SONY®

SDDS Laboratory Process

SDDS Sony Dynamic Digital Sound®

LABORATORY PROCESS MANUAL

Version 3.1

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1. INTRODUCTION

1.1. THE FILM LABORATORY SETTING FOR SDDS

The Film Laboratory provides and controls the final and most crucial step in the creation of SDDS digital sound data tracks - the printing of SDDS on color print stock. The expertise required to print the SDDS digital tracks is as significant as the complexity of the hardware in the Theaters which will read the SDDS Tracks and fill the theater with sound. The challenge to the Film Laboratories is maintaining tight tolerances and repeatability in the face of enormous production requirements and ever shrinking production schedules. If the tracks suffer from a number of possible printing problems, the SDDS hardware in the theaters will not recover the sound information. This manual is dedicated to the skills of the Motion Picture Film Laboratories and is intended to help them meet their goals while providing maximum yields of high quality SDDS release prints.

RELEASE FILM PRINTER TYPES

The following table indicates the general industry matrix of printers, their performance and their primary use.

Printer Name	Description	Speed	Type of Print & Yields
Model C	Manually intensive thread up. Normally employed with “wet gate” image printing.	2X	Original negative, check, or answer prints
Panel Printer	Forward/Reverse printer that requires a pause for raw stock to be loaded for each direction	4X–10X	100 or less production printing orders
Continuous Contact Printer	Custom Hi-Speed continuous printers without pause for loading	10X-20X	Hi-Volume Print orders over 100 prints
Loop Printer	Modified Model C that allows continuous printing of trailers	4X-10X	Hi-Volume 100 foot trailers printed in bulk

SDDS TRACK POSITIVE PRINTING ENVIRONMENTS

The challenge of printing SDDS is the need for the Film Laboratory to address the various problems that can occur when key Post Production milestones in the Lab are eminent.

SDDS Printing for Answer or Check Prints

<u>Crucial Post Production Step</u> - Customer approval of sound negative and resultant show prints.

Customer normally exhausted and rushed must approve image and up to four sound formats so that full production printing can commence.

The printing of answer or check prints can effected by:

- Printing is always performed on the manually intensive wet gate Model C printers. This invariably introduces a high potential for sound track printing errors from little to no time for printer setup tests.
- Scheduling of answer print reel processing around production runs operating a 600 ft/min with the inevitable delays and temporary storage causing fogging.
- Potential damage to sound track during required 2X image viewing check
- The service of a real time QC report of the answer print is not offered by the Lab to Post Production

SDDS Printing for Production prints

Full production presents a different set of problems. Among them are bulk handling of stock, storage of exposed but unprocessed reels, and no high speed QC capability to catch problems early. The release prints shipped to the field are assembled from stacks of various reel numbers which have been printed as a reel number group days before. A problem in the sound track printing is only caught with a 1X QC audit of say every 100th reel which is truly just a spot check.

Multiple Digital Format Sound Printing Heads

Contact Printing of SDDS soundtracks requires the use of digital Sound Printer heads provided by the following manufacturers:

Print Head Type	Manufacturer	
Bi-Directional Panel Printer	BHP, INC 1800 WINNEMAC AVE CHICAGO, ILL 60640-2662 773-989-2140 - TEL 773-989-2144 - FAX	HOLLYWOOD FILM COMPANY 3294 East 26th Street Los Angeles, CA. 90023 213-462-3284 - TEL 213-263-9665 - Fax
Model C	PETERSON INTERNATIONAL ENT. LTD. 761 GLENN AVE. WHEELING, ILL 60090 847-541-3700 - TEL 847-541-3790 - FAX	HOLLYWOOD FILM COMPANY 3294 East 26th Street Los Angeles, CA. 90023 213-462-3284 - TEL 213-263-9665 - Fax

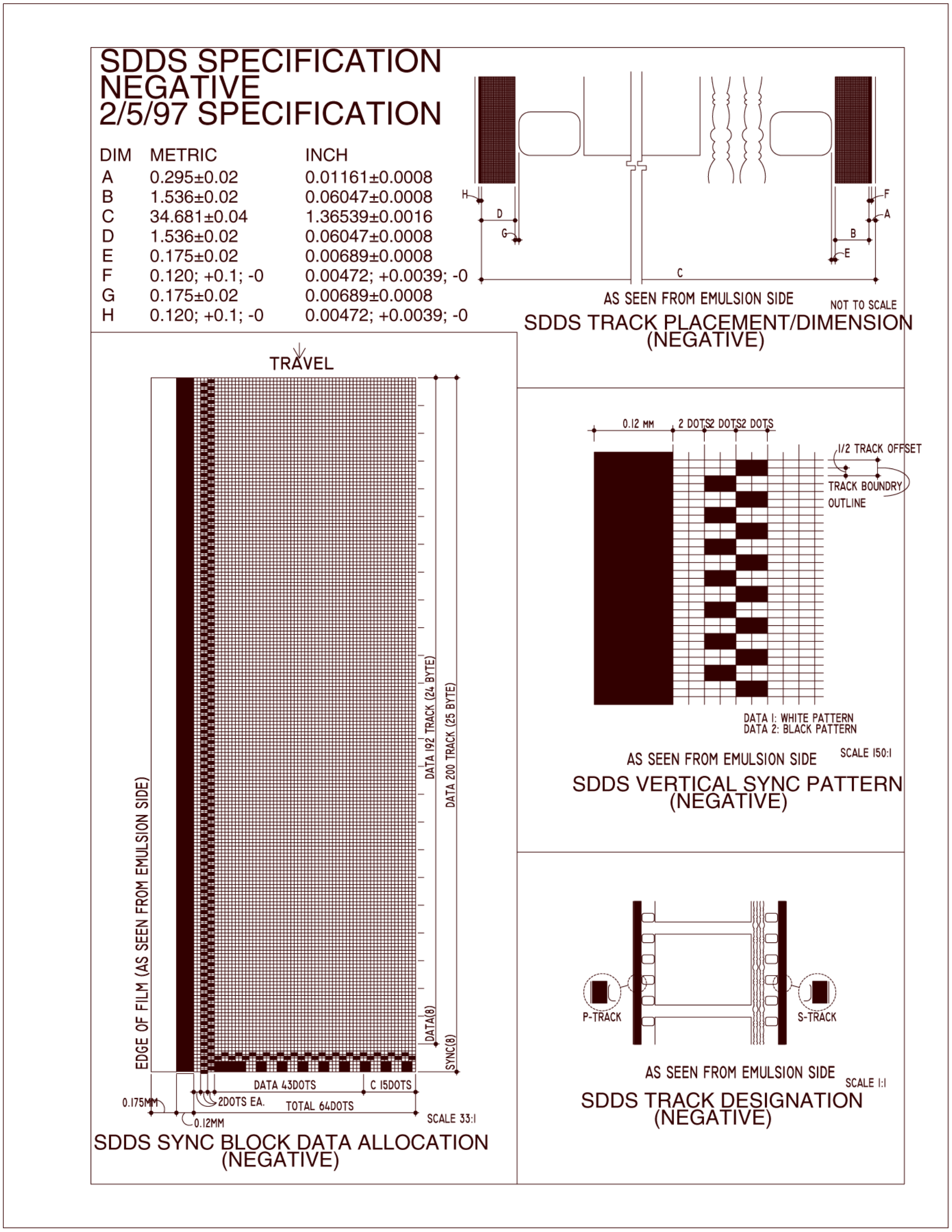
Whether answer printing or full production printing, the SDDS tracks must be printed to meet a minimum set of standards which address mechanical placement and optical quality.

This Lab Process manual will address the key physical printing issues that must be recognized during the printing process. The manual will explain the basic format, how the format is read by the electronics, and how the film laboratory creates the format on film. The manual will introduce the concept of RF Video waveform analysis to identify physical printing issues followed by extensive examples.

