in case of modality. Filename in case of testimage.
Da	Date	Dd-mmm-yy
Ti	Time	hh-mm
DbM	Dmax(**)	maximum density on the film as requested by the host (Dbmax)
IntP	Interpolation type(**)	--
Sm	Smoothfactor(**)	--

(*) indicates the film calibration initiation + frequency.
e.g. ON 5 means: Film cal. Initiation = ON, will start every films 5 packs
OFF means: Film cal. Initiation = OFF

(**) Optional token: set when the images in this job have different Dmax, Interpolation type or Smoothfactor.

Table with System Info explanation for Drystar 5500:
(refer to Figure 43: System info on the film).

Abbreviation	Meaning	Comment
Part one: printer info		
Dm	Densitometer	Selection of : MacB 924 X-rite 310 X-rite 331 X-rite 341
Dmu(*)*	System Dmin upper	Dmin after calibration
Dtu	Dmax target upper	
DMu	System Dmax upper	Dmax after calibration
Onu	Order no upper	
Pnu	Pack no upper	
Dml	System Dmin lower	Dmin after calibration
Dtl	Dmax target lower	
DMl	System Dmax lower	Dmax after calibration
Onl	Order no lower	
Pnl	Pack no lower	
Sn	SN printer	--
TFC	Total film count	… of installed thermal head
FCC	Film count after the previous / next TPH cleaning	divided by slash '/'
FCP	Film count after the previous / next TPH profile calibration	divided by slash '/'
Sw	SW version	--
Ma	Remaining maintenance actions	Yes or No
Aa	Active alert status	Yes or No
FCl	Film calibration initiation (auto)	ON/OFF + Frequency(**)
Part two: controller info Condition is given for the first image of a job		
Src	Image source	IP-address in case of modality. Filename in case of testimage.
Da	Date	Dd-mmm-yy
Ti	Time	hh-mm
DbM	Dmax(***)	maximum density on the film as requested by the host (Dbmax)
IntP	Interpolation type(***)	--
Sm	Smoothfactor(***)	--

(*) In case Dmu is shown first, film comes from upper magazine; in case Dml is shown first, film comes from lower tray.
(**) indicates the film calibration initiation + frequency.
e.g. ON 5 means: Film cal. Initiation = ON, will start every films 5 packs
OFF means: Film cal. Initiation = OFF
(***) Optional token: set when the images in this job have different Dmax, Interpolation type or Smoothfactor.

3.5 Emulsion Side Recognition

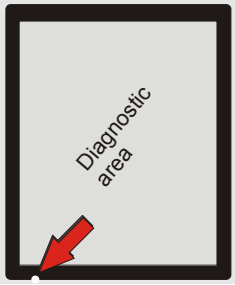
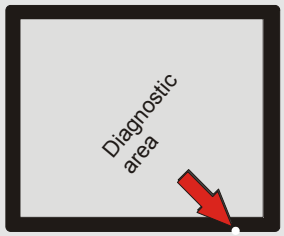
In case one or more film sheets are taken out of the film tray / magazine, it is important to know, which side is the emulsion side.

Printing of a wrong inserted film at a laser imager results in very low densities (approx. 1 instead of 3 O.D.)
Printing of a wrong inserted film at a dry imager results in a contaminated thermal head and very, very low densities, just above fog level.

At re-filling of an empty input tray / magazine, an instruction on the film package ensures that the film is inserted the right way (not for Drystar 5500 and Drystar 5300: there a sticker on the input tray explains the correct film loading procedure).

At Drystar 5300 and Drystar 5500 the proper insertion of a new film pack is even checked by the RF tag in the protection sheet.

Following means exist to ensure, that a film is inserted the right way:

Film	How to recognize emulsion side	
'Wet' films for laser printing	Notch at the lower left side	
TS2 color films	Notch at the lower right side	
DT1 films	No indication at the film. Refer to hint below.	
Mammo films	No indication at the film. Refer to hint below.	
DT2 films	Corner at lower right side with small radius	

Hint: The emulsion side in general is slightly smoother than the backing layer. This can be felt with the finger nail.

4 Aspects of Film Viewing

Two main parameters regarding physiology of the eye influence, whether two pixels can be distinguished from each other.

Parameter	Refer to ….
Resolution viewing capabilities	4.1
Contrast viewing capabilities	4.2

4.1 Resolution viewing capabilities

The eye in general is capable to distinguish two points that have a distance of 1/60 degree.
This can be measured with so-called "Landolt Rings": By checking whether a slit can be recognized from a certain distance the so-called "visus" is determined.
For a normal viewing distance of 30 cm (film, screen, paper) this corresponds to 80µm. I.e. two dots of 80µm distance can be distinguished. This equals approx. 300 dpi.

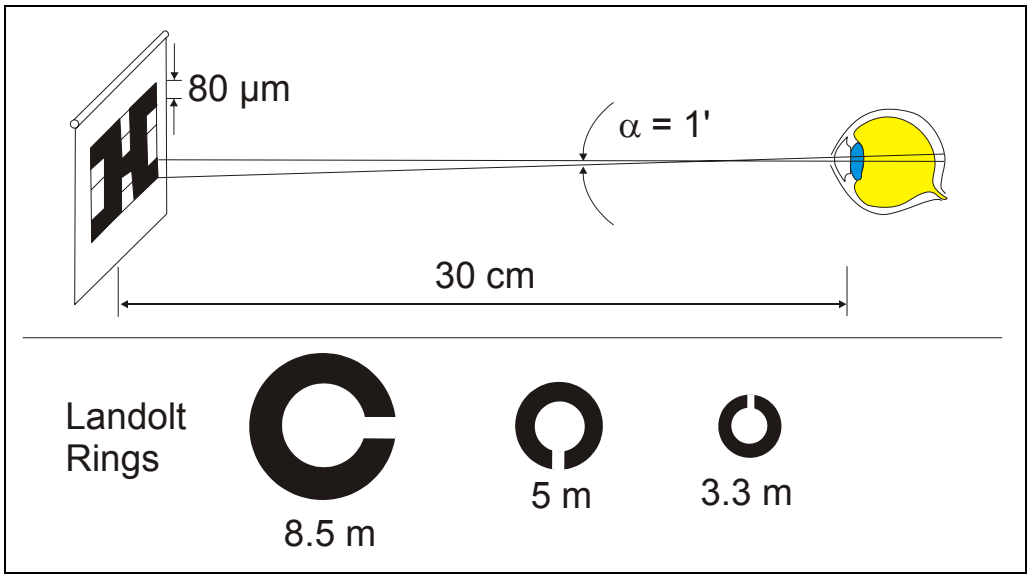


Figure 44

If printed on DIN A4 or letter, Figure 44 can be used to roughly check your resolution viewing capabilities.
Usually resolution viewing capabilities get worse with advancing age.

4.2 Contrast viewing capabilities

To be able to distinguish between two similar light stimuli is one characteristic of vision.
The **differentiation threshold** is the measure for it:

- **Absolute differentiation threshold**: Two light intensities I and I' are only just distinguishable
- **Relative differentiation threshold**: $\frac{I - I'}{I}$

- Scientific tests showed that the **minimum differentiation threshold** for the human eye **is 0.01**.
  It depends on the illumination and is best for a light intensity of approx. **100 cd/m.** It is not linear**.**
- The correlation between differentiation threshold and luminous density was examined by Mr. Kanamori in the early 1960s. Therefore this curve is also called **Kanamori curve**.

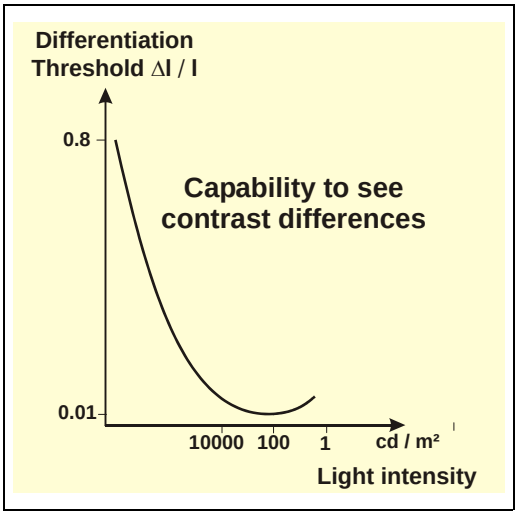


Figure 45

This means, the image preferably has to be reproduced on the film this way that the important information is in the area of approximately 100 cd/m².

- In the system 'film – light box' this can be achieved with following parameters: Light box light density between 2000 and 4000 cd/m² (European Guidelines on Quality Criteria for Diagnostic Radiographic Images - 1996)
- Important information of films should be in the density range of 0.5 to 2.2 O.D. (for definition of O.D. refer to 4.2.1)

Enclosed two examples of lightboxes with 2000 cd/m² and 4000 cd/m²:

Lightbox 2000 cd/m²

O.D.	cd/m²
0.5	Approx. 625
1	200
2	20
3	2

Lightbox 4000 cd/m²

O.D.	cd/m²
0.5	Approx. 1250
1	400
2	40
3	4

These two examples show, that for light boxes with a light density of 2000 to 4000 cd/m² the image information in the area of 1 to 2 O.D. fits to the most sensitive area of the eye.

4.2.1 Definition of parameter ‘Optical Density’

Definition of parameter ‘Optical Density’:
Optical density is the ability of an object to absorb light. Density values are obtained by measuring the proportion of the original light value to the reflected or transmitted light value. This is called transmittance.
The logarithm of the reciprocal transmittance value is the optical density.

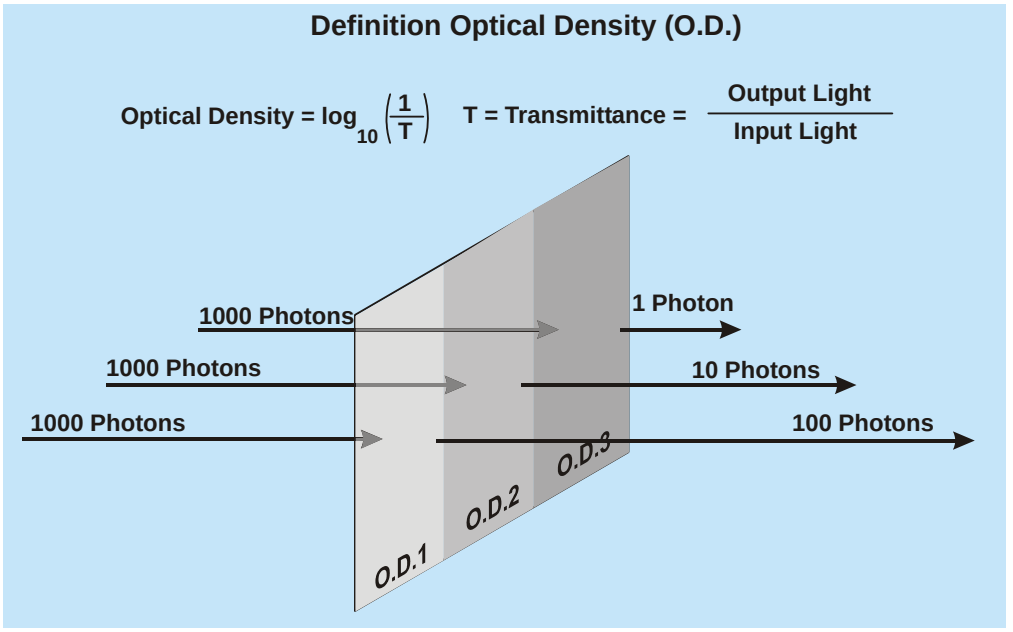
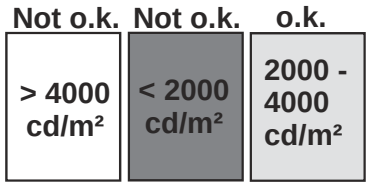


Figure 46

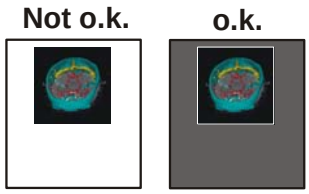
4.3 Lightbox Viewing Conditions

From the physiology of the eye different conditions for viewing diagnostic images at the lightbox can be derived:



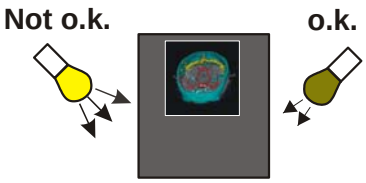
A light box which is to dark or to bright reduces the recognition capabilities of small contrast differences.

→ For optimum density differentiation the lightbox intensity of light should be between 2000 and 4000 cd/m² to get the important information in the density range of 0.5 to 2.2.



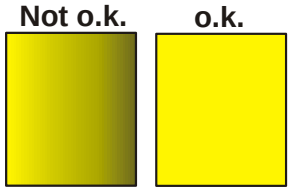
Extraneous light from non-covered areas alters the adaptation level and scatters within the readers eye, causing dazzle which decreases contrast discrimination.

→ Non-covered areas have to be covered.



Excessive ambient light reduces contrast while a dark ambient causes the pupils to open wide resulting in deterioration of visual acuity.

→ The ambient light should be moderate.



A lightbox with uneven illumination leads to wrong interpretation in the clinical image.

→ The lightbox illumination should be even.

5 Image Quality Adjustment

In this chapter following topics are treated:

Topic	Refer to ….
Calibration as base for proper Image Quality	5.1
Image Quality Parameters	5.2
Special image adjustments: Layouts, annotations and true size printing	5.3
User Interfaces for Image Quality Adjustments	5.4

In general we have to distinguish two printer types regarding image quality adjustments:

‘Old’ generation printers	‘New’ generation printers
	
Printer names: • Drystar 2000 • Drystar 3000 • LR3300 / LR52000*	Printer names: • Drystar 4500 (M) • Drystar 5500 • Drystar 5300
Properties: • Input via network (DICOM or APIP) and • Input via local VME interfaces	Properties: • Pure DICOM network printers • Optional: Postcript printing
Image adjustments made ….. • Partly via configuration at the modality • Partly via ‘customization’	Image adjustments made …..: • At the modality • In some cases at the printer**
Valid parameters described in …. • NVE parameter description DD+DIS115.98E (for all kinds of inputs) • DICOM Conformance statement of the individual printer (only for DICOM inputs)	Valid parameters described in …. • DICOM Conformance statement of the individual printer

*The Laser Imager belongs in combination with an MG3000 to the ‘old’ generation printers.

In combination with the LR DICOM Controller it belongs to the ‘new’ generation printers.

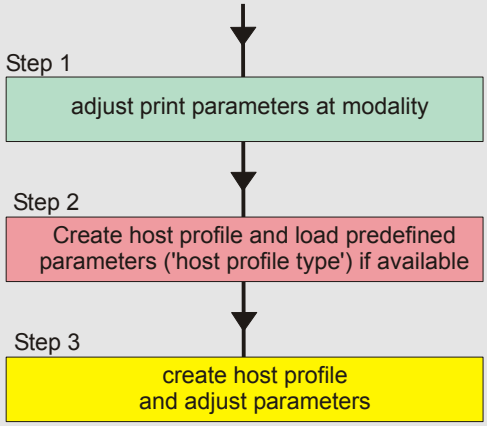
** In DICOM the responsibility for image quality lays at the modality side.

Sometimes the required parameter adjustments to get an optimum image quality cannot be performed at the modality, as the change of certain parameters was not foreseen.

The new generation printers (incl. the gateways Paxport, Multi-Flex and LR DICOM Controller) allow to manipulate (to add or to overrule) certain parameters via a so-called ‘host profile editor’.

Basic rule:

1) Try to adjust the Image Quality parameters at modality side! In case the modality offers no or only limited parameters to be adjusted, the default Image Quality settings of the printer fit almost all applications nevertheless!
2) Check in the ‘host profile settings, whether settings for the connected modality type exists. If yes, load the settings.
3) In case image quality requirements cannot be reached make adaptations for these modalities at the printer side by creating a host profile.



The parameters which are available for image quality adjustments at ‘new’ and ‘old’ generation printers in principle are the same.
The ‘new’ generation printers offer some additional parameters mainly regarding connectivity, which are explained in chapter 5.4.1.2.

5.1 Printer Calibration as base for proper Image Quality

To calibrate means, to ‘adjust by comparison with a standard’.

Example 1: In case the gasoline pump is not calibrated, it’s possible that we pay for 60 liters of gasoline, but only 56 liters are in the tank.

Example 2: In case the printer is not calibrated for the inserted film (and is of a different film batch than the one which is used for previous calibration), it’s possible that the Dmax and overall contrast is much too low.

Following parameters influence a constant image quality and make calibrations necessary:

- The film sensitometry (i.e. the sensitivity of the film for a certain light/heat intensity)
- At dry printers: The thermal head calibration (i.e. uniform heat emission for uniform signal input).
- A proper calibrated internal (Drystar 3000, Drystar 4500 (M), Drystar 5300, Drystar 5500) or external densitometer.

Table with printers and corresponding calibrations:

	Laser Imager	Drystar 2000	Drystar 3000	Drystar 4500(M)	Drystar 5500	Drystar 5300	Refer to ….
Film sensitometry	☑	☐	☑	☑	☑	☑	5.1.1
Internal Densitometer	☐	☐	☑	☑	☑	☑	5.1.2
TH Calibration	☐	☐	☑	☑	☑	☑	5.1.3

Proper image adjustments only can be made, in case the printer is calibrated properly.

The calibrations described in the following subchapters (5.1.1, 5.1.2, 5.1.3) shall only give an overview.

For a complete description about calibrations of the corresponding printer refer to chapter ‘Repair and Service – Adjustments and Calibrations’ in the Technical Documentation.

5.1.1 Film Sensitometry

Why to be executed:	The printer needs to know the correlation between input signal and density on the film. Refer to Figure 51, right hand side.
When to be executed:	Ideally with every new film pack.
How to be executed:	• Laser Imager: Offline menu – Calibrate Density • Drystar 2000: Local Mode – Calibration – Maximum Density* • Drystar 3000: Local mode – Calibration – Film Sensito • Drystar 4500(M); Drystar 5500: Key Operator menu – Calibration – Film • Drystar 5300: Key Operator menu – Calibration – Film Calibration ⇒ In all cases a testfilm with different grey areas is printed. Example see Figure 51, left hand side. ⇒ The density values of the different grey areas are measured and stored in the printer. ⇒ At printer with internal densitometer the measurement is made automatically. Refer to 5.1
What happens internally:	A table is created with correlation ‘input signal – density’. It is also called ‘sensitometric LUT’
Comment:	*Drystar 2000 creates sensitometric LUT by using the Dmax value only.