The topics will cover:

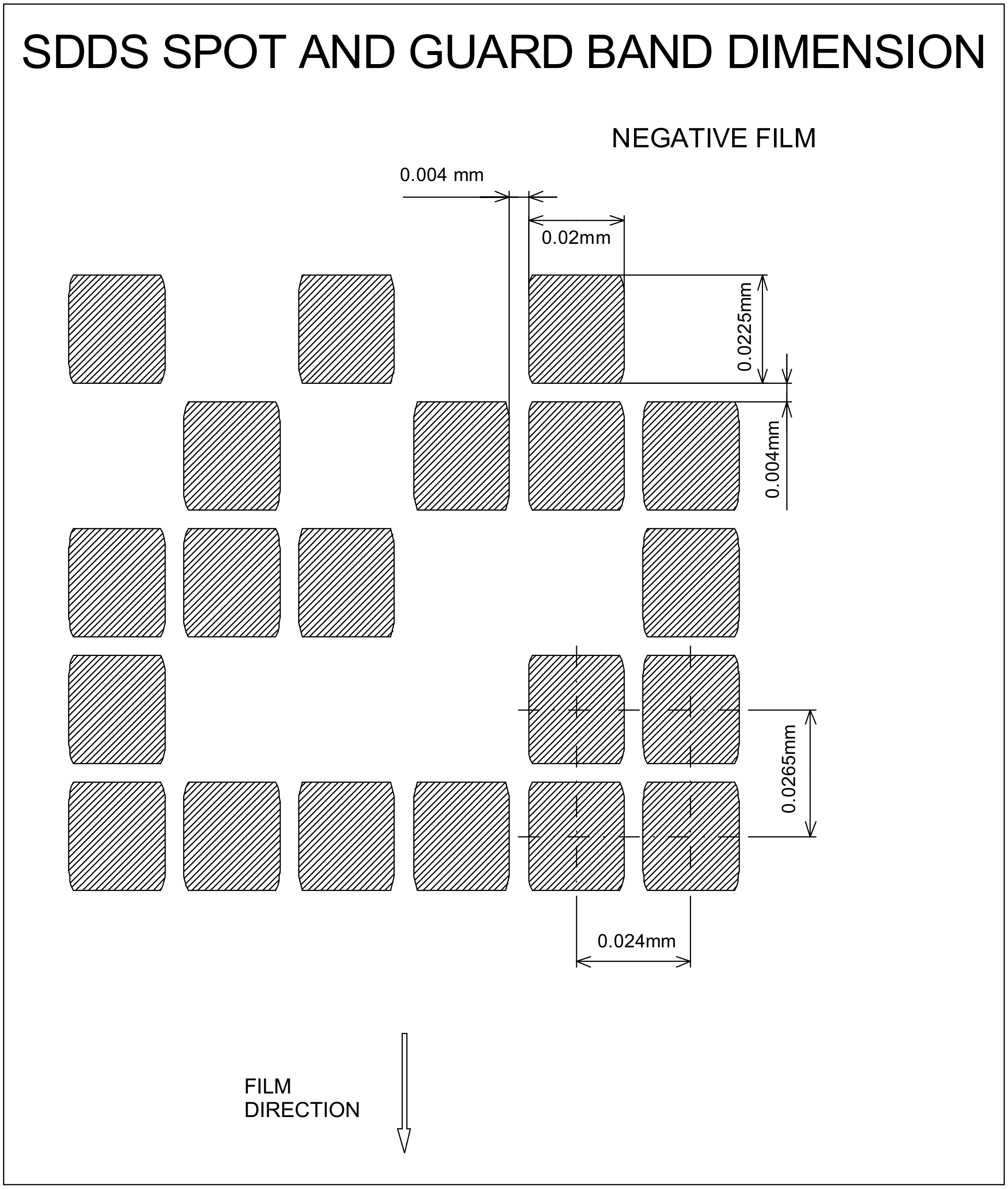
- **MECHANICAL PLACEMENT**
- **SDDS DATA FORMAT**
- **SDDS DATA RECOVERY**
  - **TRACKING**
  - **DATA DECODING**
  - **ERROR CORRECTION**
- **PRINT DENSITY AIMS**
- **PRINTING PROBLEMS**
  - **DENSITY VARIATION**
  - **EDGE ARTIFACTS**
  - **CONTACT**
  - **WHITE LIGHT FOG**

2. SDDS TRACK PLACEMENT



DIM	METRIC	INCH
A	0.295±0.02	0.01161±0.0008
B	1.536±0.02	0.06047±0.0008
C	34.681±0.04	1.36539±0.0016
D	1.536±0.02	0.06047±0.0008
E	0.175±0.02	0.00689±0.0008
F	0.120; +0.1; -0	0.00472; +0.0039; -0
G	0.175±0.02	0.00689±0.0008
H	0.120; +0.1; -0	0.00472; +0.0039; -0

SDDS SPOT AND GUARD BAND DIMENSIONS



3. OPTIMAL PRINT DENSITY

3.1. SDDS DENSITY SPECIFICATIONS

SDDS PRINT DENSITY AIM

R = 1.30 $\pm$ 0.20

G <= 0.50

B <= 0.35

The following measurements are performed on a Macbeth Densitometer or equivalent RGB densitometer with a 0.001 inch aperture. The reading is taken as a Status A Red Density from the SDDS Density Patch.

The Cyan layer is the only color dye layer of interest and is scanned by the SDDS reader which employs a 660 nanometer light source. Density control should focus on variations in the Red/Cyan layer.

FILTER PACK SUGGESTIONS

When employing a white Halogen Light Source for printing, a # 29 RED Wratten or Glass filter is recommended.

SDDS NEGATIVE DENSITY, KODAK 2374 NEGATIVE FILM.

Aim SDDS Negative density should be:

2.0 $\pm$ 0.10

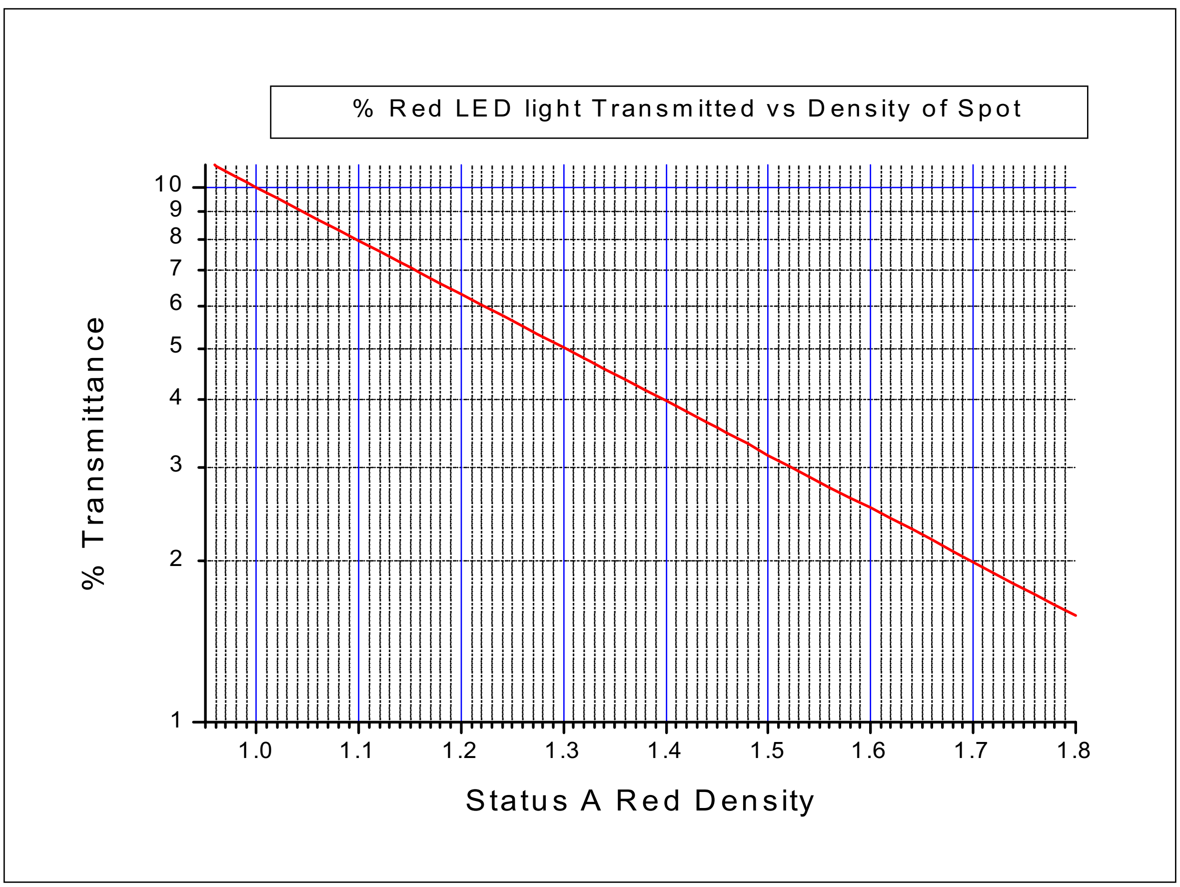
3.2. SDDS SPECTRAL THEORY

DENSITY VS TRANSMITTANCE

The relationship between density and light transmission is expressed in powers of 10 (logarithmic scale). With a SDDS sound negative and color print stock, the Lab contact prints and processes the Cyan layer resulting in a series of opaque and clear spots.

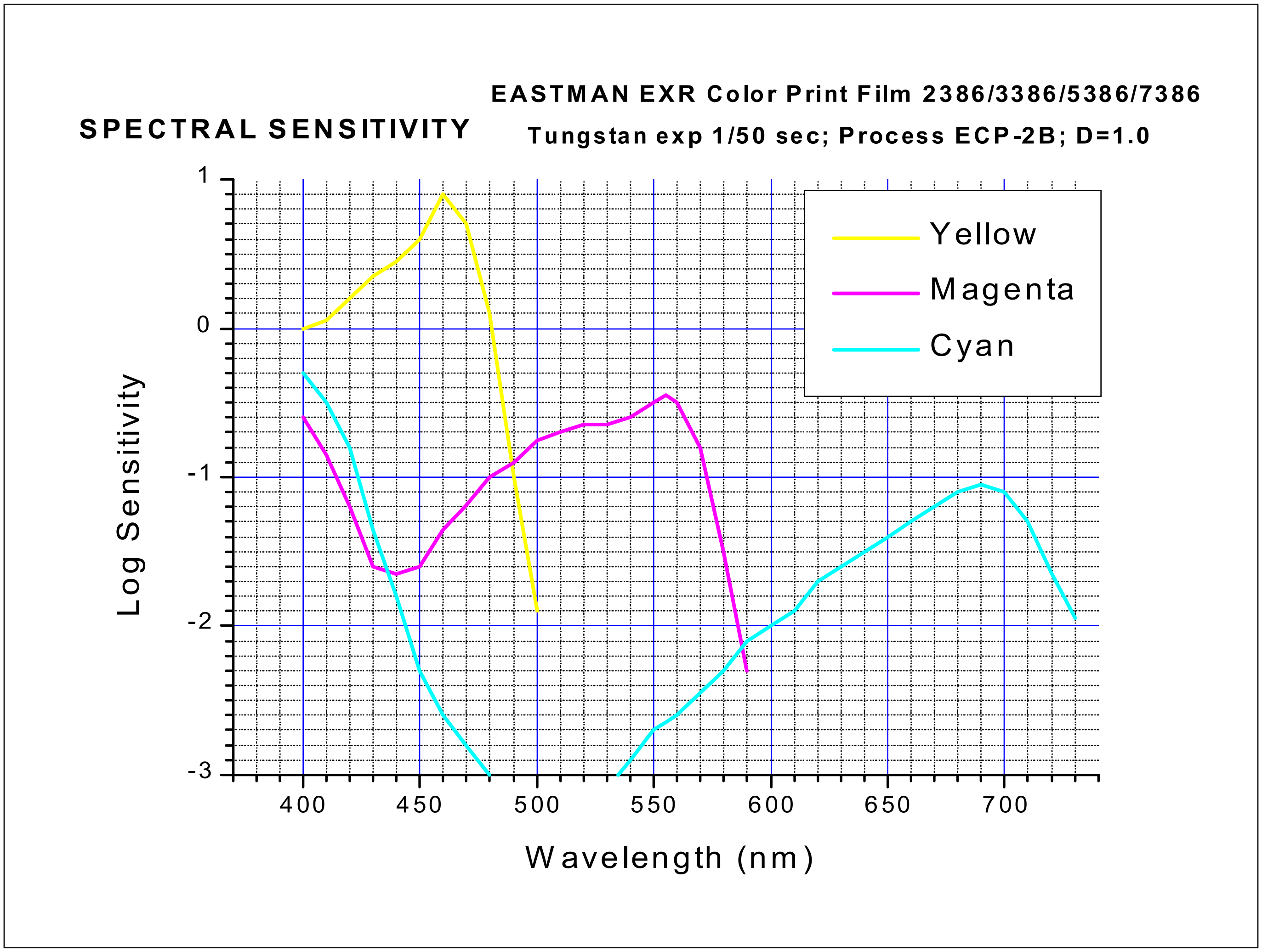
Depending on exposure and processing variables the opaque Cyan spots can be printed and measured to various aim densities. If we then illuminate the processed opaque spots and measure the amount of light that is allowed to pass through the spot for different densities, we can relate aim density to % transmission of light. For example a print density of 1.0 will allow 1/10 or 10% transmission of the total light to pass through the opaque Cyan spot, a print density of 2.0, 1/100 or 1% of the light to pass through the spot, and a density of 3.0, 1/1000 or 0.1% of the light to pass.

The density versus transmittance curve shows this log relationship. Film Labs adjust all exposure and processing variables in terms of print density. The electronic signal processing in the SDDS Reader operates with derived RF video voltage that is a linear measure of the % Transmittance of light. How can this relationship be employed to optimize Lab Practice? From the curve we can see that if 1.30 is our nominal print density and the low side tolerance is at 1.10, the total percentage difference in Transmission will be 3% from 1.3 to 1.10. If we operate from 1.30 to 1.50, the % transmission variation is only 2%. Thus we conclude that if the <u>Lab operates above the nominal density in the 1.30-1.50 density, the Film Lab SDDS tracks will inherently maintain tighter light transmission tolerance</u>.

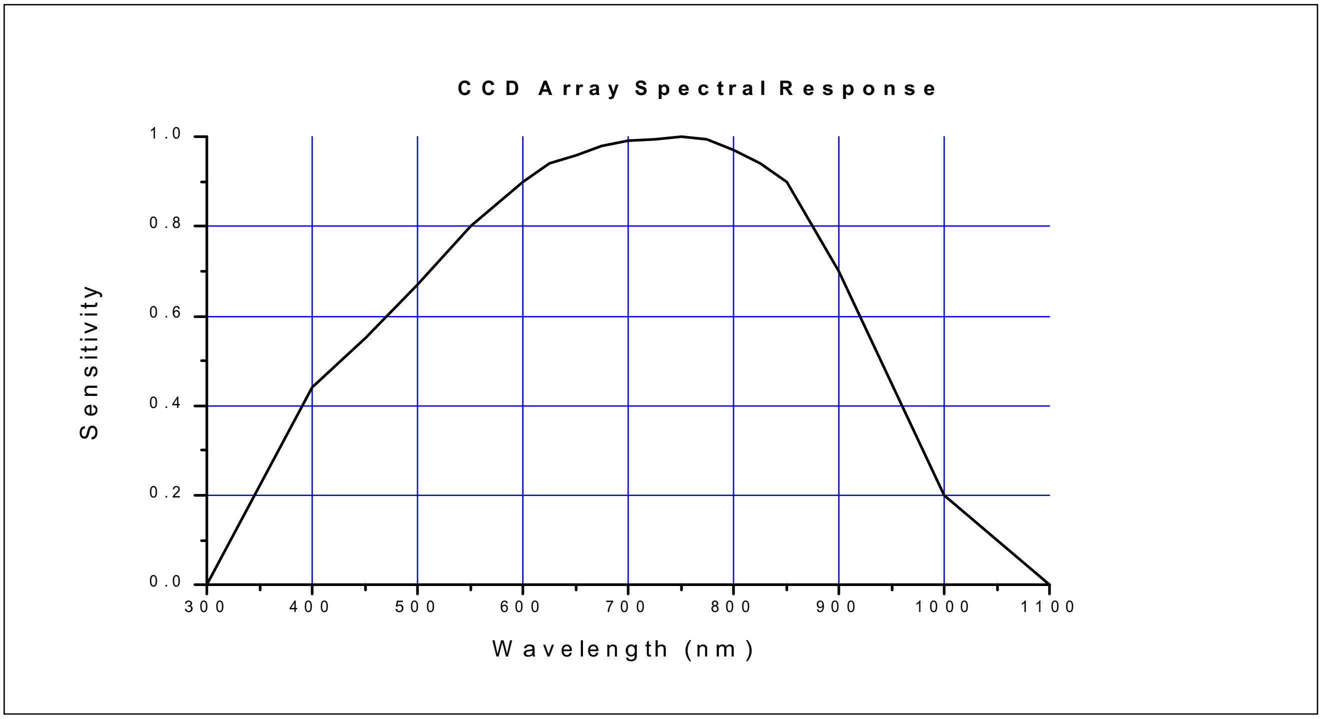


The following charts depict how the Cyan layer becomes the dye layer of interest for SDDS. The CCD (Charge Coupled Device) of the SDDS reader achieves maximum sensitivity near 700 nanometers. The Cyan layer of color print film is the most sensitive to light exposure at 690 nanometers which maximizes the density of the Cyan layer. The Cyan layer absorbs ("holds back") the light from the SDDS red LED illumination source. The combined spectral response curve shows the optimum relationship between the CCD array sensitivity, the maximum absorption wavelength of the Cyan layer, and the Red LED SDDS reader light source. The SDDS format need only print to one layer in the color print stock - the Cyan Layer (visual blue-green).

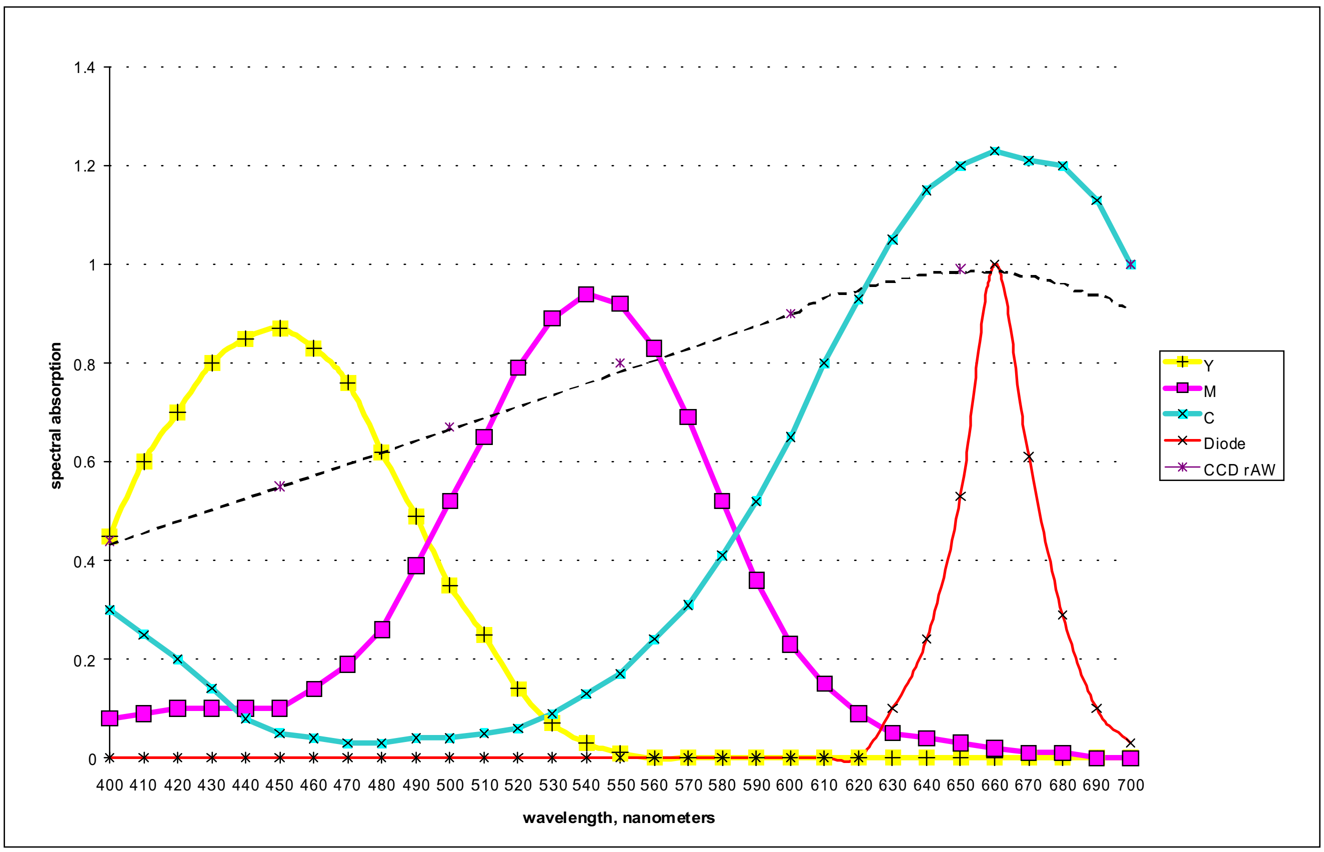
SPECTRAL SENSITIVITY OF COLOR PRINT STOCK



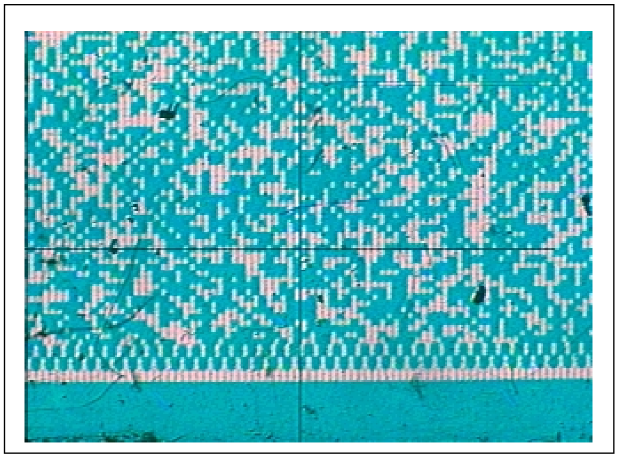
SPECTRAL RESPONSE OF CCD ARRAY IN SDDS READER