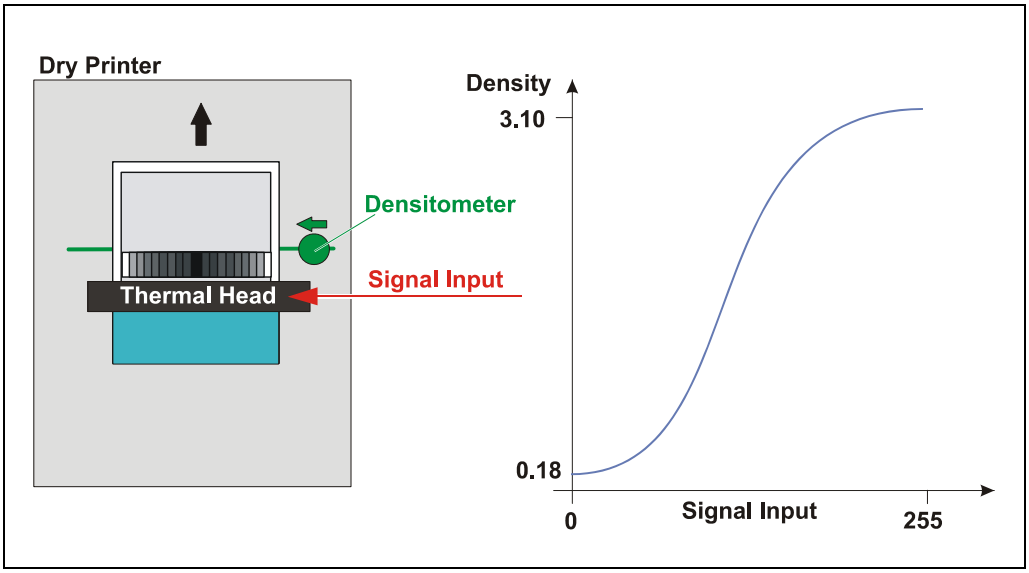


Figure 47: Sensitomteric (Film) Calibration

5.1.2 Internal Densitometer Calibration

Why to be executed:	The sensitivity of the photosensitive sensor as well as the light output of the light source can change in long term.
When to be executed:	• Drystar 3000: Once a year • Drystar 4500(M), Drystar 5300 and Drystar 5500: If the density reproduction check is not okay. Refer to 8.2.2
How to be executed:	• Drystar 3000: IMOS Drystar 3000 – Print Engine – Modules – MDM Calibrations - MDM • Drystar 4500(M); Drystar 5500: Service Menu – Adjust&Calibrate – Calibrate - MDM • Drystar 5300: Homepage – Service Engineer Tools – Calibration – Internal Densitometer Calibration ⇒ At Drystar 3000 a small film stripe with different densities is inserted and measured. The different density values are measured automatically.* ⇒ At Drystar 4500(M), Drystar 5500 and Drystar 5300 a testfilm is printed and measured with an external densitometer. The different density values have to be entered manually.
What happens internally:	A table is created with correlation 'light intensity – density'.
Comment:	*Drystar 3000 also allows to calibrate the internal MDM to an external densitometer. This function is called 'Reference Film' Calibration. In general, only a few densitometers are capable to measure the film density of dry films correctly. Refer to 8.2.

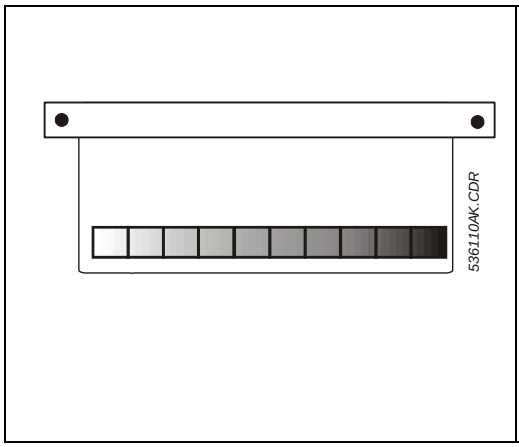


Figure 48: Drystar 3000 MDM stepwedge reference film

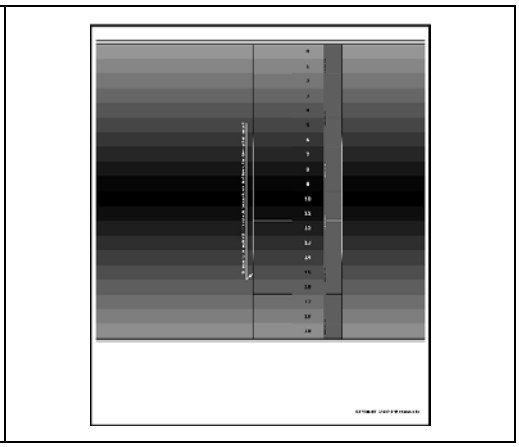


Figure 49: Drystar 5300 Densitometer Calibration film

5.1.3 Thermal Head Calibration

Why to be executed:	The correlation between current through a certain resistor of the thermal head and corresponding temperature can change in long term.
When to be executed:	• During maintenance (i.e. once a year) • Whenever unacceptable line artifacts in print direction are visible in the medical image
How to be executed:	• Drystar 3000: Local mode – Calibration – TH profile • Drystar 4500(M); Drystar 5500: Key Operator menu – Calibration – Print Head Profile • Drystar 5300: Homepage – Service Engineer Tools – Calibration – Print Head Calibration ⇒ In all cases a testfilm with constant density is printed. ⇒ The density values at a high number of positions vertical to the print direction are automatically* measured and stored in the printer.
What happens internally:	The TH calibration table originally created in production is adapted to guarantee, that for constant signal input over a line the density is uniform.
Comment:	*The measurement at Drystar 5300 has to be made manually, with an external densitometer, as the internal densitometer (called CDM) is not capable to move vertical to print direction.

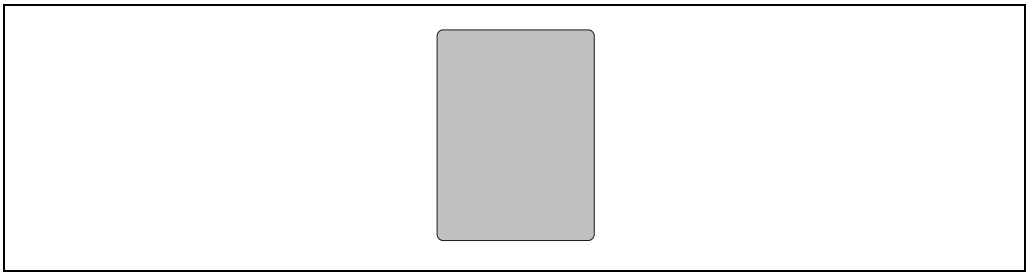


Figure 50: Drystar 5500 Print Head Calibration Film

5.2 Image Quality Parameters

In this chapter the most important image quality parameters are explained.
In general software engineers build in all kinds of parameters, to be prepared for all kinds of image adjustments.
Here following parameters are explained in greater detail:

Parameter	Refer to ….
Taste LUT	5.2.1
Interpolation	5.2.2
Window / Level	5.2.3

5.2.1 Taste LUT

Purpose Adjust the contrast of the image to adapt it to the physiology of the eye

How it works By defining the taste LUT (LUT = Look Up Table) a table is created in the printer with 256 or 4096 entries. With this table each individual pixel is manipulated before the image is prepared for printing in the printer RAM memory.

Available LUTs In general it is possible to create any taste LUT. The most simple one is a linear taste LUT.

In the table enclosed is a list of taste LUTs used in the Agfa printers:

Default value For all printers the default value is ‘Kanamori’.

Taste LUT	‘Old generation’ printers	‘new generation’ printers	Refer to …
Linear	**X**	**X**	5.2.1.1
Kanamori / Kanamori_like	**X**	**X**	5.2.1.2
Barten hardcopy transmission / reflection	**--**	**X**	5.2.1.3
Custom	**X**	**X**	5.2.1.4

The taste LUT is fit in between the minimum and maximum density of the printed film.
We distinguish between

- Dmin and Dmax as physical limits of the system film & printer and
- Dbmin and Dbmax (b stands for German "Bild" = image) as parameters that belong to the image control file.

The taste LUT will be fit between the highest value of Dmin / Dbmin and the lowest value of Dmax / Dbmax.

Example:

Printer limits: 0.2 (= fog level) and 3.5 (=film or printer limit)

Configuration parameter limits: Dbmin = 0.15 and Dbmax = 3.1

⇒ Dmin on the image will be 0.2 and Dmax will be 3.1

When judging the selected taste LUT, it is usually compared with the monitor (e.g. ‘image is too dark compared to the monitor’).

Be aware, that usually the Kanamori taste LUT fits, in case the monitor is adjusted properly.

How to check the monitor adjustment: Let an SMPTE image be loaded on the monitor. The display should be adjusted this way (brightness/contrast) that the 5% and 95% fields can be distinguished.

If this is not the case, the responsible service engineer should adjust the monitor, before the contrast of the hardcopy image can be judged.

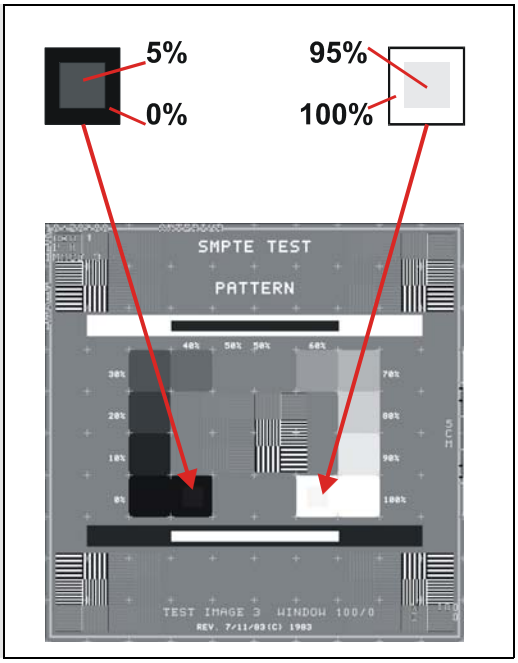


Figure 51

5.2.1.1 Linear taste LUT

The linear taste LUT is represented by a straight line between Dmin and Dmax.

For an 8 bit printer like e.g. the Drystar 3000 the taste LUT in fact is a table with 256 values.

For a 12 bit printer like e.g. the Drystar 4500 (M) the LUT is a table with 4096 values.

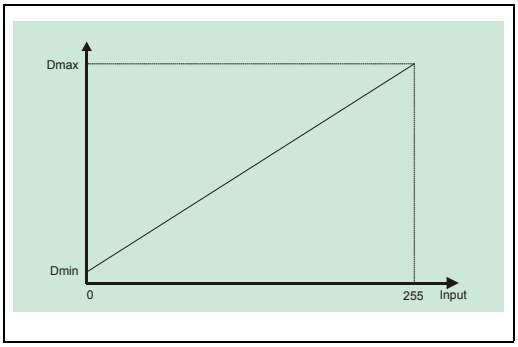


Figure 52

5.2.1.2 Kanamori and Kanamori_like taste LUT

The Kanamori taste LUT considers the experimentally found ‘non linear’ sensitivity of the eye for contrast differences.

By a so-called ‘user taste LUT sub identification’ (abbrev. utl_subid) variations of the Kanamori LUT can be defined. Utl_subid 100 (=default) corresponds to a true Kanamori curve, utl_subid 200 corresponds to a linear taste LUT.

Limits: Lower limit is utl_subid 75, upper limit utl_subid 220.

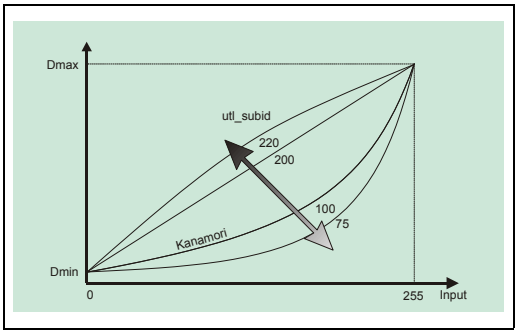


Figure 53

Example:

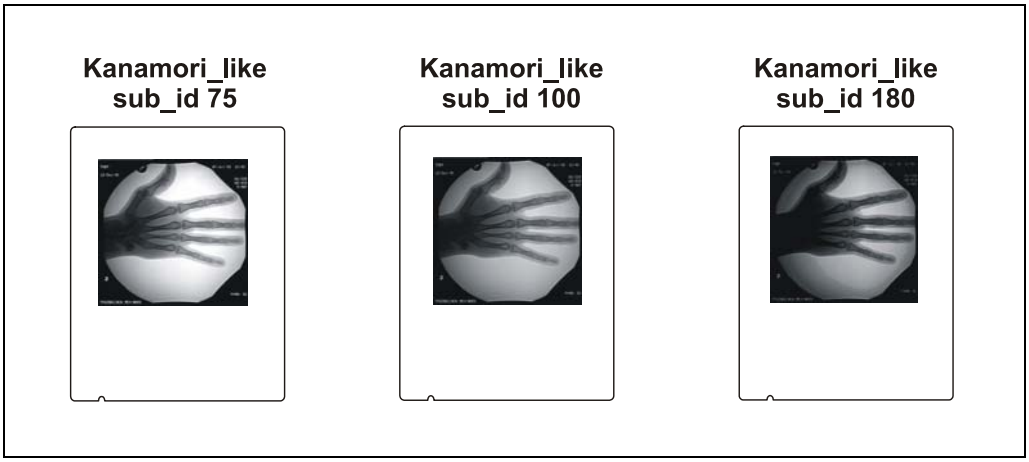


Figure 54

5.2.1.3 Barten hardcopy transmission / reflection taste LUT

The Barten taste LUT not only considers the experimentally found 'non linear' sensitivity of the eye for contrast differences, but also uses external parameters like the ambient light for creation of the LUT.

For transparent films the 'Barten hardcopy transmission LUT' is available, for opaque film material the Barten reflection is the best choice.

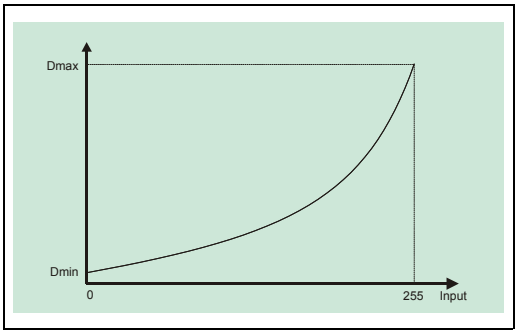


Figure 55

The Kanamori and the Barten taste LUT are quite similar. The Barten taste LUT is this approach, which considers environmental parameters, too: To be able to let the printer create the proper Barten taste LUT, the light density of the lightbox and the ambient light has to be measured and entered into the printer.

5.2.1.4 Custom taste LUT

Custom taste LUTs (‘custom’ like customized i.e. especially adapted) are created by the Connectivity Engineers for special applications.

Example: To adapt the Agfa printers to the Philips Easyvision workstation, the custom LUT OEM0001.UTL (selection: Perception LUT ‘custom’ with custom value ‘001’) is used.

Refer to Figure 56.

```
2021 2079 2136 2194 2251 2308 2365 2422
2478 2535 2591 2647 2703 2759 2815 2871
2927 2982 3038 3094 3149 3205 3261 3317
3372 3428 3484 3540 3596 3652 3708 3764
3821 3877 3934 3991 4048 4105 4162 4220
4277 4335 4393 4452 4510 4569 4627 4686
4746 4805 4865 4925 4985 5045 5106 5166
5227 5289 5350 5412 5474 5536 5599 5661
5724 5787 5851 5915 5978 6043 6107 6172
6237 6302 6367 6433 6499 6565 6632 6699
6766 6833 6900 6968 7036 7104 7173 7241
7310 7380 7449 7519 7589 7659 7730 7800
7871 7943 8014 8086 8158 8230 8303 8375
8448 8522 8595 8669 8743 8818 8892 8967
9042 9118 9193 9269 9346 9422 9499 9576
9654 9731 9809 9888 9966 10045 10125 10204
10284 10365 10445 10526 10608 10689 10772 10854
10937 11020 11104 11188 11273 11358 11443 11529
11615 11702 11790 11877 11966 12055 12144 12234
12325 12416 12508 12600 12693 12787 12881 12976
13071 13168 13265 13363 13461 13561 13661 13762
13864 13967 14071 14175 14281 14387 14495 14603
14713 14823 14935 15048 15162 15277 15394 15511
15630 15750 15872 15995 16119 16245 16372 16500
16631 16762 16896 17031 17167 17306 17446 17588
17732 17877 18025 18175 18326 18480 18636 18793
18953 19116 19280 19447 19616 19788 19962 20139
20318 20500 20685 20872 21063 21256 21452 21651
21852 22057 22266 22477 22692 22910 23131 23356
23585 23817 24053 24293 24537 24784 25036 25291
25551 25815 26083 26355 26632 26914 27200 27490
27785 28085 28390 28700 29014 29300 29659 29988
```

Figure 56

In Drystar 5300 SW Version 2.0, Drystar 5500 SW Version 2.0 and Drystar 4500 (M) SW Version 3.0 it is possible to select custom value 999.

This represents a custom LUT, which can be edited manually at the service PC. It has to be stored on the printer as ‘C:\oemlut\OEM999.txt’.

OEM999.txt is a textfile which has one lut entry per line. Example:

1800 (= 0.18 O.D.)

1953

...

31000 (= 3.1 O.D.)

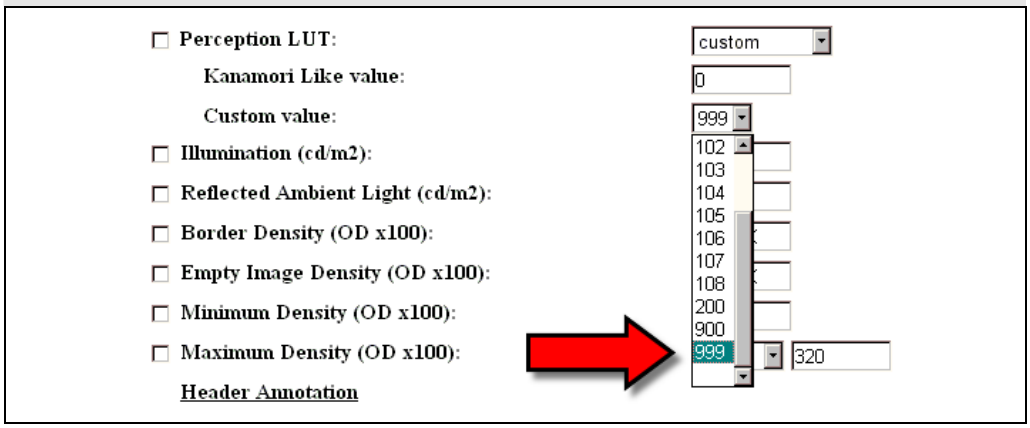


Figure 57

The own created LUT OEM999.txt may only be used in these very rare cases, where no predefined taste LUT fits.

In case of a wrong value in this LUT image faults or printer hang-ups can happen.

In case you need such a LUT call your support center to let the LUT be created by the hardcopy application team in Agfa headquarter.

5.2.2 Interpolation

Purpose

Adjust the sharpness of the image

How it works

The image size of the scanned image in certain cases is different than the image printed by the printer.
Example: A modality scans e.g. 2024 x 2024 pixels, the printer however prints it with 4352 x 4352 pixels.
By defining an interpolation type, the method for calculation of the new pixels as well as adaptation of the existing pixels is defined.

Available interpolation types

The Agfa printers offer many interpolation types that partly can be modified by smooth factors. The simplest ones are ‘replicate’ and ‘linear’.
Enclosed is a list of interpolation types used in the Agfa printers:

Default value

For all printers the default value is ‘high res cubic’.

Interpolation Type	‘Old generation’ printers	‘new generation’ printers	Refer to …
replication	**X**	**X**	5.2.2.1
Linear / bilinear	**X**	**X**	5.2.2.2
cubic	**X**	**X**	5.2.2.3

5.2.2.1 Replication

The interpolation type ‘replication’ is also named ‘nearest neighbor’, as the new created pixel gets the same pixel value than the neighbor.

It gives a very ‘pixely’ image impression.

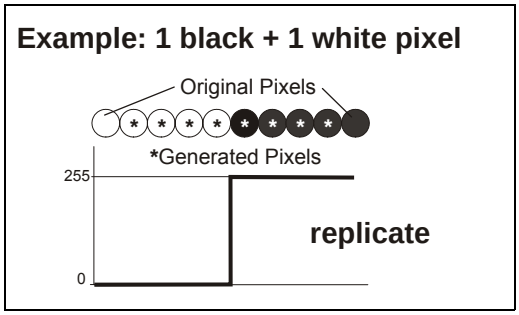


Figure 58

Example:

Original Image:

Figure 59

Image magnified 4 x with replicate interpolation

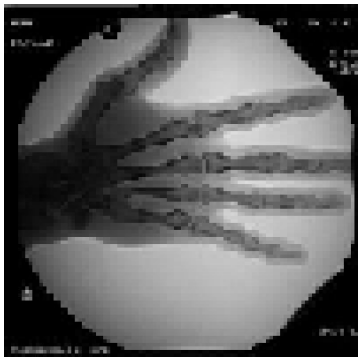


Figure 60

5.2.2.2 Linear / bilinear

The interpolation type ‘linear’ fills in the new pixels between two original pixels according to a linear curve. It is also named bilinear, as the interpolation works in both directions, i.e. in pixel and line direction.

It gives a very smooth image impression.

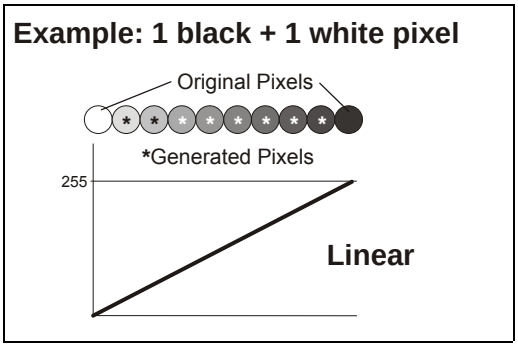
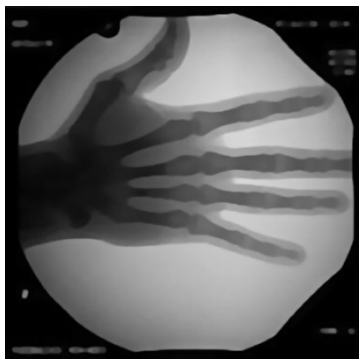


Figure 61

Example:

Original Image:	Image magnified 4 x with bi-linear interpolation
	
Figure 62	Figure 63

5.2.2.3 Cubic

The interpolation type ‘cubic’ fills in the new pixels between two original pixels according to a cubic curve (x^3).

It can be very smooth to very sharp, depending on the type of cubic interpolation and the smooth factor. Refer to info box below.

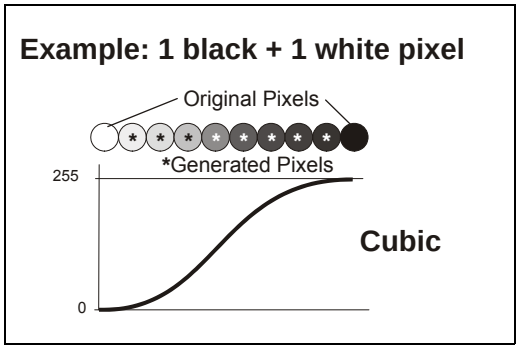


Figure 64

Example:

Original Image:

Figure 65

Image magnified 4 x with cubic interpolation

Figure 66

Cubic Interpolations

Following cubic interpolation methods are available in the Agfa printers:

- Cubic B
- Cubic High Res
- Cubic Bell

Type	How to adjust in old gen. printers	How to adjust in new gen. printers	Property	Default value for smoothfactor
Cubic B	Select HighRes Cubic with smoothfactor 0	Select Cubic B	Very smooth	--
Cubic High Res	Select HighRes Cubic with smoothfactor 137 to 150*	Select HighRes Cubic with smoothfactor -4.9 to +4.9*	137 sharp – 150 less sharp -4.9 sharp – +4.9 less sharp	140 for old. gen. printers / -2.5 for new gen. printers
Cubic Bell	Not available	Select Cubic Bell with smoothfactor 0.1 to 25	0.1 sharp – 25 less sharp	0.35

In case an image is sent from the modality, but this image is larger than the image box it is placed in, the image size has to be reduced. A reduction icon can indicate this fact. This is a sign for pixel loss.

Example: A CT sends 24 images with 2048 x 2048 pixels, the single image box on the film has 1360 x 1360 pixels only.

Adjustment at old generation printers: Via DSP parameter icon_pos. Refer to NVF manual DD+DIS115.98E.

Adjustment at new generation printers: Via parameter ‘reduction icon on image’. Refer to Figure 67.

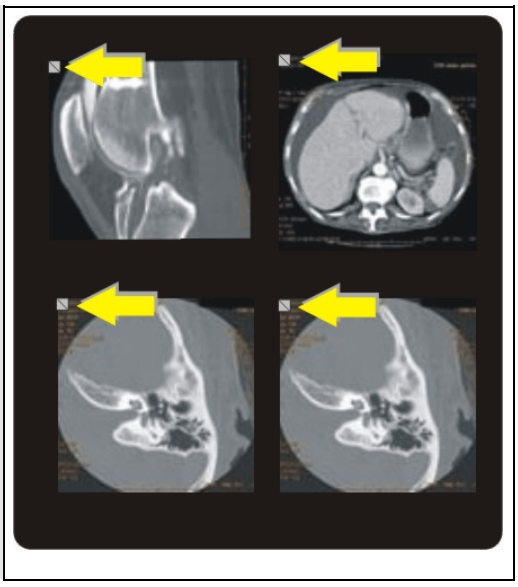


Figure 67

Remark to cubic interpolation at ‘new generation printers’:

Cubic High Res interpolation only should be applied, in case the modality sends the images in ‘image mode’, i.e. the single images of a print layout. Cubic High res only works, in case the image is scaled (magnified or reduced)

In cases where the modality sends the images in page mode, i.e. just one huge file per print layout, **cubic bell** interpolation with smooth factor 0.35 should be selected. Cubic bell interpolation also sharpens the image, even if it has not to be magnified.

In Drystar 5300 SW Version 2.0, Drystar 5500 SW Version 2.0 and Drystar 4500 (M) SW Version 3.0 it is possible to switch to cubic bell interpolation **automatically**, in case the modality sends in page mode (i.e. in case no magnification is required). Refer to Figure 68.

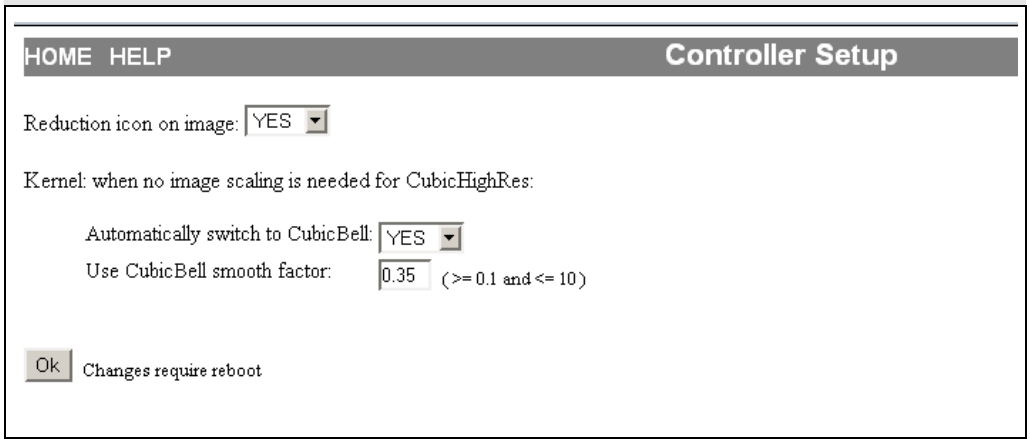


Figure 68

For an explanation what is an ‘old’ and ‘new’ generation printer refer to page 44.

*Correlation between ‘old’ and ‘new’ generation printer high res cubic interpolation smoothfactor settings:

-1 corresponds to MG3000 highres cubic 140 (sharp)
0 corresponds to MG3000 highres cubic 150. (sharp, but les sharp than 140)
0.6 corresponds to MG3000 highres cubic 156 (sharp, but less sharp than 150

Smoothfactor in ‘new’ gen. printers	-1	-0.9	-0.8	-0.7	-0.6	-0,5	-0.4	-0.3	-0.2	-0.1	0	0.1	0.2	0.3	0.4	0.5	0.6
Smoothfactor in ‘old’ gen. printers	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156

In old generation printers the smoothfactor is entered as defined by the DICOM standard.

In new generation printers the smoothfactor is entered as ‘Kernel smoothfactor’, as it is used in the printer for calculation for the smoothing.

Refer to the appendix page 109 regarding correlation ‘DICOM smoothfactor – Kernel smoothfactor’.

Unsharp masking:

Unsharp Masking is a digital process that enhances the apparent sharpness of an image by artificially increasing the contrast at the edges where different tones meet.

Or to say it in more practical words: Using high resolution cubic with smooth factor 137 (the interpolation method that gives the sharpest impression) still does not give the desired sharpness. Then "unsharp masking" is applicable.

It can be used for Drystar 2000, Drystar 3000 and LR5200 / LR3300, but by experience it should only be used for CR applications on Drystar 3000.

Following weight tables are present (on C: partition):
wgt6_140.tbl (= weight table for no unsharp masking).
wgt6_142.tbl (= weight table for 2% unsharp masking)
wgt6_143.tbl (= weight table for 3% unsharp masking)
wgt6_146.tbl (= weight table for 6% unsharp masking)
wgt6_150.tbl (= weight table for 10% unsharp masking)

Proceeding:

- Set NIPXXX11 parameter user_taste from 3 (default = no unsharp masking) to 1
- Set parameter MNUXXX0A ?? (A = input number; ?? = menu number) smooth_factor to either 140 (corresponds to 0% unsharp masking), 142 (corresponds to 2% unsharp masking), 143 (corresponds to 3% unsharp masking), 146 (corresponds to 6% unsharp masking) or150 (corresponds to 10% unsharp masking).
- Print 5 films; for each unsharp masking level one (normally level 3% fits best !)
- Choose the desired unsharp masking level for the desired menu.

Note: If unsharp masking is switched on (NIPXXX11, user_taste 1), it is active for all inputs.

Workaround to have unsharp masking switched off for certain menus:
The Drystar 3000 contains also two files "wgt2_140.tbl" and "wgt2_150.tbl". These two files represent the high resolution cubic interpolation with smooth factor 140 and 150 respectively, without unsharp masking.
Proceeding:

(1) Copy “wgt2_140.tbl” and "wgt2_150.tbl" to “wgt6_140.tbl” and "wgt6_150.tbl" (this has to be made, as the Drystar 3000 is only looking for “wgt**6**…” files if unsharp masking is switched on.
(2) Select for the desired menu either high resolution cubic with smooth factor 140 (very sharp) or 150 (less sharp).

5.2.3 Window/Level

Purpose

Cut off densities that do not contain clinical image information.

How it works

By defining window and level settings, an input LUT is created. Input LUT means, that pixels that are read in by the printer first go through a look up table.

Window / level settings

Following conditions for window/level settings must be fulfilled:

- level must be ≤ 1
- level + window must be > 0
- window must be > 0

Default value

For ‘old’ generation printers the default value is window 100 / level 0 (no clipping of pixels)

For ‘new’ generation printers the default value is window 1 / level 0 (no clipping of pixels)

Window / level should only be applied at video connections, where text is more white than the white of the clinical image.

In case the window/level setting it is applied wrong, clinical image information can be clipped, what can reduce the diagnostic value of the image.

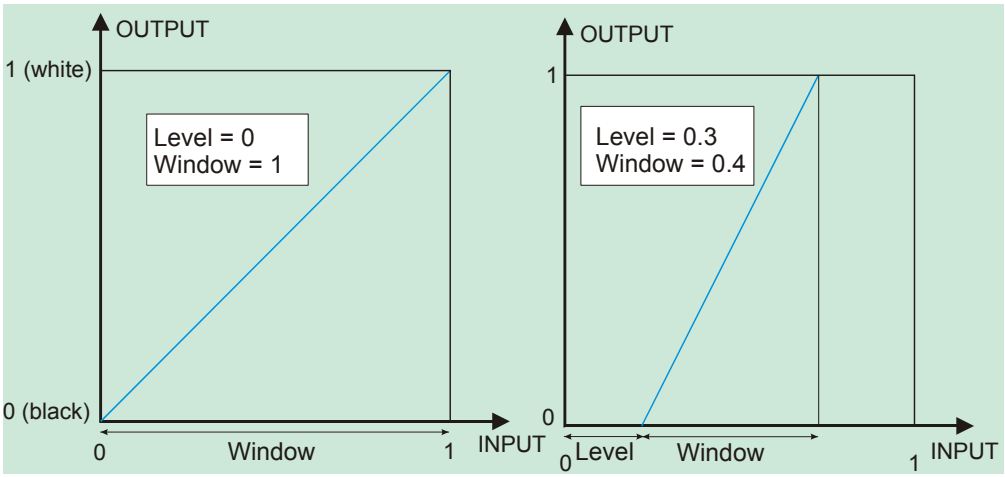


Figure 69

Example:

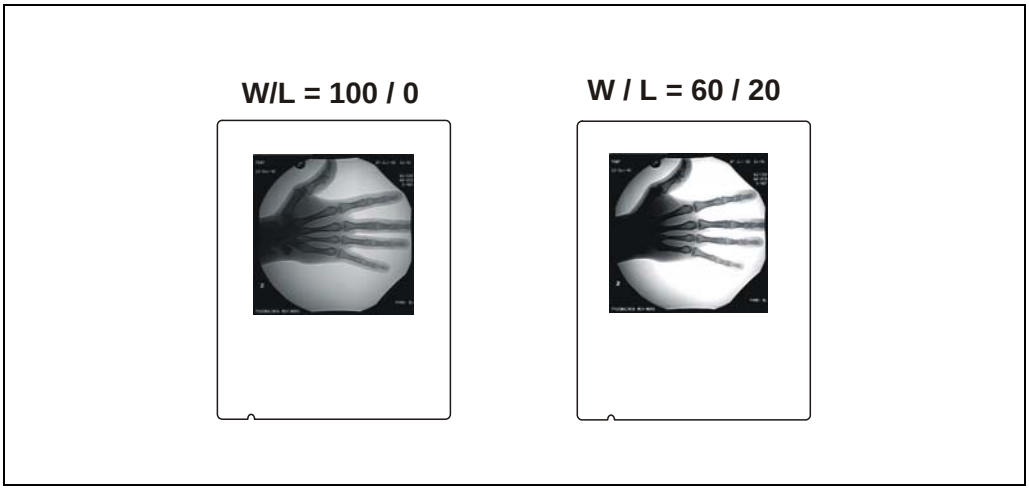


Figure 70

*In DICOM window and level is defined as shown in Figure 71. The 'new' generation printers make this re-calculation to DICOM standard internally.

In 'old' generation printers the window/level settings for DICOM inputs have to be entered via bw_wcenter and bw_wwidth (bw = black & white).

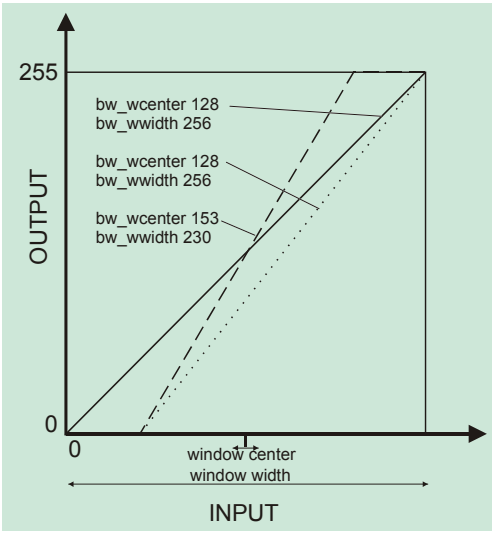


Figure 71

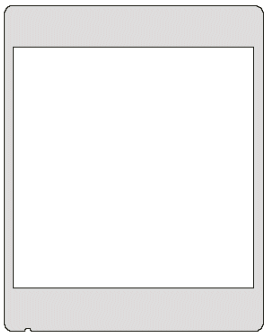
5.3 Special Image Settings

Following special image settings are introduced in this chapter:

Setting	Short description	Refer to …
Layouts	At network inputs the control of the layouts is made by the sending modality. At local inputs (Paxport and old generation printers) the layouts are chosen in the printer. Here the creation and usage of the layouts is explained.	5.3.1
Annotations	An annotation is text or graphical information, which is not part of the diagnostic image sent by the modality. Here the different mechanisms for ‘old’ and ‘new’ generation printers are explained.	5.3.2
True size printing	True size printing means, that the size of the x-rayed object corresponds to the size of the object on the printed film. Here the ‘true size printing’ mechanism is explained.	5.3.3

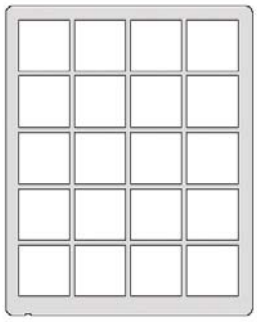
5.3.1 Layouts

The layout is the way the single image or the images are positioned on the film. Examples for two layouts:



8" x 10" 100

Figure 72



8" x 10" 106

Figure 73

In general, following two types of layouts for the Agfa printers can be distinguished:

Layout Type	Short description	Refer to …
.mg3 layouts	The layouts with extension .mg3 (e.g. OEM01XX.mg3) are only used in the **'old' generation printers**. The .mg3 files contain the complete definition of the layouts (width, height, borders, images per film; borders between images etc.).	5.3.1.1
DICOM layouts	DICOM layouts are used in the 'new' generation printers.	5.3.1.2

5.3.1.1 .mg3 layouts

The .mg3 layouts have been created by the connectivity group in Mortsel with the film layout editor (see Figure 74 and Figure 75).
They are part of IMOS OEM and downloaded to the 'old' generation printers during configuration.

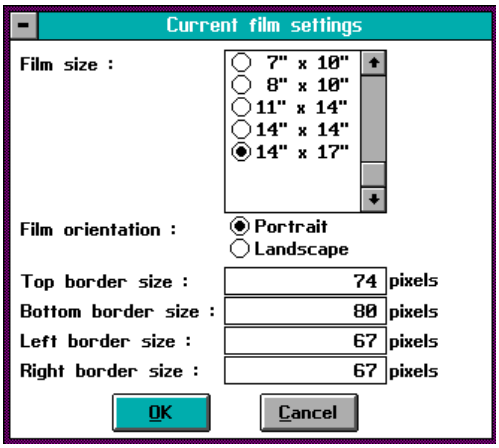


Figure 74

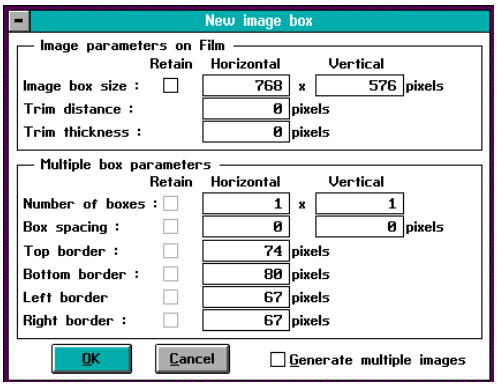


Figure 75

An .mg3 layout is identified via its name, which consist of 3 or 4 digits. (e.g. Layout 1024).
The 'film layouts' section of the Connectivity Documents describes all available layouts in detail. Connectivity release document 000051.pdf describes the basics of the .mg3 film layouts.

5.3.1.2 DICOM layouts

In DICOM layouts are defined either as standard layouts, row oriented or column oriented. Selection of the layout is done via DICOM print protocol. Three examples:

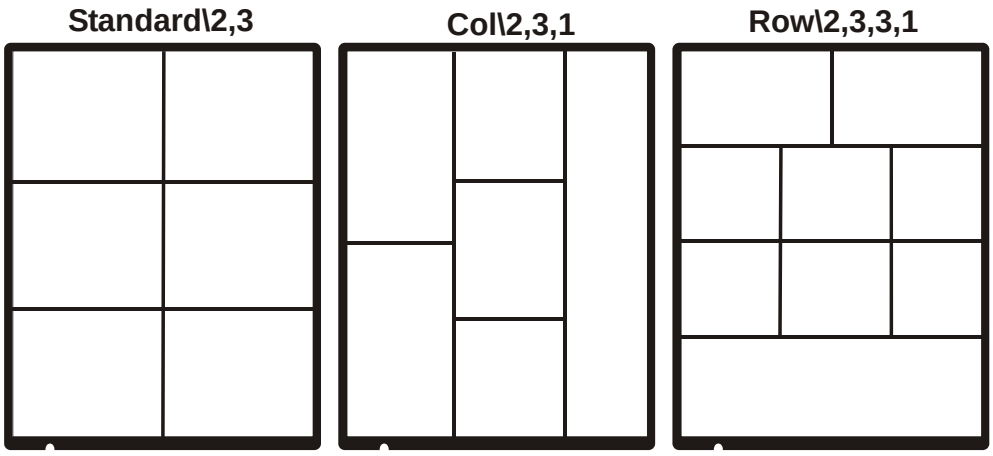


Figure 76

Explanation:

Standard\X,Y means	create a layout with X columns and Y rows
Col\C1,C2,Cx means	create a column oriented layout with C1 images in the first column, C2 images in the second column and so on.
Row\R1,R2,Rx means	create a row oriented layout with R1 images in the first row R2 images in the second row and so on.