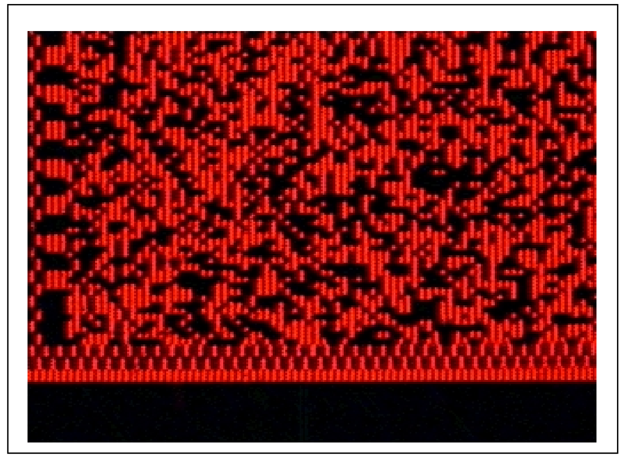
COMBINED SPECTRAL RESPONSE



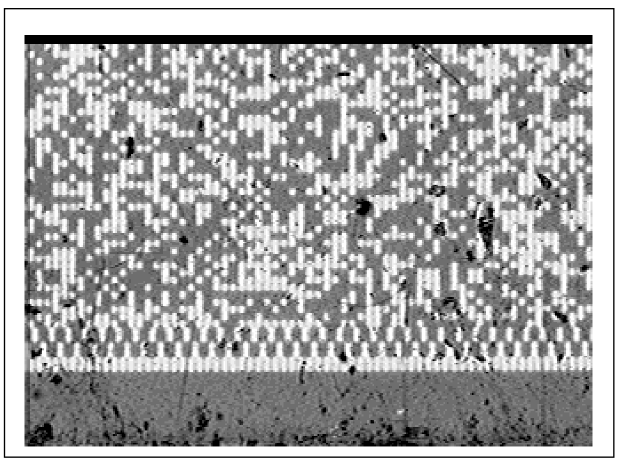
3.3. WHITE VERSUS RED LIGHT FOR VISUAL CHECK



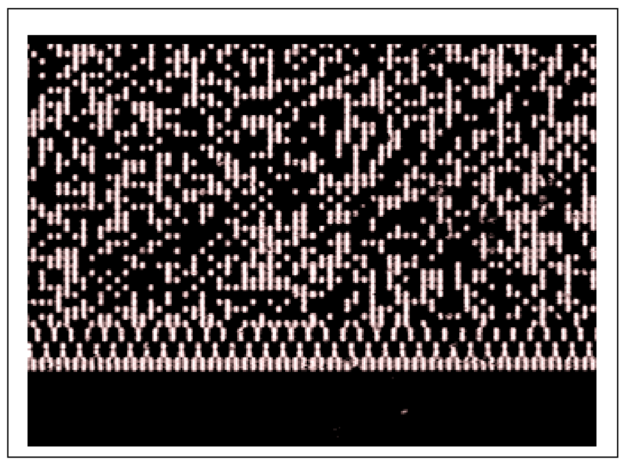
Cyan Print at 20X viewed with white light.



Same Cyan Print at 20X viewed with Red filtered white light



Sample above viewed in B&W

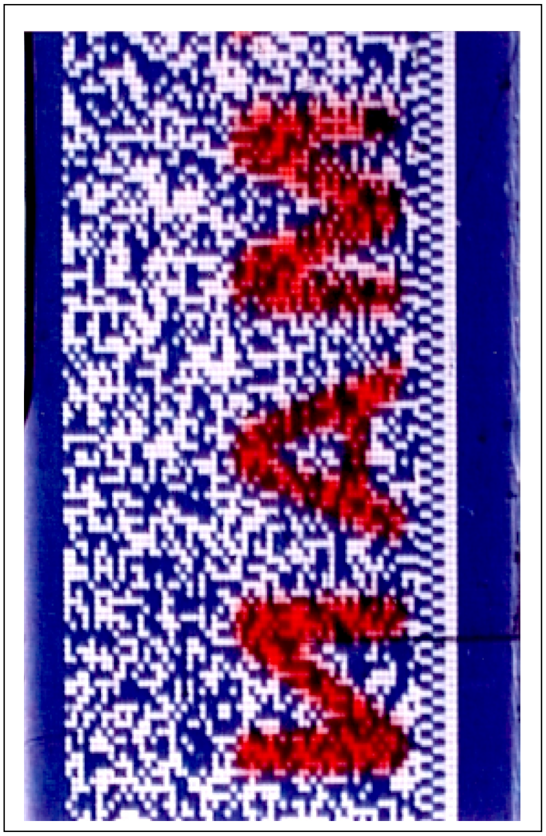


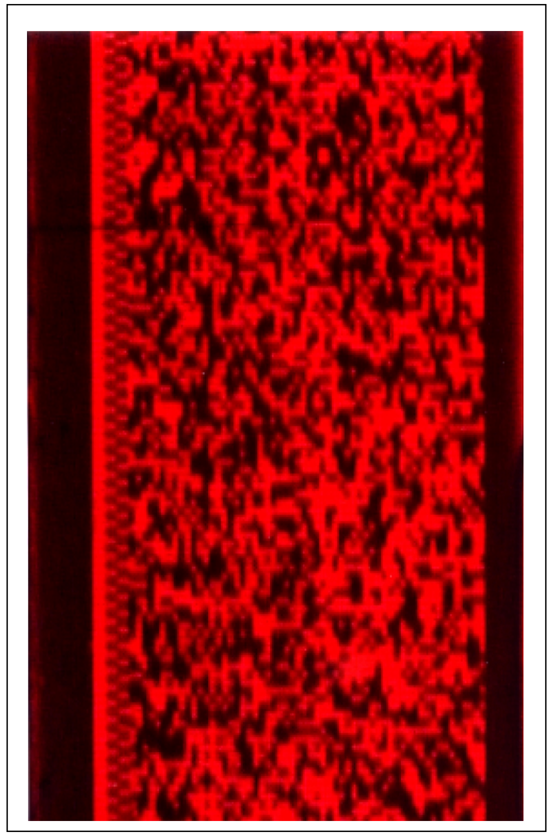
Sample above viewed in B&W

Normal QC practice employs a white light source through a 10X to 20X microscope when a QC tech is required to judge static image quality. Optimal checking of the static printing issues should be done with a red filter in the path of the white light source. This allows the human eye to see the contrast characteristics seen by the CCD array in the SDDS Reader. The examples are shown above

3.4. FILM LABORATORY EDGE CODE

Another example of the effective use of the Cyan layer has been the gracious modification by the Color Print Film manufacturers in the spectral placement of their color stock Edge Code. Prior to SDDS, the manufacturers placed their stock identification field (known as edge code) in the Cyan layer. Film lab personnel would read the magenta appearing code during the printing process for internal quality and tracking purposes. SDDS requested the film manufacturers to expose in the yellow/magenta region. The code is easily read by lab personnel but is invisible to the red LED light source of the SDDS reader.





The example above on the left is viewed with white light. The same sample on the left is viewed with Red Light. The Edge Code is rendered invisible.

3.5. USE OF SOLID STATE LASER FOR ILLUMINATION PRINTING SOURCE

CURRENT LIGHT SOURCE

A white-light halogen bulb, intensity adjusted by an arbitrary voltage scale.

Light Source Coupling

- Spectral filtering with accompanying insertion loss provided by either a Gel or Glass filter pack.
- Losses due to both fiber optic coupling and light path reflections and absorption's in mechanical design of head.

Current Problems

Heat generated by light source

- Flatness of field at aperture
- No means of field adjustment
- Short life of light source bulb. Less than 200 hours requiring average down time of from 2 to 4 hours to recalibrate printer for a given track with three different print stocks (Kodak, AGFA, & Fugi)
- Short life of Gel filter packs requiring average down time of from 2 to 4 hours to recalibrate printer for a given track with three different print stocks (Kodak, AGFA, & Fugi). (statistics based on 8 months of production at ASTRALTECH operating 2 1000 ft/min BHP panel printers at 7 days/week, 24 hours/day)

SOLID STATE LASER SOURCE

Benefits for SDDS printing

- Concentrated beam of photons/in^2 at optimal Cyan density of 660 nano-meters, NO Filter Pack required.
- Beam energy can be controlled by linear voltage control
- Low Heat Dissipation, less than 1.2 watts.
- Long life, between 10,000 and 100,000 hours.

CURRENT PROGRESS

For almost 6 months, ASTRALTECH in Montreal, Quebec, Canada have employed solid state lasers with holographic diffusers on their BHP 1000 ft/min panel printer. This printer has been operating a peak capacity at 7 days per week, 24 hours/ day. There has been no downtime associated with the laser illumination sources for the SDDS tracks with over 10,000,000 feet printed as of 11/17/98.

LASIRIS of Saint Laurent, Quebec, Canada has provided the initial engineering and OEM packaging for the ASTRALTECH development project. Contact Information for both references is:

ASTRALTECH, INC.
2101, RUE SAINT CATHERINE WEST
MONTREAL, QUEBEC, CANADA H3H 1M6

514-939-5060 - TEL
514-939-5070 - FAX

Contact: Serge Nadeau, Director of Laboratory or
David Metzger, Manager Quality Control
E-Mail: dmetzger@astral.com

LASIRIS
3549 Ashby
Saint-Laurent, Quebec, Canada H4R-2K3

514-335-1005 or 1-800-814-9552 - Tel
514-335-4576 - Fax

Contact: Tony Marzilli, Application Engineer
E-Mail: marzilli@lasiris.com
Website: http//:www.lasiris.com

4. EDGE ATRTIFACTS: PHYSICAL PRINT AND NEGATIVE HANDLING

4.1. SDDS LABORATORY PRINT HANDLING

Contact Printing of SDDS soundtracks requires the use of digital Sound Printer heads and an expanded view of impact to standard laboratory practices. Printing data on the edges of the film can include a new family of problems that we will call **Edge Artifacts**. These Edge Artifacts fall into two distinct areas: Edge Artifacts caused by white light exposure and Edge Artifacts caused by mechanical damage or contact. To ensure successful production yields the following procedures and specifications should be followed:

WHITE LIGHT FOG OR EDGE FOG

Eliminate all unnecessary safe-lights and indicator lights on machinery and in the film handling areas. SDDS printing is most vulnerable to stray light exposure which alters the density of the Horizontal Sync area of the format thus impacting data tracking. Any Red indicator lights, red or white flashlights, or a safe-light emitting in this spectrum should be covered or eliminated. The easiest way to avoid Edge Fog is to print, handle, and process in total darkness. Another approach is to station a pair of night vision goggles at the printing station. Prior to startup, the operator can scan the room for stray or indicator light.

Edge Fog attacks the edges of the unprocessed film. Laboratory practice and procedures dictate the cause of fogging for each side of the film.

P Side fog is usually the result of a safe-light flashlight passing over a stacked, unprocessed reel. S Side fog is usually the result of an overlooked indicator light or stray source on the printer deck-plate.

This exposure or fogging results in blemishes that need only penetrate into the normally clear tracking portion of the SDDS format. Under a loop with a white background, QC personnel can see a Blue-Green tint or “fog” filling in the clear Horizontal Sync area and the zipper or clock track.

Fogging of the Horizontal Sync lowers the effective amplitude of the Sync pulse. The SDDS row tracking circuitry subsequently becomes lost which overwhelms the error correction circuitry with blocks of mis-decoded data.

Flashlight induced fog usually is periodic in nature occurring with fixed regularity. Electrically this shows up as a dynamic bouncing of the amplitude in the Horizontal Sync waveform and collapse of the Data Eye pattern.

MECHANICAL HANDLING

Care should be taken to avoid damaging the SDDS tracks on the edges of the film during negative mounting, cleaning, and rewinding. To minimize damage and handling problems, the following areas in the laboratory should be checked.

Check emulsion rollers in ultrasonic and brush cleaning machines. Rollers with metal burrs or worn flanges can easily tear away the emulsion.

In the negative make-up area and printing area, check all rollers and guides to insure that the bearings are in good condition. Make sure all moving parts touching the emulsion are indeed moving, and free from burrs that may cause scratches.

Check emulsion rollers and tension arms on high speed rewind machines. Sharp flanges and excessive tension will wear the emulsion away.

The negative and resultant print can handle moderate amounts of damage and scuffing to the base side of the film. In particular base damage to the negative will not be seen during printing process.

Keep developer areas and rollers as clean as possible. Emulsion rollers between the developer stages and the film drying equipment can frequently become mis-aligned or heavily laden with developer / emulsion sludge. In extreme circumstances the emulsion on the edge of the print is removed (skiving). Mechanical scratches, skiving, or printed-in lines must be kept below the specifications listed below to insure that the SDDS print has maximum tracking margins.

4.2. EDGE ARTIFACT PLACEMENT AND WIDTH SPECIFICATIONS

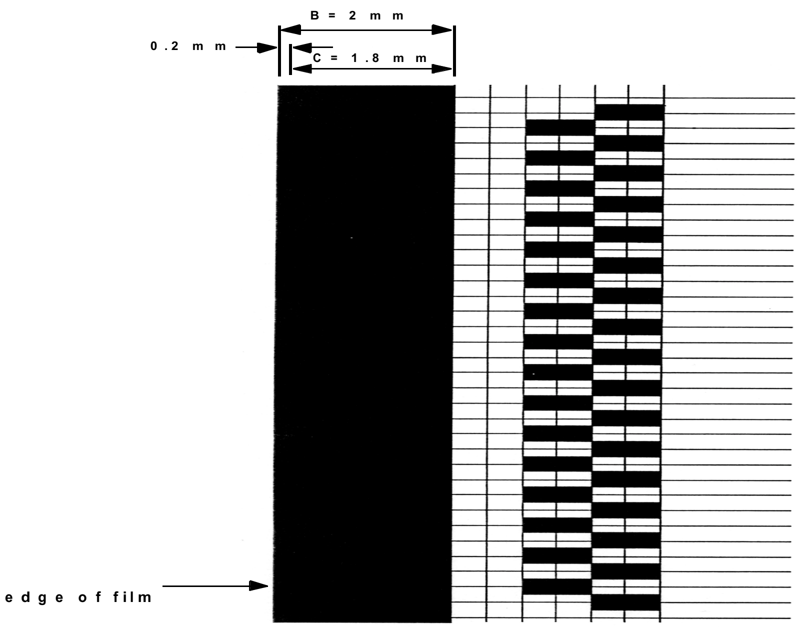
Edge **A**rtifact

Position: **A** < 50 micro-meter
Width of **E**dge **A**rtifact: within 10 micro-meter

An Edge Artifact should never be farther than 50 microns (0.002 inches) from the film edge and never exceed a 10 micron (0.000396 inches) in width.

4.3. EDGE ARTIFACT KEY DIMENSION SPECIFICATION

General Edge Artifact Specification



Fog: Negative: No Fog in B dimension
Positive: No Fog in C dimension

Scratches: Negative & Positive: No Scratches in B dimension

Skiving: Negative & Positive: No Skiving in B dimension

note: the above spec applies to both film edges

Edge Artifacts should be confined to 0.2 mm along the film edge. The Edge Artifacts cover both mechanical and fog issues.

5. SDDS PHYSICAL TRACK CHARACTERISTICS DEFINED WITH RF VIDEO SIGNAL

5.1. INTERPRETATION OF SDDS RF VIDEO SIGNALS

For those laboratories equipped with a SDDS QC reader and processor, the various printing phenomenon can be observed on an oscilloscope with probes attached to analog test points in the SDDS DFP-D2000 processor.

The top board in the DFP-D2000 is the EQ 53. Attach 10x or 1X scope probes to the following test points.