Further DICOM layouts:

Slide	create a layout with 35 mm slides. The number of slides per layout is defined in the printer. In ‘old’ generation printers this is done via a .idf file.
Superslide	create a layout with 40 mm slides. The number of slides per layout is defined in the printer. In ‘old’ generation printers this is done via a .idf file.
Custom\	Use a specific layout of the printer as defined in the DICOM conformance statement. Example: custom\2011 defines the printer specific layout 2011.

5.3.2 Annotations

An annotation is text or graphical information, which is not part of the diagnostic image sent by the modality.

In the example of Figure 77 the textbox on top (Dr. Huber (089)12345) and logo at the bottom (**AGFA**) is an annotation each.

Figure 77

In **'old' generation printers** up to 6 annotations can be defined.

Most layouts allow to display annotations. Whether a layout is capable to display annotations is described in the film layout document part of the Connectivity Release Documents.

Annotations in 'old' generation printers have to be TIF files, which reside on the hard disk of the printer.

Connectivity release document 000051.pdf specifies the size of the annotation per film size and the type of TIF file.

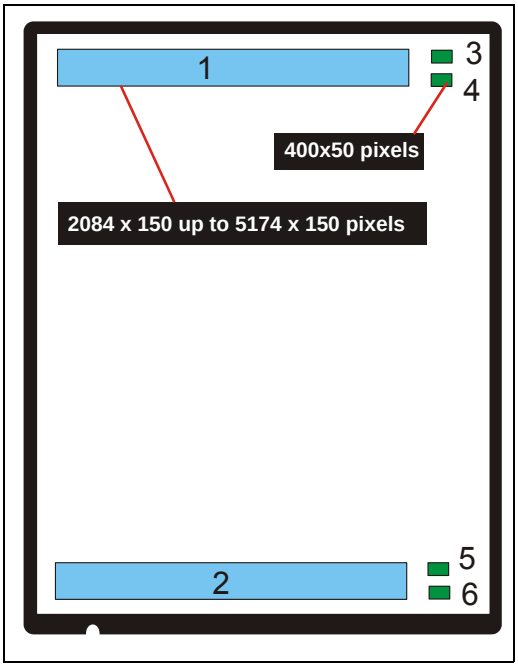


Figure 78

In **'new' generation printers** up to 2 annotations can be defined.

The annotation can either be any text (e.g. Dr. Huber), a DICOM tag (e.g. PATIENTID - if sent by the modality!) or a TIF file.

DICOM tags and text can even be combined with each other. Example: Film nr. %modalitypagenumber%

The DICOM conformance statement of the printer describes the valid annotations.

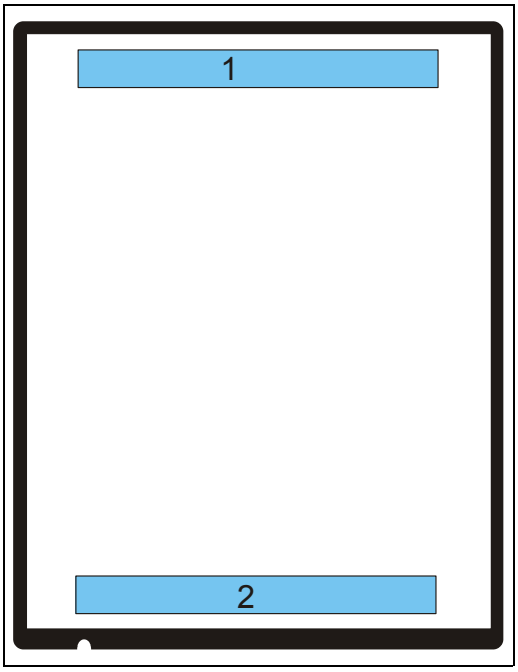


Figure 79

For more info to annotations refer to the help pages of the corresponding printer. An 'offline' version is also available on MEDNET, GSO library – Hardcopy - <printer> - documentation.

5.3.3 True size printing

True size printing means, that the size of the x-rayed object corresponds – in certain limits - to the size of the object on the printed film.

In case the modality prepares the complete image and sends it to the printer, the modality needs to know ….

- Number of pixels and number of lines (NPi/NLi) of the connected printer or the film layout used.
- The resolution of the printer (lines / mm or dpi)

In addition it has to tell the printer …..

- which film size has to be used

Enclosed an example of true size printing from ADC VIPS to LR5200:

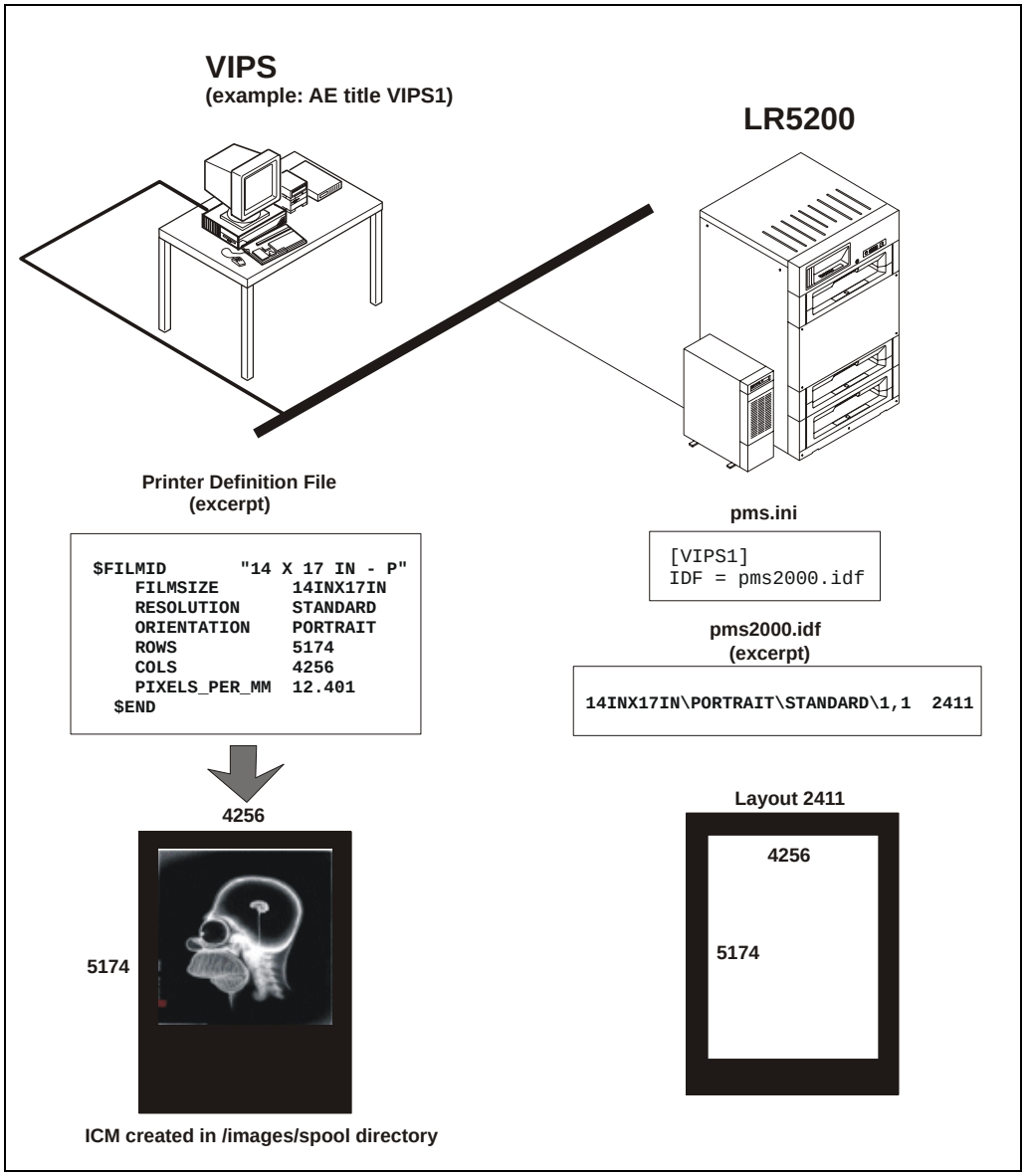


Figure 80

In cases, where the modality does not send the already prepared (i.e. magnified) image, but the printer has to prepare the image itself, two possibilities can be distinguished:

- The image is sent via DICOM and the parameter ‘requested image size’ is sent with the image. In this case the modality can determine how large the image has to be on the film.
- The image is sent via local input (VSI or MFRI). In this case you have to select the proper layout (i.e. NPi/NLi) to display the x-rayed object in scale 1:1. Possibly a special layout has to be created. Contact GSO Munich in case you need such a layout for true size printing from a local input.

When checking the correct size of the x-rayed object on the film consider the depiction scale in case the image detector – in this case an ADC image plate – is not directly under the x-rayed object:

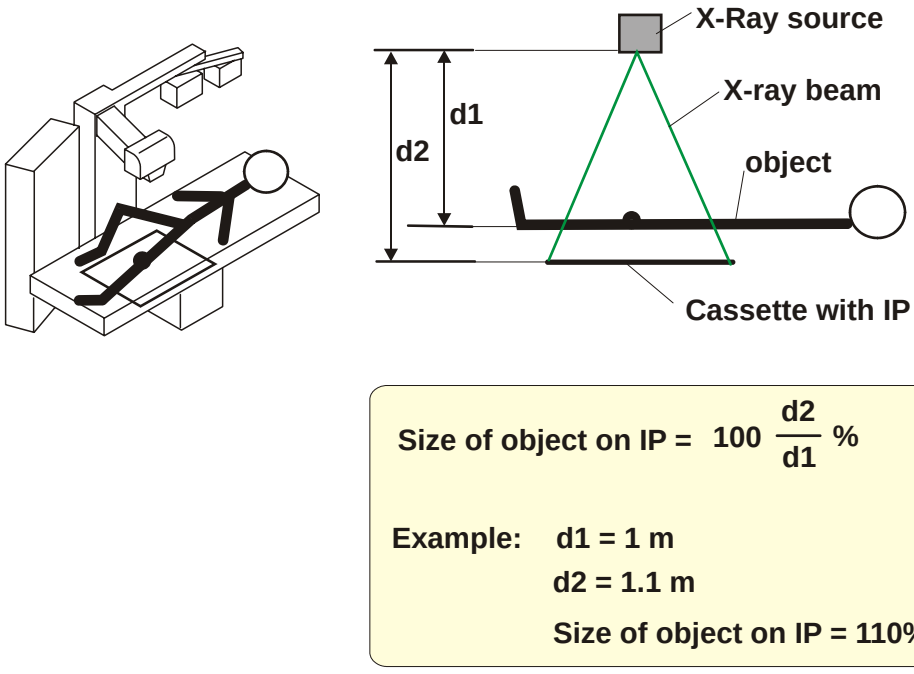


Figure 81

Remark to DICOM layouts for ‘old’ generation printers:

In case a modality sends the image via DICOM, the proper layout (which uses the maximum available space for printing) is only selected, if the pms2000.idf file is used for mapping of DICOM formats to Agfa .mg3 formats. The file pms2000.idf is always present on the C: drive of the printer (it gets downloaded during configuration).
To let the modality use the pms2000.idf, a ‘pms.ini’ file has to be created on the printer with IMOS DICOM.
Enclosed an abstract of the configuration steps:

(1) Check, that the file pms2000.idf is really on the C: partition of the (old generation) printer

(2) If the pms2000.idf is not present on the C: partition, start IMOS Megacon and select ‘Configure’ without any changes of inputs or output: This downloads (amongst many other files) the pms2000.idf.

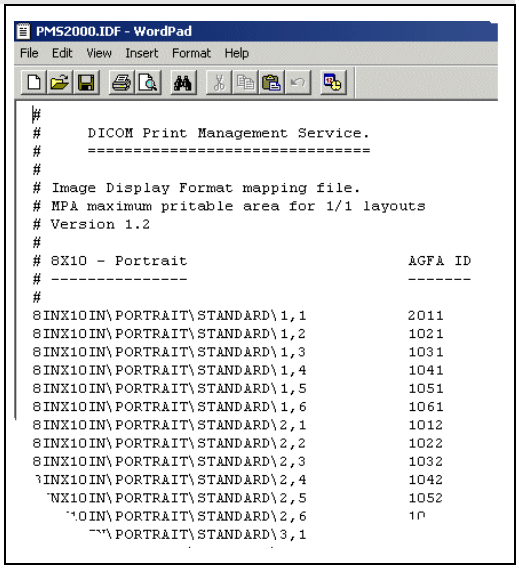


Figure 82

(3) With IMOS DICOM create a PMS profile:
a) Enter the AE title of the input modality.
b) Enter the location of the pms file (default: C:\pms2000.idf)
c) Select ‘Apply’.

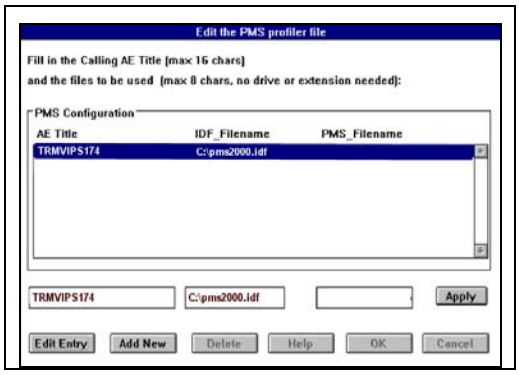


Figure 83

5.4 User Interfaces for Image Adjustments

Depending on the printer (old / new generation) different user interfaces are available for image adjustments. The table enclosed gives an overview:

	Old gen. printer	New gen. printer	Refer to ..
Browser	no	yes	5.4.1
NVE program	yes	no	5.4.2
IMOS	yes	no	5.4.3
Local keypad	no	yes	5.4.4

5.4.1 Browser as Interface for Image Adjustments

Browser pages as user interface are only available for the new generation printers.

They provide a comfortable user interface with online help for all available parameters.

They are divided in

- Key-operator tools
- Service engineer tools
- Specialist tools
- Security tools

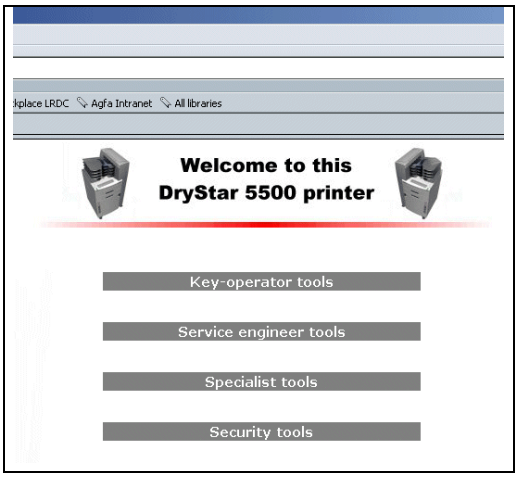


Figure 84: Drystar 5500 Homepage

Following pages of the Service Engineer Tools are used to adjust the image quality:

Page name	Purpose	Refer to ..
DICOM Print SCP Servers	Define ‘logical’ printers	5.4.1
DICOM Host Profile	Adjust and / or overrule DICOM print parameters	5.4.2
LPD Profile	Adjust and / or overrule Postscript print parameters	5.4.3

5.4.1.1 Logical Printer Setup

The DICOM print SCP server pages allow to setup logical DICOM print SCP printers.

To configure logical SCP printers can be necessary, in case for example printing is initiated at a PACS system, which has several modalities as input.
Example:
The PACS system collects CR and DSA images.

- CR images shall be printed with taste LUT Kanamori
- DSA images shall be printed with linear taste LUT.

Problem:
The workstation at the PACS system has one AE title. The Drystar 5300 does not recognize, for which type of modality (CR or CT) the user wants to print.
Solution:

- Create one logical printer 'Drystar5500_CT' and one 'Drystar5500_DSA'.
- Create two different host profiles for the two logical printers, one with Kanamori LUT, the other with linear taste LUT.
- In the workstation setup both printers: The user has to select the proper logical printer.

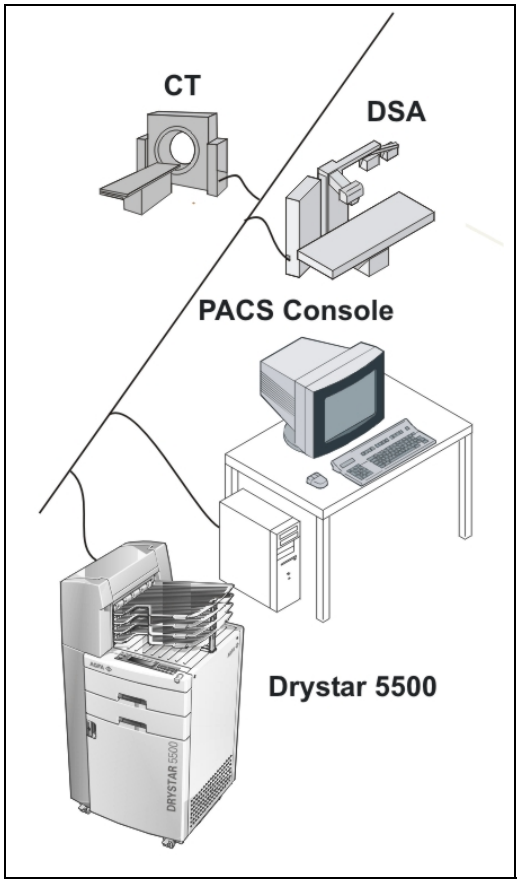


Figure 85

Following parameters can be adjusted in the DICOM print SCP server page:

Parameter	Description
Internal name	Internal name of the print SCP server. This name is only used to differentiate internally between 2 SCPs.
Called AE title	AE title of the printer. Use uppercase letters only (e.g. DS5500_1). A second DICOM print SCP server requires a different AE title (e.g. DS5500_2). This AE title has to be entered at the host modality for AE title of the printer.
Port	Default: 104. Changes have to be adapted in the modality. A second DICOM print SCP server requires a different port. Default for the second SCP server: 105

Max. allowed associations	Default: 10 Higher values should not be required - in case modalities are connected which do not quit the association better create a host profile for this modality and set the Association Timeout to e.g. 3600 secs. (1 hour).
Activate at startup	Default: on (checked). Only uncheck this checkbox in case the Print SCP Server is temporarily not required.
Secure channel (SSL)	In case the SSL checkbox is checked, this connection has to be configured in the 'Security Setup' pages.
Comments	These comments are just for information.

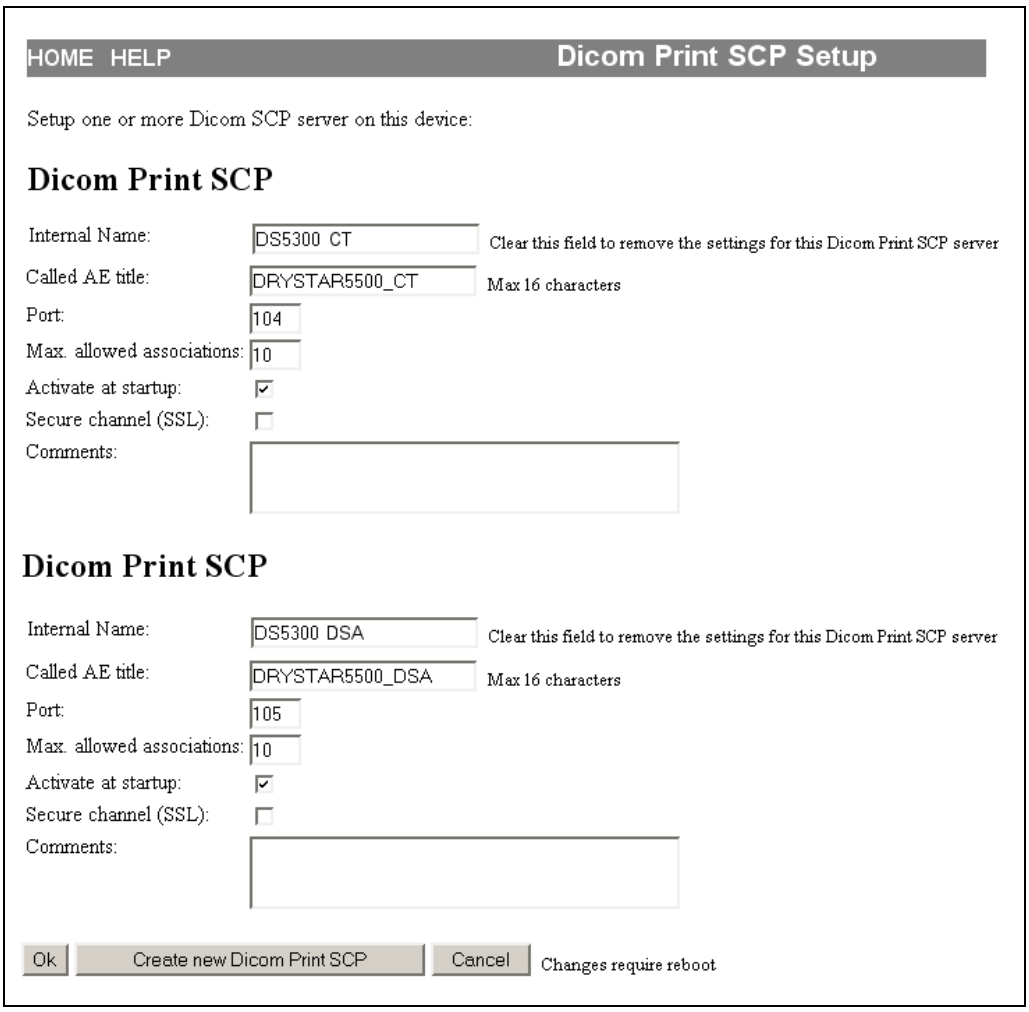


Figure 86

The number of logical SCP printers is not limited. As each configured SCP server consumes resources of the printer, use as little SCP servers as possible. Rule of thumb: Define max. 4 logical printers.

5.4.1.2 DICOM Host Profiles

When to use DICOM Host Profiles:

- In case of bad image quality of images printed via DICOM (e.g. modality sends taste LUT linear instead of Kanamori)
- In case images cannot be printed due to a parameter mismatch (e.g. modality wants to print on clear base film instead of blue base film)

….but only in case the parameter cannot be changed at the modality.

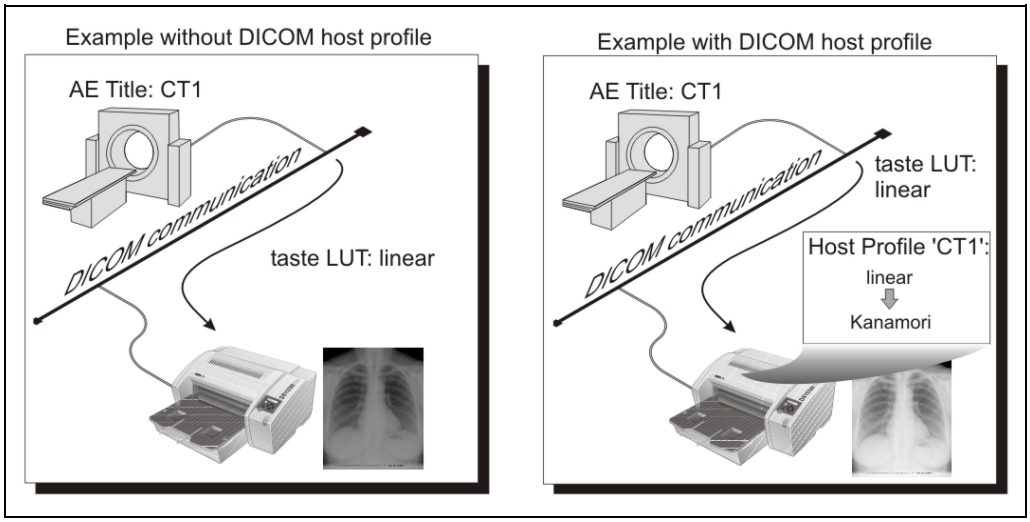
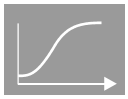


Figure 87

DICOM host profiles are depending on
a) the AE title of the modality
b) the logical printer setup

Parameters sent from a modality can be overruled by checking the checkbox before the corresponding parameter.
Before overruling any parameter, first check, whether it can be set at the modality. Preferably adapt the setting at the modality!

It is also possible to define a ‘Site Profile’.
A site profile is valid for all hosts.
At the current time (February 2004) only the parameters ‘annotation’ and ‘Mammo Modality’ can be setup for all hosts.



Following parameters can be adjusted in the DICOM host profile page (refer to Figure 88, page 83:

Parameter	Description
Nickname:	Enter the nickname (= name of the modality, how the staff names it) of the host modality. The nickname is only used for the queue display.
Use this profile only for incoming 'Calling AE title'	Enter the calling AE title of the host modality. Mandatory! With this parameter the printer detects, that it has to apply the parameter changes further specified below.
Use this profile only for local SCP Servers:	Select the SCP server (i.e. logical printer), which shall use this host profile. Default: 'All'. The logical printer is configured in the 'DICOM Print SCP setup'. Normally only one logical printer is required. Refer to 5.4.1.1
Host profile type	A Host Profile Type is a profile that contains host specific parameter values to ensure a proper printer connection for a certain Modality Type. Example: Selection 'Fuji Eyepix' sets the Perception LUT to OEM011. These parameter settings are tested in cooperation with the respective modality manufacturer and should not be changed. Selecting the 'GENERIC-GENERIC' profile assigns the default printer values to the parameters.
Number of copies:	Fill in the desired number of film copies
Print Priority:	Default = low. High corresponds to "emergency", i.e. in case you set it to "high", the jobs from this modality always will be set in front of the job queue.
Polarity:	Select the desired polarity of the images on the film. This entry can be used to invert the images of a certain modality.
Film orientation:	Select portrait or landscape
Trim	Select whether or not a trim (small white frame) should be displayed around the single images
Film size ID	Select the desired film size (e.g. 14x17”), to which the images should be mapped.
Medium Type:	Select the medium type that is available at the printer.

Print even if Film Size ID/Medium type not supported:	Select, whether films have to be printed also in case film size or film type are not supported by the printer. Default is set to NO. If set to 'NO': If the customer sends a job to the printer with not matching medium type/size, error: ''EDI18 Invalid attribute value (DICOM 106)' is created. If set to 'yes': A matching algorithm prints the image on an available film format. Refer to section 'supported film size' in the corresponding Printer DICOM Conformance Statement.
Kernel:	Defines the interpolation for image magnification. For more info refer to 5.2.2
Magnification:	• None: one pixel from the modality corresponds to one pixel on the film • Max: the image is magnified as much as possible (limits = image box) • Custom: the image is magnified as many times as specified • Truesize: if the image 'pixel size' is known, true size printing can be achieved. If 'truesize' is selected, the pixel 'width' and 'height' needs to be filled in as an 'absolute' value. (see 'Pixel Size') Preferably use max. magnification.
Pixel size:	The image pixel size can be entered as a ratio (pixel aspect ratio) by entering a width and a height value and not checking the **'Is Absolute'** checkbox. By checking the **'Is Absolute'** checkbox, the values are expressed in micrometer. This is required if 'magnification = true size' is selected.
Perception LUT	Refer to 5.2.1
Kanamori like value	Refer to 5.2.1
Custom value	Defines in combination with 'custom' Perception LUT the type of 'customized' Perception LUT: For several modalities the Kanamori or Kanamori_like perception LUT does not fit properly. These modalities require a customized perception LUT. These customized perception LUTs are numbered from 001 to 200. See also 5.2.1.4.
Illumination (cd/m2)	Enter the luminance of the lightbox in cd/m². It has to be measured with a light meter (not yet an official service tool). This value is used in combination with Barten Hardcopy Transmission taste LUT.

Reflected Ambient Light (cd/m2):	Enter the diffuse reflection luminance of the viewing area in cd/m², measured with a light meter (not yet an official service tool). This value is used in combination with Barten Hardcopy Reflection taste LUT.
Border Density (OD x100):	Enter the desired border density (i.e. density around the images). E.g. desired density = Dmax --> enter "black"; desired density = 2.8 enter "280".
Empty Image Density (OD x100)	Enter the desired density for an empty image. E.g. desired density = Dmax --> enter "black"; desired density = 2.0 enter "200".
Minimum Density (OD x100):	Enter the desired minimum density. E.g. desired min. density = 0.2 enter "020". Note: Dmin can not be below "fog level" (i.e. the physical lower limit, usually around 0.2 O.D.)
Maximum Density (OD x100):	Enter the desired maximum density. E.g. desired max. density = 3.1 enter "310". Note: Dmax can not be above Dmax, for which the printer is calibrated.
Annotation 1 and 2:	Select 'none', 'site' (= the one defined in the Default Dicom Site Profile) or 'custom' (the one defined here, by pressing the "Edit custom" button). For more info refer to 5.3.2
Window/Level in %:	Select the desired window and level setting. Note: Window/level never should be applied. This is removing gray value information, what possibly reduces image quality!
Image Orientation:	Select the desired image orientation. r stands for "rotation", m for "mirroring". The figure behind represents the rotation in degree. (e.g. m270 = mirroring plus rotation 270°).
Conformance / Status level:	Two printer information levels are defined: 0 (default) = No warnings are returned. Only 'Failure' status codes are activate. This means, that the printer either returns 'normal' or 'failure' (e.g. if printer is offline or film magazine empty) to the modality. 1 = Warnings are returned. Refer to DICOM conformance status of the printer and the host system. If the host system does not support 'status level' 1, leave this parameter on default (= 0). Required Setting Conformance Status level 'Failure' status codes are returned to the host 0 'warnings' are returned to the host. 1

Nevent enabled:	This parameter is used to enable/disable the use of the asynchronous N-EVENT messages. Although, conformance to the Basic Grayscale Print Management Meta SOP Class defines that the N-EVENT mechanism should be supported by the host modality, this parameter can be used to disable the N-EVENT if the host modality does not support it. Default = disabled. To say it in more practical words: → if N-EVENT is implemented in the modality - a customer could see on the user inter face if a specific printer is ok and has film before sending the job - there is also a report sent back that the film is printed successfully → if N-EVENT is not implemented in the modality if not implemented in the modality, N-EVENT enabled could give error messages on the modality and / or block the printing process. In other words: Only set N-EVENT enabled, in case the host modality does really support it. See DICOM conformance statement of the modality to confirm.
Mammo Modality:	Only applicable at Drystar 4500 M. Refer to note at the end of this section.
Association Timeout (sec):	This is the timeout initiated by the printer when the host modality does not send any association close request. This parameter should only need to be set in case the modality does not log-off. Limits: 0 to 86.400 secs (= 24 h).
Image Timeout (sec):	This parameter only should be set, if there are frequent image transmission troubles, that cannot be solved by other measures, like "check cabling, hub, other network devices disturb network, host modality network interface hangs up frequently etc." Limits: 0 to 600 secs (= 10 minutes)
Allow IMPLICIT VR LITTLE ENDIAN:	This enables the system configurator to avoid the usage of the transfer syntax 'IMPLICIT VR LITTLE ENDIAN', even if it is supported.
Allow EXPLICIT VR LITTLE ENDIAN):	This enables the system configurator to avoid the usage of the transfer syntax 'EXPLICIT VR LITTLE ENDIAN', even if it is supported.
Allow EXPLICIT VR BIG ENDIAN:	This enables the system configurator to avoid the usage of the transfer syntax 'EXPLICIT VR BIG ENDIAN', even if it is supported.
Supported Abstract Syntaxes	In general, this parameter defines which SOP classes should be negotiated with the modality of this user profile. Usually all displayed SOP classes should be negotiated, as the LRDC supports all the

	displayed SOP classes. At Siemens modalities which operate on the so-called Syngo platform, the connectivity between the printer and the Siemens modality experiences problems when negotiating the Meta Color Print SOP class (in that case the printerdestination becomes unreachable after the first printjob sent from the modality). To resolve this problem with Siemens (Syngo based) modalities deselect the BASIC_COLOR_PM_META_SOP_CLASS in that hostprofile, which was prepared specifically for this Siemens (Syngo based) modality. Enclosed the list of SOP classes the LRDC in general supports: BASIC_FILM_BOX_SOP_CLASS BASIC_GREY_PM_META_SOP_CLASS PRINT_QUEUE_MANAGEMENT_SOP_INSTANCE PRINTER_SOP_CLASS BASIC_COLOR_IMAGE_BOX_SOP_CLASS BASIC_GREY_IMAGE_BOX_SOP_CLASS BASIC_FILM_SESSION_SOP_CLASS PRINT_JOB_SOP_CLASS PRESENTATION_LUT_SOP_CLASS BASIC_COLOR_PM_META_SOP_CLASS BASIC_ANNOTATION_BOX_SOP_CLASS VERIFICATION_SERVICE_CLASS PRINT_QUEUE_MANAGEMENT_SOP_CLASS
Resolution	Only adjustable at the LRDC (LR DICOM Controller): The printer tells the LRDC at every bootup, which resolution it can print (315 or 630 dpi). Depending on the possible print resolution, the selection that can be made here is fixed to 315 dpi (galvo printer) or can be adjusted to 315 or 630 dpi (polygon printer). The selection of 630 dpi gives a slightly better sharpness and only little reduction in throughput.
Early processing allowed:	Default this parameter is switched on. The **Drystar 5500** starts image processing already when the first pixel data come in, to have higher throughput. In case the pixel data come slower than the Drystar is processing its data, the Drystar gets a 'data underrun': A film with incomplete pixel data will be printed. For modalities which send the image quite slow this 'early processing' can be switched off. This means, in case a user profile is made for this 'slow modality', the Drystar always waits up to 10 minutes (timeout), until all pixel data are present. Then it starts

	processing and printing of the data. If this parameter is unnecessarily switched off, the throughput will slightly decrease.
Initial allocated memory size per printjob (MBytes)	This parameter defines the 'initially allocated memory size' in the **Drystar 5300** for a print job coming from the respective Host. If, at the start of a printjob, the available memory is lower than the 'initially allocated memory size', the print job association will be rejected. If, at the start of a printjob, the 'initially allocated memory size' is available, then the printjob will be accepted and spooling of the print job will start. If the total amount of memory required for this printjob is lower then the 'initially allocated memory size', it's guaranteed that the complete print job will be spooled. However, if the total amount of memory required for this printjob exceeds the 'initially allocated memory size', then it's not guaranteed that this print job can be spooled completely. This will depend on the amount of free memory at that moment of time, and this depends on the amount of prints jobs which are active (spooling) at that moment of time. In practice this will mean that, depending on the actual print load, print jobs that exceed the 'initial allocated memory size' can be completed successfully or not. Remark: Increasing the 'initially allocated memory size' can guarantee print job spooling for the respective host, but will influence the print job spooling for the other hosts.

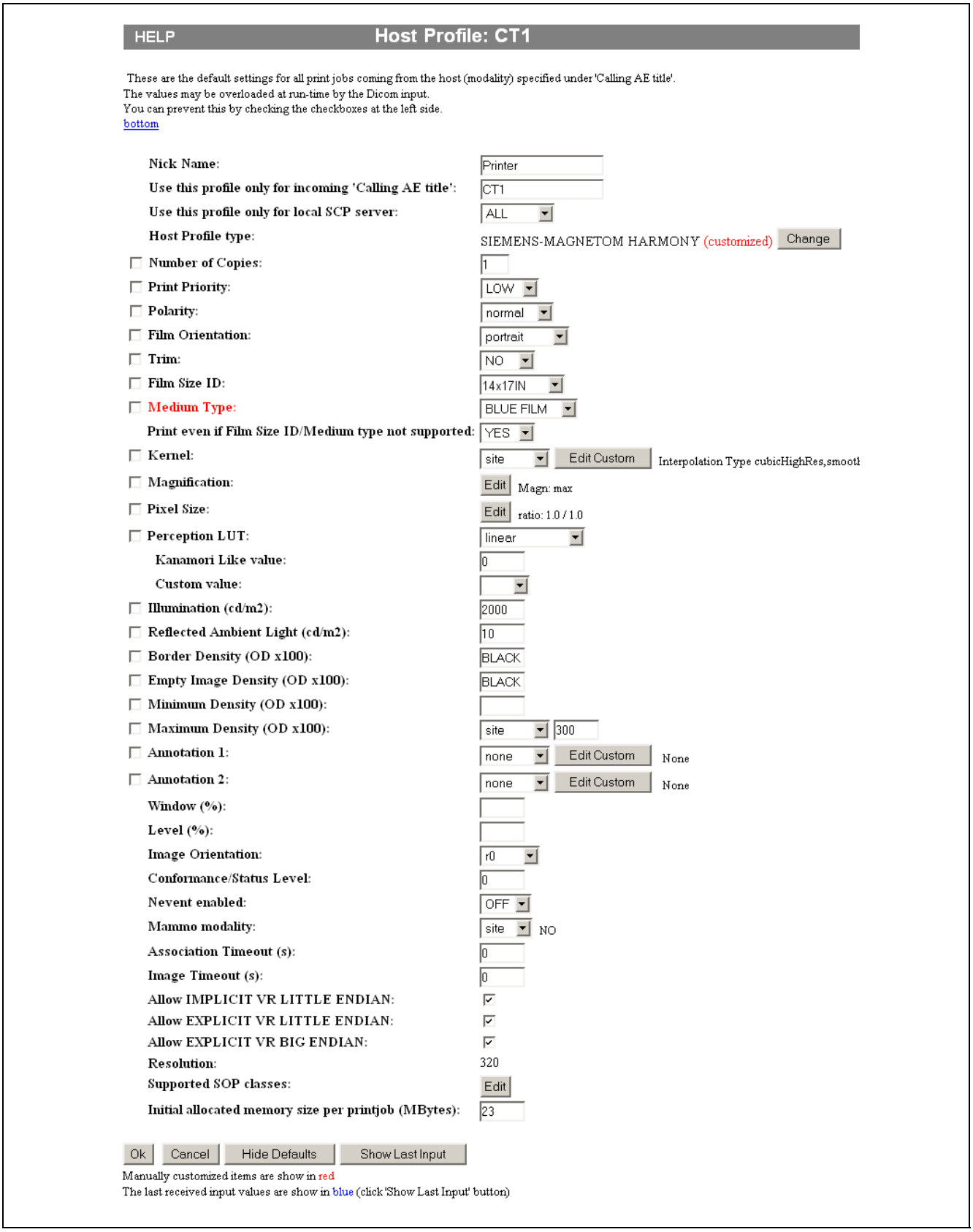


Figure 88: Host profile screen of a Drystar 5300

Note to parameter 'Mammo Modality':

Mammography specific settings

Main requirements for a digital mammography printer:

- Dmax ≥ 3.6
- Resolution ≥ 10 line pairs per mm (508 dpi)
- Images with black borders, to have no stray light between the images of the left and right breast.

Agfa has two printers for digital mammography in its assortment: The LR5200 and the Drystar 4500 M.

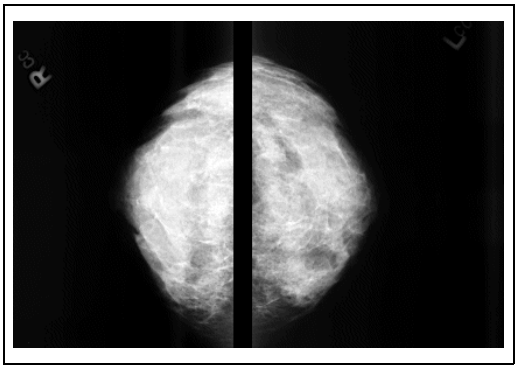


Figure 89

The only special setting for digital mammography printer is the Dmax of ≥ 3.6.