P Track (Picture Side)	Signal Name	S Track (Sound Side)
TP-300 (P1 DATA IN)	Analog Video Signal	TP100 (S1 DATA IN)
TP-304 (TRACKING)	External Sync	TP-104 (TRACKING)

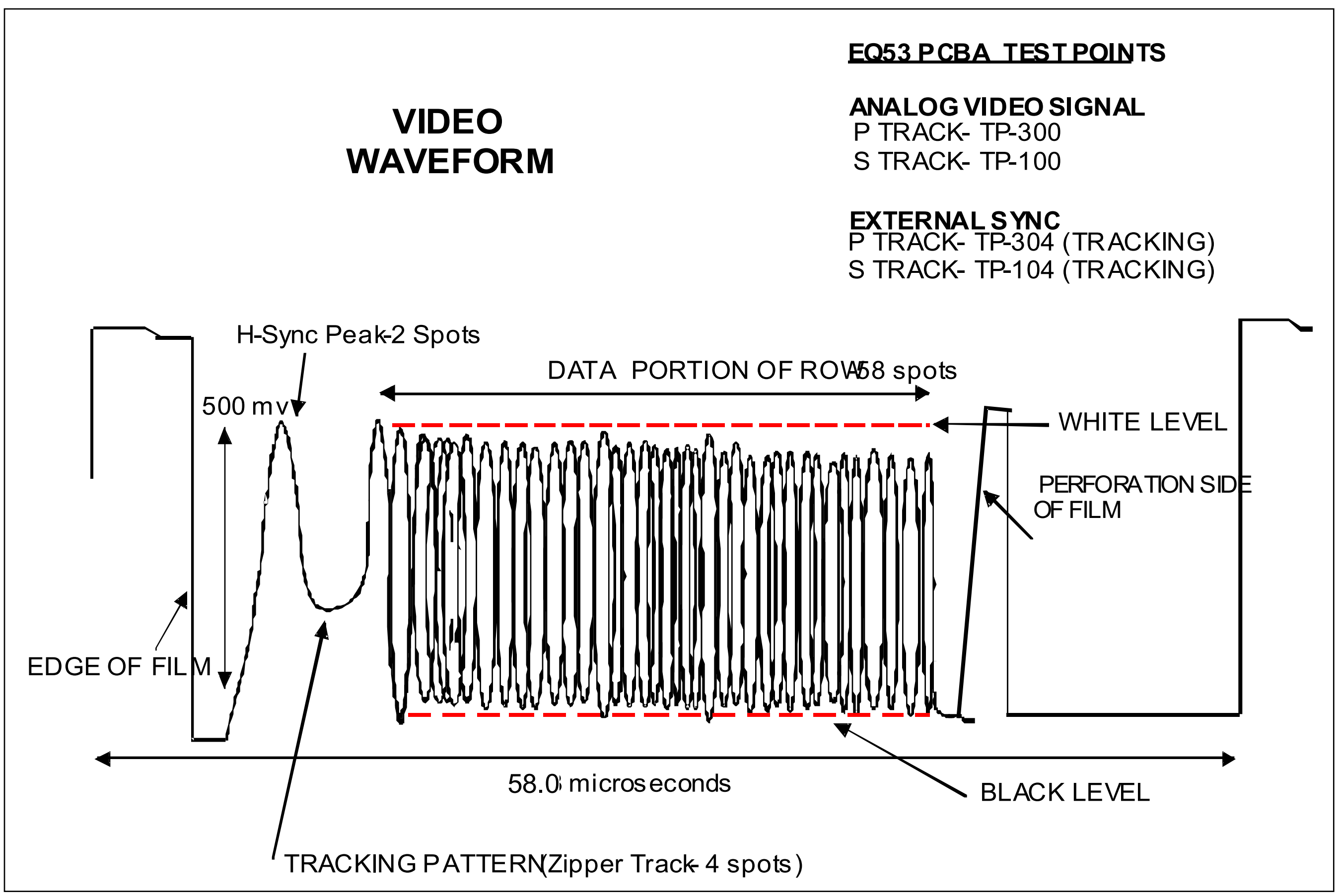
With the film operating at speed, the ideal data waveform will be as follows on both sides.

RF VIDEO WAVEFORM REFERENCE RENDERING

On the oscilloscope the signal will start at the edge of the film and move to the perforation.

The 2 spot white peak is the Horizontal Sync reference defined earlier as the **Sync Mark**

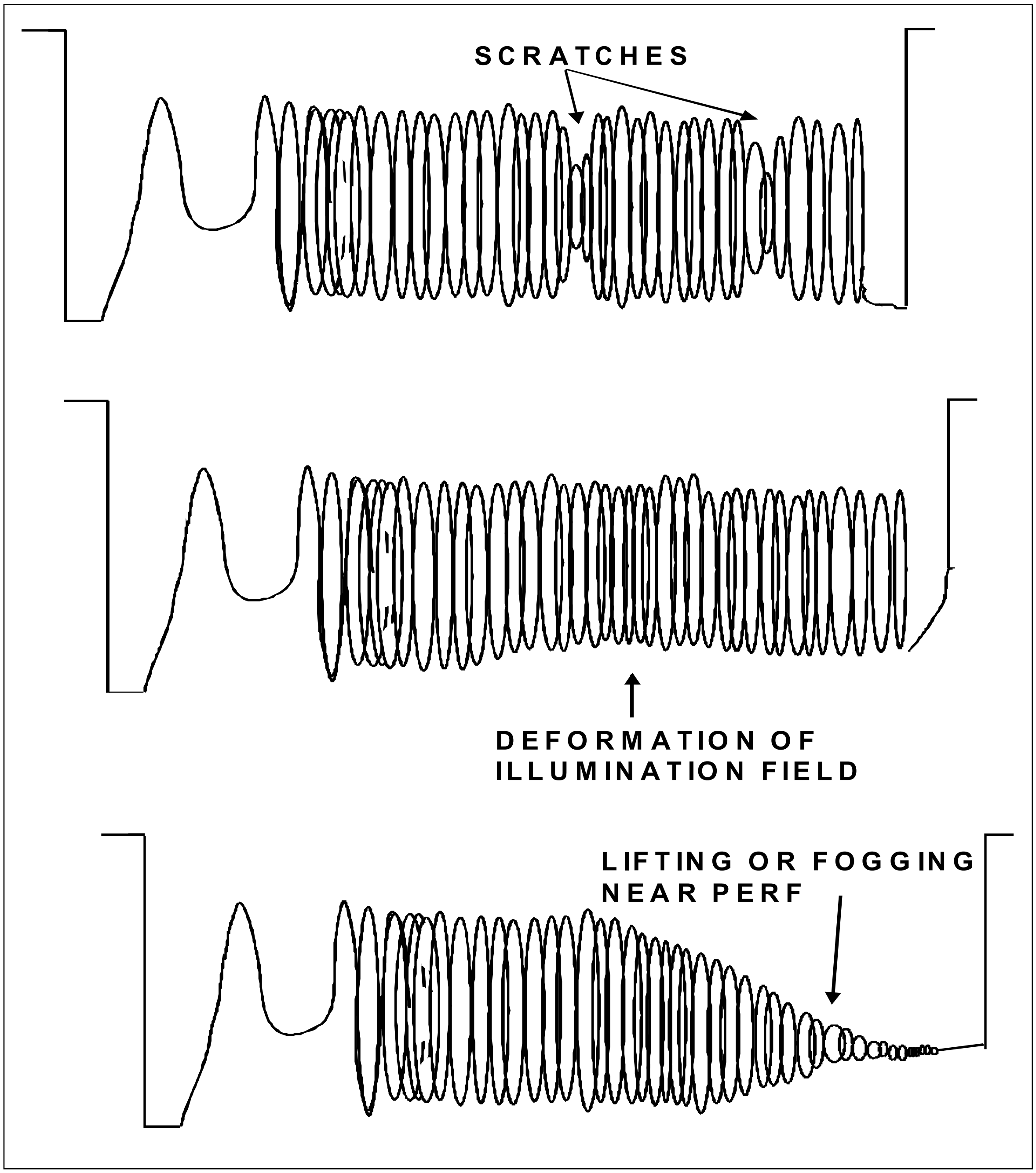
The **Tracking Pattern** signal or the **Zipper Track** provides a grey level that is used by the tracking servo. The Tracking Pattern can be employed as a visual aide to establish the electronic cross over point for a logical 1 or logical 0 decision. The actual Electronic Threshold is set 10% higher than the Tracking Pattern.



The **Black level** is the electrical signal established by the target Cyan density exposed by the Film Laboratory. As discussed previously an aim density range from 1.3 to 1.5 will insure that the print will hold back the LED illumination source in the SDDS reader.

The **White level** is the electrical signal established by passing the SDDS reader illumination source (red LED's) through the clear areas on the print.

Below you see 3 examples of both the white and black levels being effected by various physical effects. The first rendering shows the effects of scratching as visible creases in the waveform.