This ensures that no dazzling light reduces the recognition of small particles in the breast.

As the control of the Dmax is made by the modality, you only have to take care that the printer is using the proper film and is calibrated for Dmax ≥ 3.6.

Black border printing at Drystar 4500 M

In case the host profile for a certain modality specifies, that the input modality is a Mammo modality, the Drystar 4500 M has to print black borders.
To achieve the goal 'black borders' the implementation in the printer is as follows:

1. A minimal clear border of approx. 1.1 mm is printed. Refer to Figure 90: Mammography layout.
2. A 'chest wall recognition software' analyzes the image data and determines the chest wall of the image (i.e. the opposite side of the nipple). The 'chest wall' of the image will be printed towards the side of the film with the minimal clear border.

As the border is minimal, the corners of the film are partly blank, due to the round edges of the film (otherwise the Drystar 4500 M would possibly print on the film edge or the drum). This is what we call 'triangle corners are blank'.

3. Before hanging the image at the lightbox, the customer is rotating the image of the left breast again by 180°, and overlaps the two images by > 1 mm, leading to a black border between the two images. Refer to Figure 91.

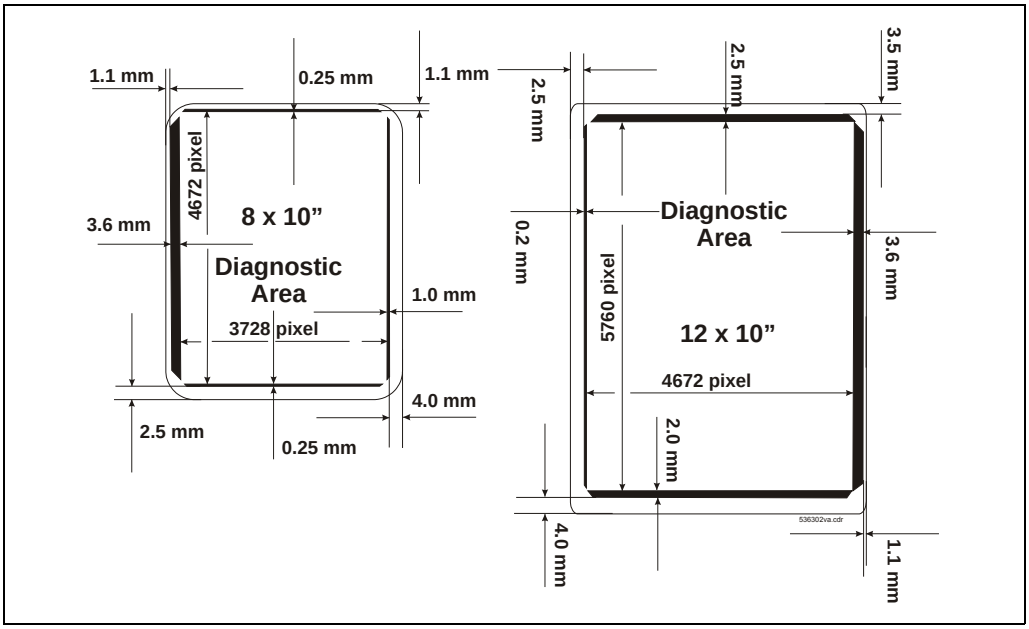


Figure 90: Mammography layouts

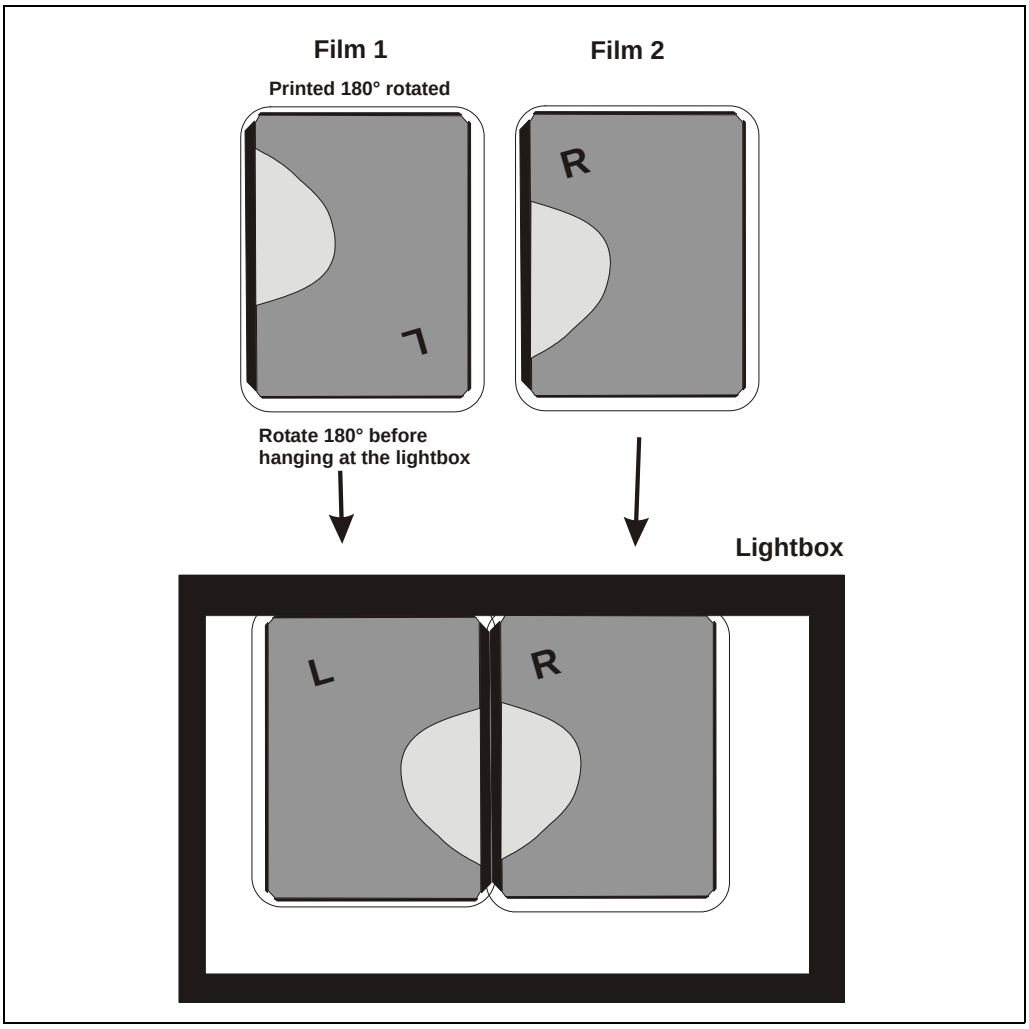


Figure 91

5.4.1.3 LPD Host Profiles

The 'LPD profiles screen' allows to adjust the parameters, that are sent from a host supporting the LPD protocol (line printer daemon). Image formats can be postscript (Postscript LEVEL 3), TIFF, JPEG and DCM (DICOM).

For an explanation of the different parameters refer to the HELP pages of the corresponding printer web page.

The online help pages of each printer are also available in the MEDNET, GSO library – hardcopy - <printer> - documentation section.

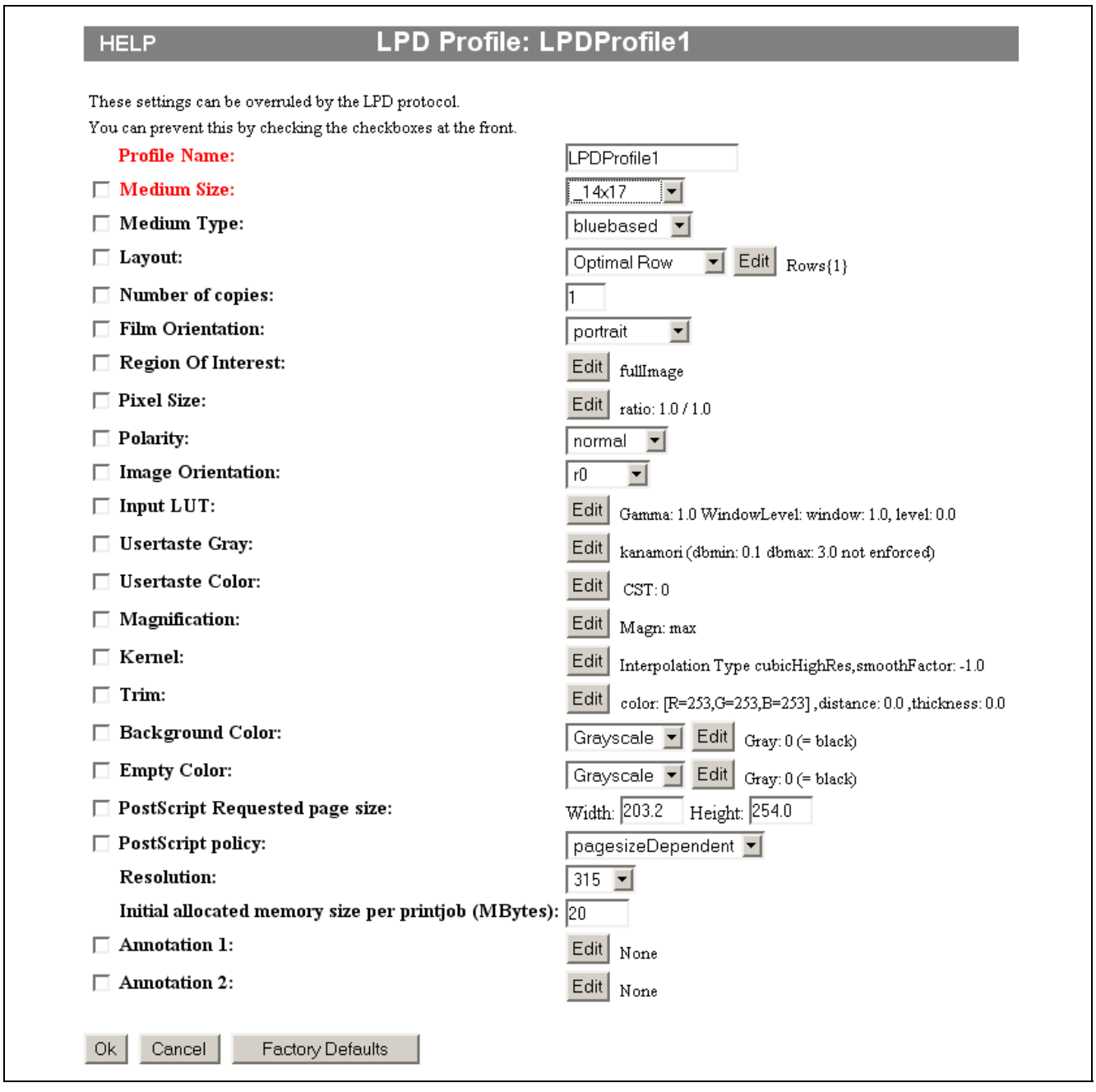


Figure 92: LPD profile screen of a Drystar 5300

5.4.2 NVE program as Interface for Image Adjustments

NVE (Name Value Edit) is a program running on old generation printers only. It allows to change all available parameters on command line level.

The usage and the meaning of the different parameters is described in the NVF manual DD+DIS115.98E.

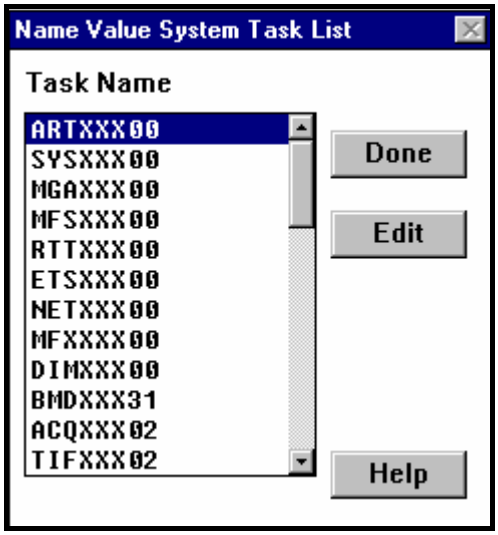


Figure 93

5.4.3 IMOS as Interface for Image Adjustments

IMOS (Image MOnitor Software) is a service program which provides a more user friendly user interface than NVE. It is a printer specific program running on the Windows service PC.

It is only required / available for the old generation printers (Drystar 2000, Drystar 3000, MG3000, LR3300, LR5200)

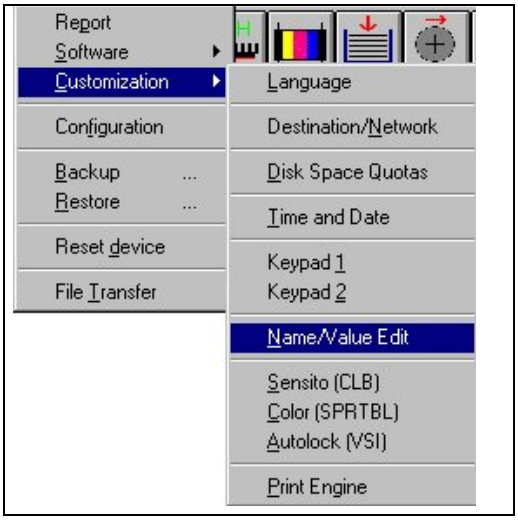


Figure 94

5.4.4 User keypad as Interface for Image Adjustments

The **Keypad** offers the possibility to change the most common image parameters.

At the old generation printers the adjustments only can be made at the user keypad, not the local keypad.

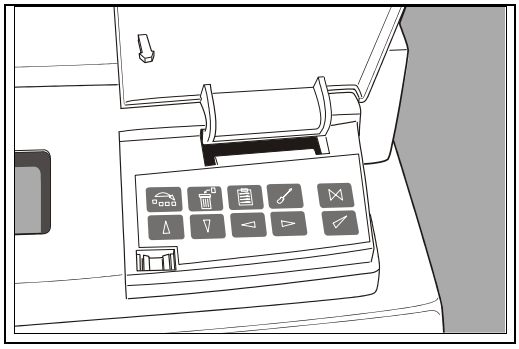
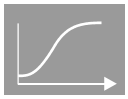


Figure 95

5.4.4.1 Overview of Adjustments via Keypad and Browser

Only the most important DICOM host profile parameters can be changed via keypad. The browser allows to change all parameters.

DICOM Host Profile Parameter	Adjustable via Browser	Adjustable via Keypad
Nickname:	☑	☑ Part of installation wizard
Use this profile only for incoming 'Calling AE title'	☑	☐
Use this profile only for local SCP Servers:	☑	☐
Host profile type	☑	☑ Part of installation wizard
Number of copies:	☑	☐
Print Priority:	☑	☐
Polarity:	☑	☐
Film orientation:	☑	☐
Trim	☑	☐
Film size ID	☑	☑ Part of installation wizard
Medium Type:	☑	☑ Part of installation wizard
Print even if Film Size ID/Medium type not supported:	☑	☐



Kernel:	☑	☑ Named 'Interpolation'
Magnification:	☑	☐
Pixel size:	☑	☐
Perception LUT	☑	☑ Named 'Look-up table'
Kanamori like value	☑	☑
Custom value	☑	☐
Illumination (cd/m2)	☑	☐
Reflected Ambient Light (cd/m2):	☑	☐
Border Density (OD x100):	☑	☐
Empty Image Density (OD x100)	☑	☐
Minimum Density (OD x100):	☑	☐
Maximum Density (OD x100):	☑	☐
Annotation 1 and 2:	☑	☐
Window/Level in %:	☑	☐
Image Orientation:	☑	☐
Conformance / Status level:	☑	☐
Nevent enabled:	☑	☐
Mammo Modality:	☑	☐
Association Timeout (sec):	☑	☐
Image Timeout (sec):	☑	☐
Allow IMPLICIT VR LITTLE ENDIAN:	☑	☐
Allow EXPLICIT VR LITTLE ENDIAN):	☑	☐
Allow EXPLICIT VR BIG ENDIAN:	☑	☐
Supported Abstract Syntaxes	☑	☐
Resolution	☑	☐
Early processing allowed:	☑	☐
Initial allocated memory size per printjob (MBytes)	☑	☐

6 Image Quality Control

→ Image quality control has the goal to check the image quality constancy.
→ It is carried out by the customers.
According to national regulations it may also be possible, that image quality control has to be carried out after installation, repair or maintenance.
Local regulations may determine additional quality control checks.

At Agfa hardcopy printers in general two different approaches regarding quality control can be distinguished:

- Image quality control according to IEC1223-2-4
- Image quality control according to Mammography Quality Standard Act (MQSA) of the FDA (Food and Drug Administration)

Short characterization of both approaches:

IEC1223-2-4

- Based on the evaluation of the SMPTE test pattern
- Base line values have to be generated after installation
- Values have to be measured again daily, weekly, annual and after major repairs
- The values have to be in certain limits

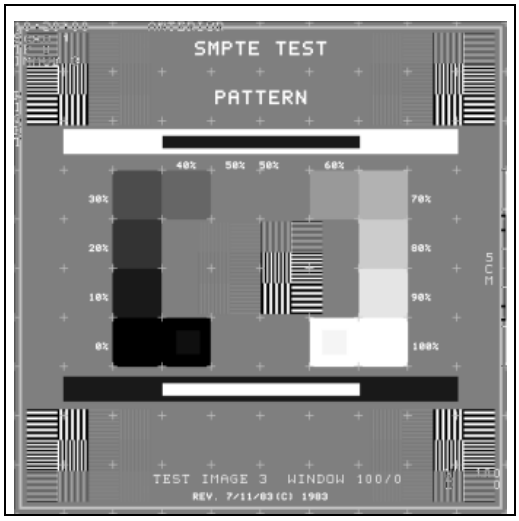


Figure 96

MQSA

- Based on an Agfa own QC testpattern, based on guidelines of the FDA
- Base line values have to be generated after installation
- Values have to be measured again daily, weekly, annual and after major repairs
- The values have to be in certain limits

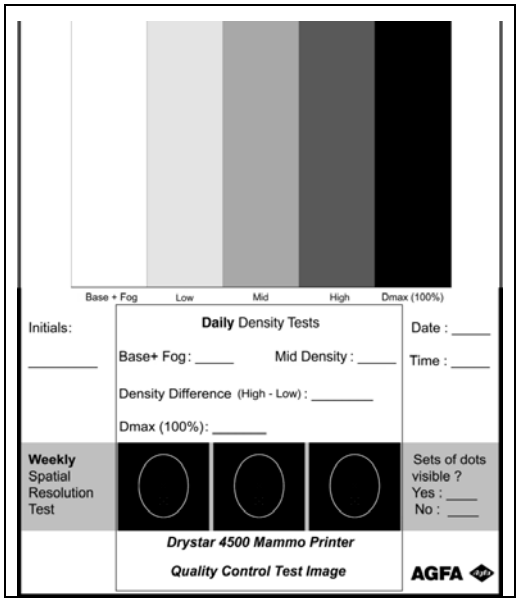
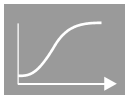


Figure 97



The table enclosed lists the printers and corresponding type of image quality control:

Printer	QC according	Comment	Refer to …
LR3300 / 5200	IEC1223-2-4	SMPTE test image has to be provided by modality or LR DICOM Controller (if available)	6.1
Drystar 2000	IEC1223-2-4	--	6.1
Drystar 3000	IEC1223-2-4	The step by step QC procedure is described in the latest Drystar 3000 reference manual.	6.1
Drystar 4500	Similar MQSA*	Implemented as of software release 3.0	6.1
Drystar 4500 M	MQSA	The step by step QC procedure is described in the Drystar 4500 M reference manual.	6.2
Drystar 5500	Similar MQSA*	Implemented as of software release 3.0	6.1
Drystar 5300	Similar MQSA*	Implemented as of software release 1.8.	6.2

Table 3

6.1 Quality control according to IEC1223-2-4

When to be carried out:

- At installation
- In case of exchange of imaging components (Laser, TH etc.)
- Usage of other film type or film batch
- In any case once a week (at a certain time of the day, i.e. a certain time after switch on of the printer)
- In case of variations every day (at a certain time of the day, i.e. a certain time after switch on of the printer)

Which tests have to be done?

1) Grey scale reproduction
2) Geometry of the image
3) Spatial resolution and low contrast resolution
4) Image stability and
5) image artifacts

Description of the tests:

In general for the tests a SMPTE testimage has to be provided. In case this is not possible, internal testimages providing the possibility for the same measurements can be used.

1) Grey scale reproduction

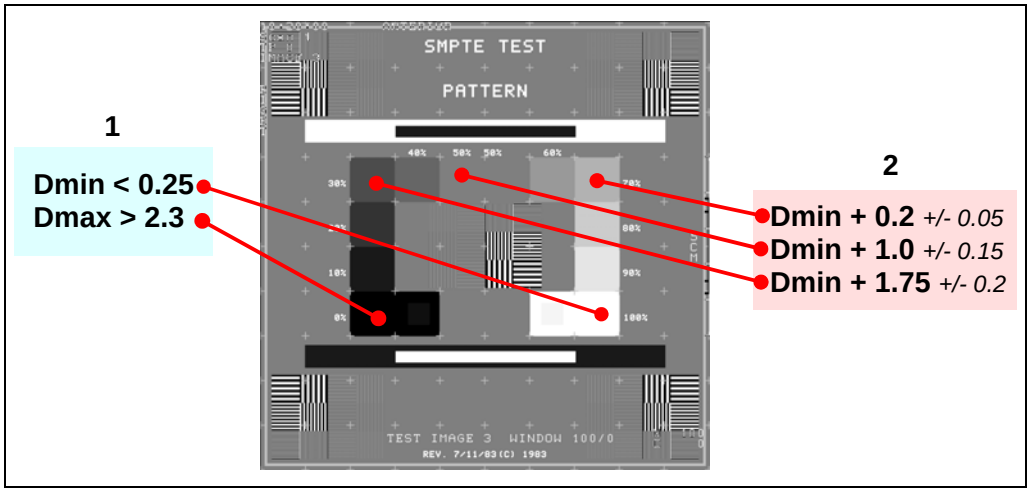


Figure 98

Note 1: In case the SMPTE image cannot be provided at the modality side, the sensitometry testfilm also can be used for this test.

Note 2: In the example above the 70%, 50% and 30% squares are used for measurement. Depending on the whole imaging chain, other squares may represent the Dmin + 0.2 and 1.0 and 1.75 densities.

2) Geometry of the image

Deviation of values A, F, B and values C, E, D from each other may not exceed 1%.

Or in other words: A = F = B and C = E = D

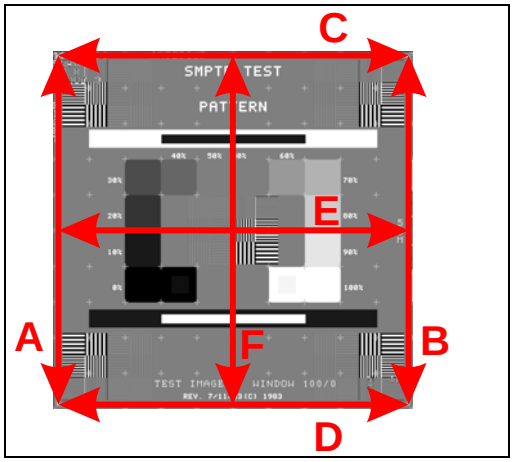


Figure 99

3) Spatial resolution and low contrast resolution

At Fields 1, 2, 3, 4, 5 the horizontal and vertical lines must be visible.

At Fields 6, 7, 8, 9, 10 the horizontal and vertical lines must not explicitly be visible, but the result must be documented.

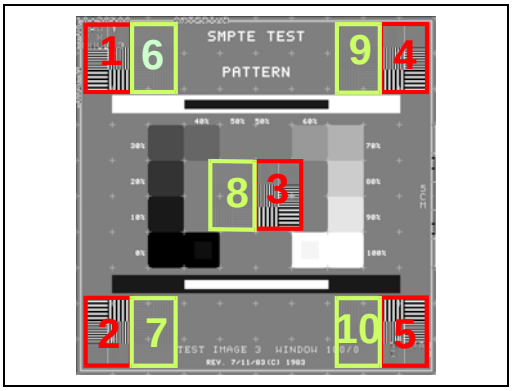


Figure 100

4) Image stability

At testpoints E1, E2, E3, E4 and M1 deviations of +/- 0.1 within one image may not be exceeded.

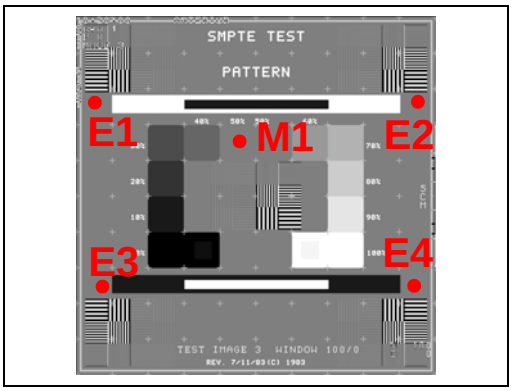


Figure 101

5) Image artifacts

To judge image artifacts a flat field **with density 1.2 +/- 0.3** should be used.
Look for:

- Scratches
- Horizontal or vertical line structures
- Discharge effects
- In general: Image inhomogeneities

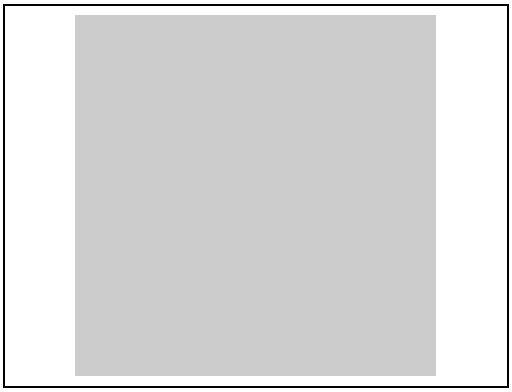


Figure 102

6.2 Image quality control according to MQSA

Drystar 5300, Drystar 5500 and Drystar 4500 also use the Image Quality Control procedure as described by MQSA. The valid limits however are less stringend than for Drystar 4500 M.

The detailed procedure is described in the reference manual of the corresponding printer (e.g. Drystar 4500 M).
Here only an overview of the QC steps is provided.

The MQSA (Mammography Quality Standard Act) quality control procedure can be divided in following 3 different procedures:

1. Density stability check (daily)
2. Spatial resolution and image artifacts check (weekly)
3. Image geometry check (annually)

After installation, all 3 tests have to be made and documented.

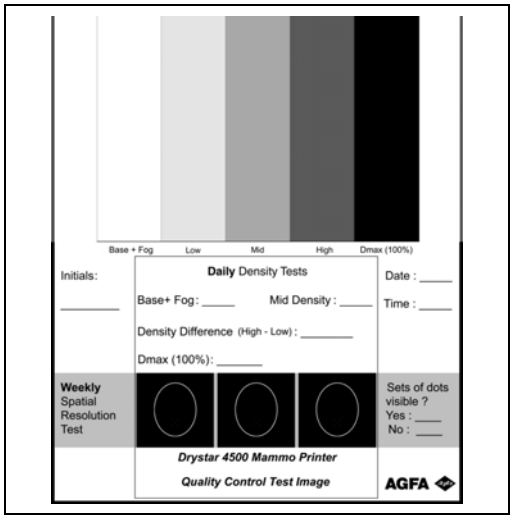


Figure 103

- The **density stability** check is initiated at the local keypad.
- The QC film is measured by the internal MDM – the values are calculated and displayed for recording on paper.

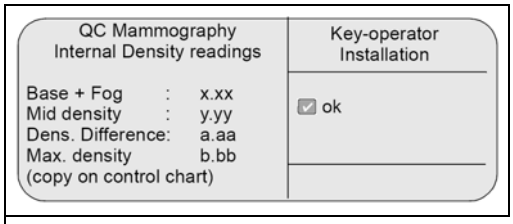


Figure 104

- The lower part of the QC test image is used for the weekly '**Spatial resolution and image artifacts chec**k' as well as for the annual **'Image geometry**' check.
- The result of all checks is entered in Quality Control Charts, which are available at the end of the printer reference manual.

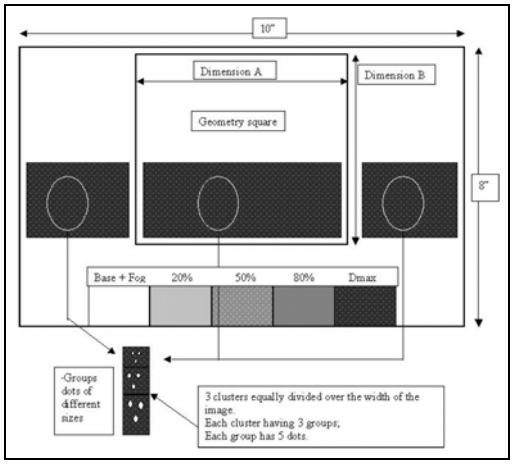


Figure 105

7 Image Quality regarding Hardware of the Input Interface

In the ‘old’ generation printers image input can be via digital, analogue or network interface.
The new generation printers only provide a network interface.

The table enclosed gives an overview of input interfaces and how the hardware can influence image quality:

Input Interface	Input Signal	Image quality …..
MFRI	 Digital	Image quality is not influenced by cable length or other parameters of the interface connection. Note: Image parity jumper on the MFRI board may not be set to ‘no parity’. In case it would be set to ‘no parity’, the check of the interface if all pixel data received correspond to the pixel data sent cannot be made.
Ethernet Board	 Digital	Image quality is not influenced by cable length or other parameters of the interface connection.
VSI / M6U	 Analog	Image quality depends on ……. • Cable type (coax / fiber). Refer to 7.1. • Video chain. Refer to 7.2. • VSI autolocking. Refer to 7.3.

7.1 Video connection via coax or fiber optic cables

The image quality of a video connection between modality and printer is influenced by following parameters:

- Cable length → the longer the cable the worse the video signal
- Frequency of the video connection → the faster the signal the worse the video signal for the same cable length

- The cable length of the analogue cable of a video connection should be as short as possible. As a rule of thumb a cable length of 5 m preferably should not be exceeded.
- In case the cable has to be longer than 5 meter, an analogue to fiber optic converter can be used. The Agfa product name is called VIDCOM. Refer to section 9 of the MG3000 or Drystar 3000 Technical Documentation.

Figure 106

7.2 Video Chain

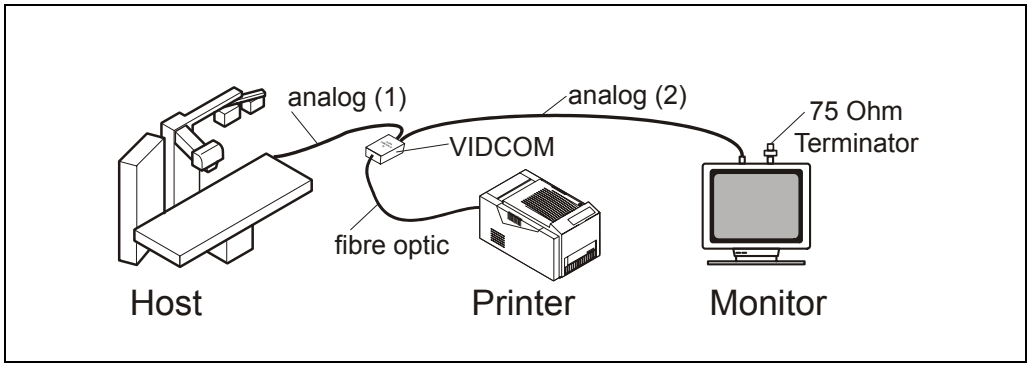


Figure 107

- The printer should be the first device in the video chain.
- The analog coax cable (1) should be kept as short as possible. For high line rate video (> 100 MHz pixel clock frequency) coax cable length has to be max. 5 m
- To keep image quality on highest possible level it is recommended always to use fiber optic connection (max. 350 m length)

7.3 VSI autolocking

VSI autolocking is a program running on the printer to adjust the video parameters of the VSI video board.
A wizard guides you through the adjustment process, however basic video knowledge is required to make the proper decisions during execution of the wizard.
For more information refer to

- Chapter 9 of the MG3000 or Drystar 3000 Technical Documentation
- Video Principles DD+DIS004.86E

VSI autolock is available on following products (in alphabetical order): Drystar 2000, Drystar 3000, MG3000, Paxport.

All other printers are pure network printers and do not require a video interface.

8 Tools for Hardcopy Printers

The chapter 'Tools for hardcopy printers' is divided in following sections:

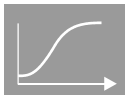
Tools	Refer to …
General tools	8.1
Densitometers	8.2

8.1 General Tools

Here all the tools are listed for hardcopy printers in general.

For a list of tools for all Agfa medical devices refer to MEDNET, GSO Library - Technical Services, GSO Newsletter 2003-016: List of Tools for HealthCare Devices.

Item	Order number	Application
Cleaning tissue (box of 50 pieces)	CM+309931.0	To clean the thermal print head
IMOS Service software on CD ROM	10+7.9820.0399.0	For service work on the 'old' generation Printer
Interface cable RS232 9pin Sub D - 25pin Sub D length 2,5 m	CM+9.5120.9030.0	To get access to the printer terminal level.
Laser goggles	CM+9.9999.1547.0	In case the optical path of the laser imager has to be opened
Loopback connectors 1 piece for network; 1 piece for RS232 interface	CM+339977.0	To check the serial and network interface of Drystar 4500 (M) and Drystar 5500
Magnifying glass	CM+9.9579.9904.0	To check image quality
MEDSET Darkscan Densitometer / Sensitometer	CM+9.9999.1023.0	Calibration of the film density of the Laser Imager
X-Rite 331/341 densitometer	Commerially available. Refer to www.xrite.com	Calibration of the internal MDM/CDM of the dry printers.



Service key 2 pieces required	CM+9.0426.6309.0	To override the safety switch
T-connector 75 Ω	CM+7.8966.0559.0	To terminate an external synchronization for measuring with the Oscilloscope.
Termination-resistor 75 Ω	CM+7.8966.0560.0	To terminate the video outputs.
Thermometer up to +50°C	CM+9.9999.0291.0	To measure the temperature of the chemicals
UTP crossed network cable	EB+72010270	Crossed network cable to connect Service PC via the network port
Vacuum cleaner 220/240V, 50Hz 110/115V, 60Hz	 CM+9.9999.0895.0 CM+9.9999.0896.0	For Maintenance
Wrist strap 2 MOhm	CM+9.9999.0830.0	To be worn when handling PCB's and other internal components (ESD precautions).

8.2 Densitometers

Densitometers are used to measure the film density for calibration and troubleshooting.
The printers Drystar 3000, Drystar 4500 (M), Drystar 5500 and Drystar 5300 have a densitometer built in.

Following items regarding density measurement are treated in this chapter:

Item	Refer to …
Density measurement in general	8.2.1
Density measurements with the internal densitometer	8.2.2

8.2.1 Density measurement in general

Densitometers consist mainly of
- A light source
- A diaphragm
- A photo sensitive sensor

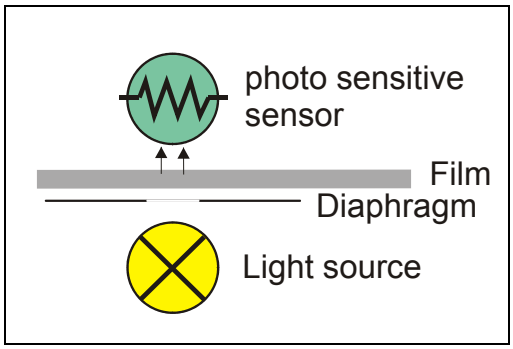


Figure 108

The density measurement depends on following factors:
- Stability of light source power
- Stability of photo sensor sensitivity
- Optical density of the film versus wave length

To make a reasonable density measurement, following prerequisites have to be fulfilled:

Item	Refer to …
The densitometer has to be nulled at each power on	8.2.1.1
The densitometer calibration has to be checked in a timeframe of approx. 1 week	8.2.1.2
The spectral sensitivity of the used densitometer regarding the used film has to be known	8.2.1.3

8.2.1.1 Nulling the Densitometer

When the densitometer is first turned on it must be zeroed (nulled) before taking measurements. To perform this task proceed as follows:
(Example: X-Rite 331)

(1) Turn on the densitometer.
(2) Close the unit with no film (read air).
(3) Hold the "NULL" and "READ" buttons until the lamp goes out (3 to 4 seconds).
(4) A second reading should be taken with no film to verify that the unit did indeed zero.

8.2.1.2 Densitometer Calibration Check

Once a week the calibration of the densitometer should be checked with the grey wedge that is shipped together with the densitometer. To perform this task proceed as follows: (Example: X-Rite 331)

(1) Null the densitometer
(2) Read the step on the grey wedge which is marked 'CAL' → the reading should be ± 0.02 O.D. units of the value marked on the CAL step.
(3) In case the limit is exceeded, calibrate the densitometer as described in the user manual.

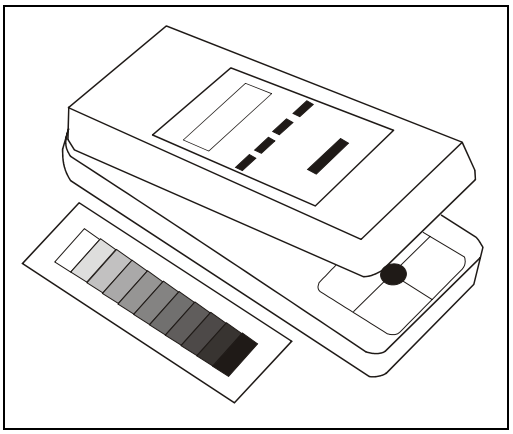


Figure 109

8.2.1.3 Spectral Sensitivity of the densitometer

A densitometer usually does not only measure the visible light transmission, but also the invisible infrared component of the light.

Laser film like e.g. The Scopix LT2B film has a quite constant transmission characteristic – even for infrared light (wavelength > 700 nm)

In opposite to this, dry films show a quite constant transmission for the visible light, in the infrared area they let transmit exceptional much radiation. An example for this fact is shown for TM1 film versus Scopix LT2B film in Figure 110.

This means, that many densitometers measure a quite low density at dry films, just because they also measure the infrared light component.

In case a calibration of the internal densitometer is made with a densitometer which also measures the infrared light component, the Dmax on the film in general will be too high, as the dry printers always try to reach the specified target Dmax: The printer will try to enlarge the power on the thermal head, what – in the worst case, can lead to a failure of single resistor elements.

It is only allowed to use supported densitometer for measurement of dry films. Refer to 8.2.2.3. These densitometers do not falsify the measurement as they do not take the invisible infrared light into account.

Refer to the Densitometer correction factors section 9.1 in the appendix.

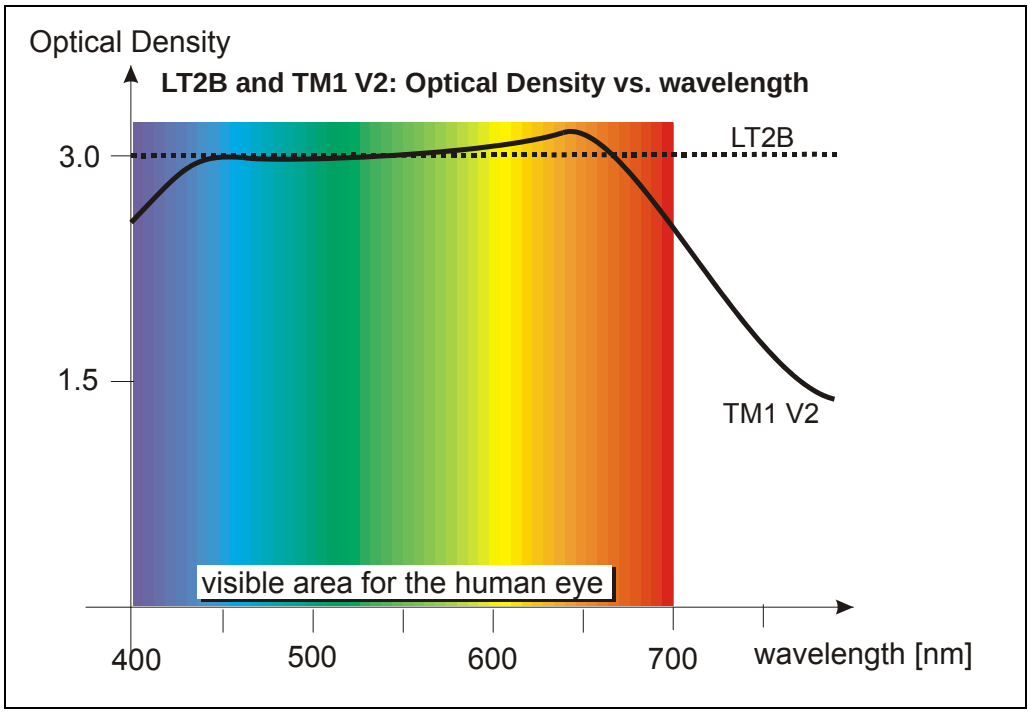


Figure 110

8.2.2 Density measurements with the internal densitometer

This chapter is divided in following sub-chapters

Sub-Chapter	Refer to ….
Calibrations with the internal densitometer in general	8.2.2.1
Density reproduction check	8.2.2.2
Supported external densitometers	8.2.2.3

8.2.2.1 Calibrations with the internal densitometer in general

The internal densitometer called MDM (Macrodensitometer; used in Drystar 3000, Drystar 4500, Drystar 5500) or CDM (Contactless Densitometer used in Drystar 5300) is used for following service actions:

Service action / Calibration	Explanation
Film calibration	Measures the film sensitometry to use these values for internal reference, so that the printer behaves linear regarding density reproduction. In addition the maximum density is adapted to the target Dmax.
Printhead profile calibration	Reduces vertical macro banding (density irregularities in print direction)
MDM calibration	Determines new reference values for the MDM. This is done via an external densitometer

For more information to the different calibrations refer to section 5.1

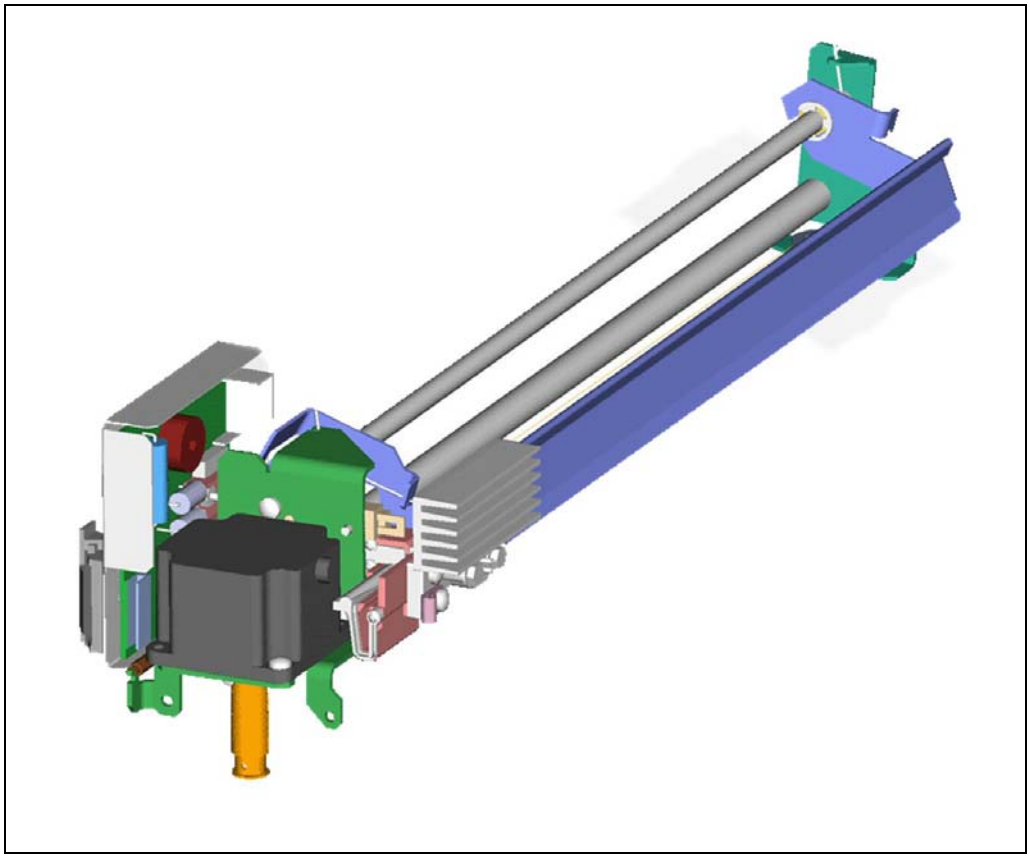


Figure 111: MDM, used in Drystar 3000, Drystar 4500(M) and Drystar 5500

Microdensitometer:
A microdensitometer is used in production to record the characteristic of the thermal head, also called thermal head profile. The measuring aperture of the microdensitometer has to be at least like the resolution of the thermal head itself. Example for Drystar 4500 (M): 50 µm.
Macrodensitometer:
The macrodensitometer in opposite to the microdensitometer has a resolution of several pixels. This is enough to measure densities and to make corrections to the thermal head profile.

A proper working MDM is required to ensure perfect image quality.
In general the MDM does **not need** to be calibrated in a regular timeframe.

8.2.2.2 Density reproduction check

In certain circumstances (e.g. maintenance → refer to the corresponding technical documentation for more info) the correct function of the MDM has to be checked via a 'Density reproduction check'.
The proceeding of the density reproduction check looks as follows:

(1) Perform a film calibration

(2) Print out test image SMPTE.tif and measure the density of the eleven 100 % – 0% squares with a calibrated MacBeth TR-924, X-Rite 331, X-Rite 341, X-Rite 301, X-Rite 310, Gretag D200-2 densitometer.

(3) To check linearity fill in measured values in corresponding Excel file:
Density reproduction check **DT1B**.xls or
Density reproduction check **DT1C**.xls (also for TM 1C new) or
Density reproduction check **Mammo**.xls
Density reproduction check **DT2B**.xls or
Density reproduction check **DT2B**.xls or

These Excel files can be downloaded from MedNet, download area 'GSO library - Hardcopy - Drystar 4x00 - CSO Freeware'.

(4) In the drop down list of tested densitometers select the one which was used for the measurement.

(5) After the measured values are filled in, the density reproduction is calculated automatically.

(6) At the right hand side of the table is shown, whether the Density Reproduction is ok or not. In case it is not ok you are requested to carry out a MDM calibration.

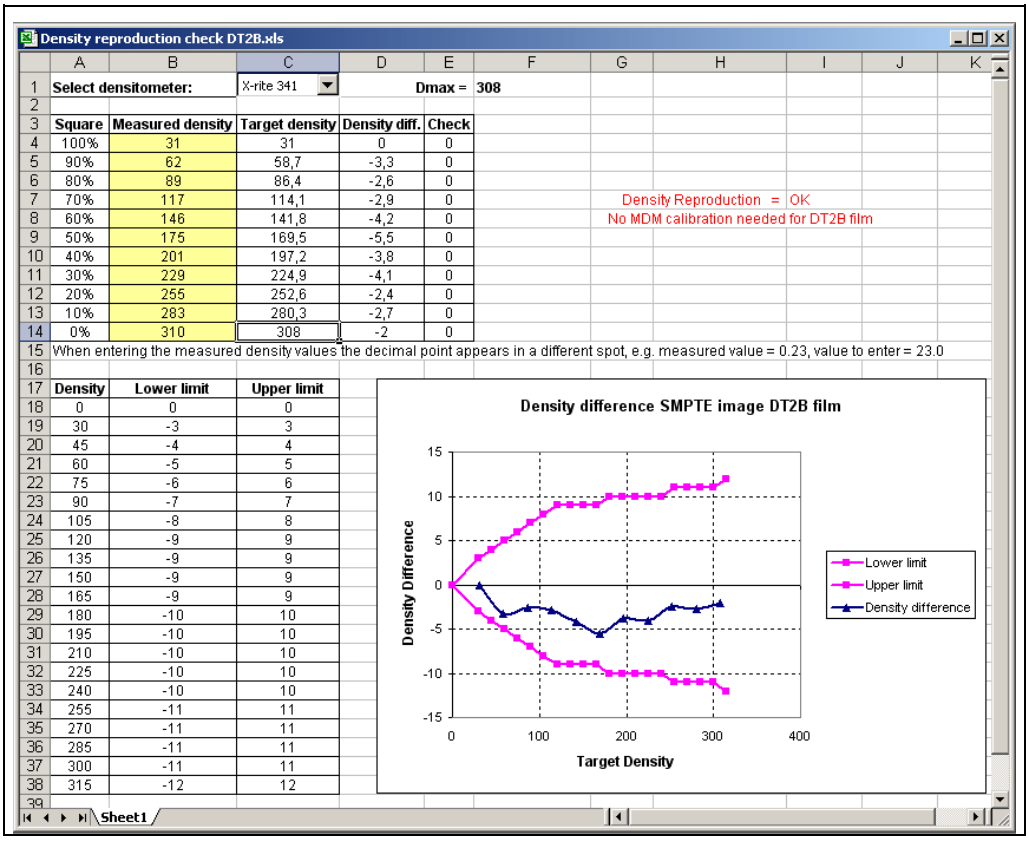


Figure 112

8.2.2.3 Supported external densitometers

In case a MDM / CDM calibration is required, the calibration menu at the local keypad offers the selection of the supported densitometers:

- MacBeth 924
- X-Rite 310
- X-Rite 331
- X-Rite 341

Default densitometer selection : MacBeth 924.

→ This ensures, that the service engineer only uses supported densitometers for MDM calibration.

For each densitometer a certain deviation is tolerated when entering the different values for the calibration procedure.
→ This is a plausibility check to avoid wrong entered values.

This feature is available as of Drystar SW 5500 release 2.0, Drystar 4500 SW release 3.0 and Drystar 5300 SW release 1.0

Default Densitometer selection for displaying densities
The operator has the possibility to display density values (Dmax, QC values etc.) according to a certain densitometer brand.
The different densitometers supported are

- MacBeth 924
- X-Rite 310
- X-Rite 331
- X-Rite 341

9 Appendix

9.1 Densitometer correction factors

Drystar TM1B

dens.	(1)	(2)	(3)	(4)	(5)	(6)
100%	0,21	0,21	0,23	0,25	0,18	0,23
90%	0,57	0,56	0,56	0,60	0,53	0,57
80%	0,86	0,85	0,86	0,89	0,82	0,87
70%	1,14	1,14	1,15	1,19	1,12	1,16
60%	1,41	1,41	1,424	1,47	1,392	1,44
50%	1,70	1,70	1,72	1,77	1,69	1,73
50%	1,69	1,69	1,70	1,76	1,68	1,72
40%	1,97	1,98	1,98	2,04	1,97	2,00
30%	2,24	2,25	2,26	2,32	2,25	2,28
20%	2,52	2,53	2,54	2,61	2,54	2,57
10%	2,81	2,82	2,84	2,92	2,84	2,86
0%	3,06	3,09	3,09	3,19	3,11	3,12

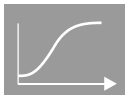
Legend:
(1) = PEHAMED DESONORM 21L
(2) = X-RITE 331
(3) = MEDSET Sarkscan
(4) = X-RITE 310
(5) = GRETAG D200 II
(6) = MACBETH TR924

Drystar TM1C

dens.	(1)	(2)	(3)	(4)	(5)	(6)
100%	0,04	0,05	0,07	0,05	0,07	0,07
90%	0,36	0,36	0,37	0,37	0,37	0,37
80%	0,64	0,64	0,65	0,65	0,65	0,65
70%	0,93	0,94	0,94	0,95	0,95	0,94
60%	1,216	1,22	1,23	1,25	1,24	1,24
50%	1,50	1,51	1,52	1,54	1,54	1,53
50%	1,49	1,50	1,51	1,53	1,53	1,52
40%	1,77	1,79	1,81	1,83	1,83	1,81
30%	2,08	2,11	2,12	2,15	2,15	2,13
20%	2,35	2,39	2,39	2,44	2,43	2,40
10%	2,66	2,7	2,70	2,76	2,75	2,72
0%	2,95	3,01	2,99	3,07	3,05	3,03

Mamoray TM2B

dens.	(1)	(2)	(3)	(4)	(5)	(6)
100%	0,22	0,218	0,24	0,26	0,20	0,25
90%	0,57	0,58	0,61	0,62	0,55	0,60
80%	0,94	0,93	0,93	0,97	0,90	0,94
70%	1,28	1,27	1,28	1,32	1,25	1,29
60%	1,60	1,59	1,61	1,65	1,57	1,62
50%	1,98	1,96	1,97	2,04	1,94	1,99
50%	1,95	1,94	1,95	2,01	1,92	1,96
40%	2,28	2,27	2,28	2,35	2,25	2,29
30%	2,64	2,62	2,64	2,73	2,60	2,66
20%	2,99	2,97	2,99	3,09	2,95	3,01
10%	3,38	3,35	3,37	3,49	3,33	3,39
0%	3,74	3,71	3,73	3,86	3,7	3,76



9.2 Correlation of DICOM Smoothing and Kernel Smoothing Factor

CubicB	
DICOM Smoothing factor	Kernel Smoothing factor
0	0,0

CubicHighRes	
DICOM Smoothing factor	Kernel Smoothing factor
100	-5,0
101	-4,9
102	-4,8
103	-4,7
104	-4,6
105	-4,5
106	-4,4
107	-4,3
108	-4,2
109	-4,1
110	-4,0
111	-3,9
112	-3,8
113	-3,7
114	-3,6
115	-3,5
116	-3,4
117	-3,3
118	-3,2
119	-3,1
120	-3,0
121	-2,9
122	-2,8
123	-2,7
124	-2,6
125	-2,5
126	-2,4
127	-2,3
128	-2,2
129	-2,1
130	-2,0
131	-1,9
132	-1,8
133	-1,7
134	-1,6
135	-1,5
136	-1,4
137	-1,3
138	-1,2
139	-1,1
140	-1,0
141	-0,9
142	-0,8
143	-0,7
144	-0,6
145	-0,5
146	-0,4
147	-0,3
148	-0,2
149	-0,1
150	0,0
151	0,1
152	0,2
153	0,3
154	0,4
155	0,5
156	0,6
157	0,7
158	0,8
159	0,9
160	1,0
161	1,1
162	1,2
163	1,3
164	1,4
165	1,5
166	1,6
167	1,7
168	1,8
169	1,9
170	2,0
171	2,1
172	2,2
173	2,3
174	2,4
175	2,5
176	2,6
177	2,7
178	2,8
179	2,9
180	3,0
181	3,1
182	3,2
183	3,3
184	3,4
185	3,5
186	3,6
187	3,7
188	3,8
189	3,9
190	4,0
191	4,1
192	4,2
193	4,3
194	4,4
195	4,5
196	4,6
197	4,7
198	4,8
199	4,9

CubicBell	
DICOM Smoothing factor	Kernel Smoothing factor
200	0,10
201	0,10
202	0,10
203	0,10
204	0,10
205	0,10
206	0,12
207	0,14
208	0,16
209	0,18
210	0,20
211	0,22
212	0,24
213	0,26
214	0,28
215	0,30
216	0,32
217	0,34
218	0,36
219	0,38
220	0,40
221	0,42
222	0,44
223	0,46
224	0,48
225	0,50
226	0,52
227	0,54
228	0,56
229	0,58
230	0,60
231	0,62
232	0,64
233	0,66
234	0,68
235	0,70
236	0,72
237	0,74
238	0,76
239	0,78
240	0,80
241	0,82
242	0,84
243	0,86
244	0,88
245	0,90
246	0,92
247	0,94
248	0,96
249	0,98
250	1,00
251	1,10
252	1,20
253	1,30
254	1,40
255	1,50
256	1,60
257	1,70
258	1,80
259	1,90
260	2,00
261	2,10
262	2,20
263	2,30
264	2,40
265	2,50
266	2,60
267	2,70
268	2,80
269	2,90
270	3,00
271	3,10
272	3,20
273	3,30
274	3,40
275	3,50
276	3,60
277	3,70
278	3,80
279	3,90
280	4,00
281	4,10
282	4,20
283	4,30
284	4,40
285	4,50
286	4,60
287	4,70
288	4,80
289	4,90
290	5,00
291	5,10
292	5,20
293	5,30
294	5,40
295	5,50
296	5,60
297	5,70
298	5,80
299	5,90

9.3 Glossary

Bitmap - A rasterized graphic image formed by a rectangular grid of pixels.

Bit-mapped graphics - Raster graphics that are constructed with individual pixels or dots, rather than object-based or vectorbased graphics.

CDM – Contactless Densitometer. Densitometer built in the Drystar 5300.

CMYK - Cyan, Magenta, Yellow, and Black, printers' process colors of ink.

Color Separations - The process of separating a color image into three or four subtractive colors, CMY or CMY K, either by photographic or electronic processes. Thus producing a set of three or four films or a computer file.

Density - The degree of opacity of an image.

Distortion - Changing the size of an image in a non-proportional manner, also known as anamorphic scaling.

D-max - The highest level of density.

D-min - The lowest level of density.

Dot matrix - The process of printing with dots to create images, lines and text.

DPI - Dots per inch, the number of distinct pixels that can be produced horizontally or vertically in a linear inch.

Dye Sublimation - Also diffusion-transfer printing. It has a variable dot intensity that can create more colors than possible with thermal printers. Most continuous-tone printers use dye sublimation thermal-transfer technology.

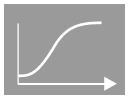
Dynamic range - The color or shade of gray assigned to each pixel. It is measured as the number of shades per primary color. Also the difference between the smallest amount and the largest amount of gray that a system can represent. Also the difference between the lightest high-light and the D-max that the system can scan, manipulate and write.

Emulsion - Coating on the light-sensitive material. The opposite side of the base.

Enhancement - The editing of an image either through color and/or density change.

Image processing - Comparable to data processing whereby captured image data can be manipulated by color, size, shape and position.

Interpolation - A technique for increasing the size of a graphic file by creating pixels. Also an extrapolation algorithm. There are three types, linear, replicate and cubic.



Laser - Light Amplification by Stimulated Emission of Radiation. Lasers provide stable and coherent single color light.

Luminance - The brightness of a color.

LUT - Look Up Table

MB or Mb - An abbreviation for megabyte. Megabyte - a unit of measurement for computer memory, 1,048,576 bytes, or 1,024Kb.

MDM - Macrodenistometer. Sub - assembly on Drystar printers. Used to determine Dmax on every film and to recalibrate the thermal head if necessary.

Pixel - Derived from the word picture elements -- the smallest visual unit in a raster file, or a single cell or information.

QC – Quality Control

Resolution - The ability to see one point in space from another, or the greatest detail or sharpness that can be seen in an image, and the size and total number of individual pixels used to build an image. The amount of data a video display screen can reproduce.

RGB - Red, Green, and Blue - primary colors. In electronic imaging, RGB systems are usually used for photographic and CT output.

Rotating - to turn an image element around its axis to provide different views.

Saturation - The amount of a primary color applied on any specific area. Also the amount of gray in a color.

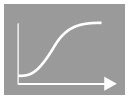
Scale - Changes in size of an image or element in both X-Y directions. Also a change in the dimensional size of a file.

TIFF - Tagged-Image File Format developed by Aldus. A neutral format used to represent black-and-white, grayscale, or color bitmapped images for Macs, PCs, and Unix. TIFF is the normal scanner output file format.

9.4 Further Literature / URLs

Literature / URL	Comment
www.smartlight.com	Information about light boxes and vieweing conditions
www.fda.gov/cdrh/mammography/	Information to the MQSA regulations

9.5 Index



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