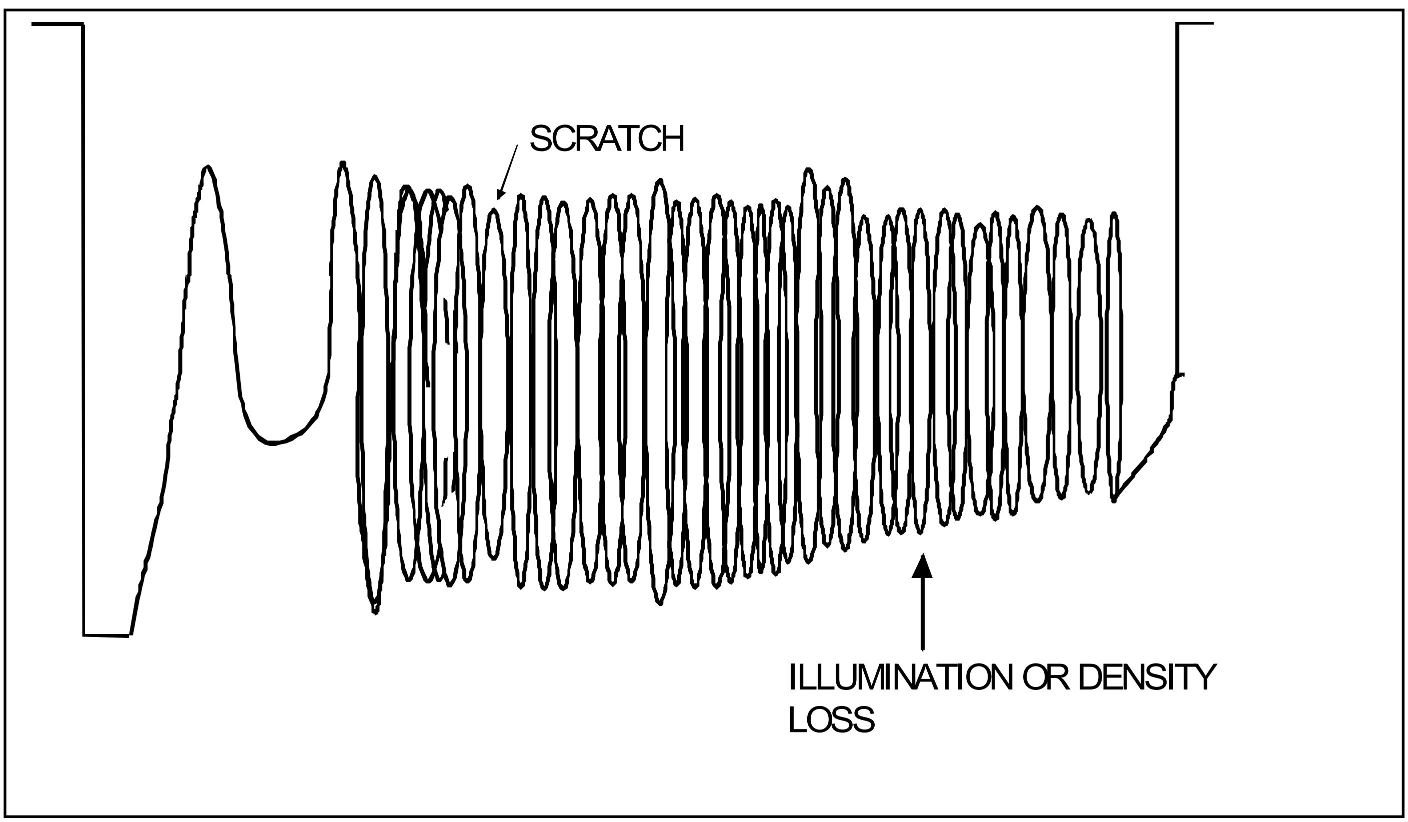


The second rendering shows the effect of a deformation in the illumination field at the print head aperture. This is normally the most difficult adjustment to make on the print head and unfortunately becomes more problematic when halogen light bulbs and filter packs which require frequent replacement (Please refer to Laser Illumination Source above).

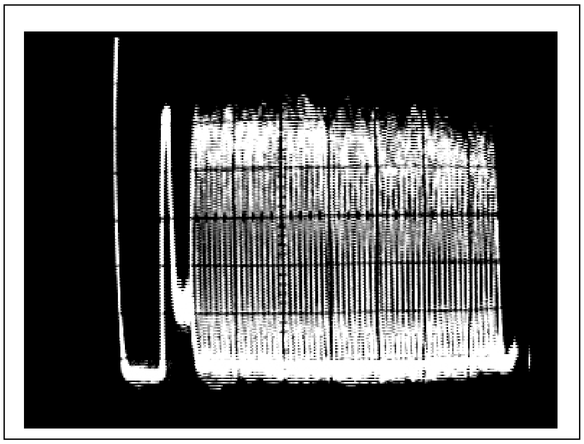
The third rendering shows the effects of a loss of contact between the negative and positive over the illuminated aperture near the perforation. The collapse of the RF waveform is basically the defocusing effect created by the negative and print not being held in tight contact.

The final example below shows a common loss of illumination near the perforation. This would not diagnose as a contact issue since the eye pattern of the waveform remains intact and the eyes open clear out to the perforation. This allows the operator to separate the phenomenon of contact and illumination field flatness.

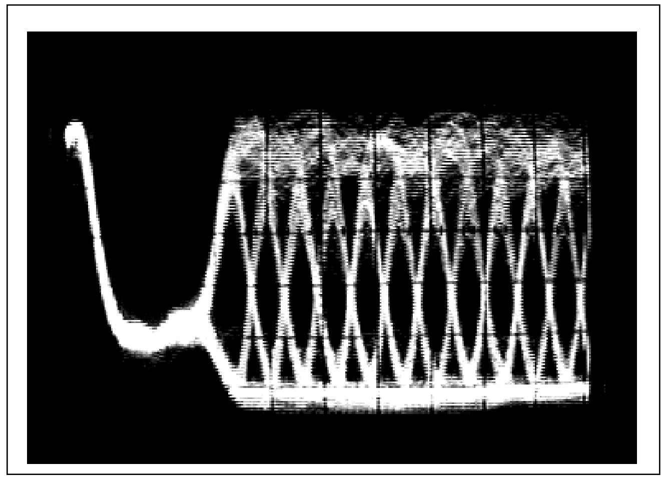
Distortion of the waveform in either the black or white level can provide immediate physical knowledge to the printer engineer. He can note poor contact as a defocusing of the spots which causes the black level to rise, the white level to fall and the loss of the eye pattern transitions in the area of poorest contact. Lack of flatness of exposure illumination will show distortion in the black level yet defined eye transitions will remain across the track. Edge damage would appear as an extra leading clear signal ahead of the 2 spot Horizontal Sync pulse.



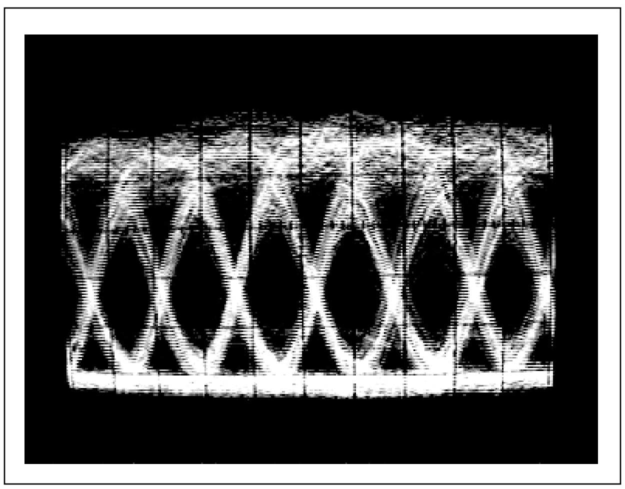
5.2. EYE PATTERN OF RF VIDEO SIGNAL



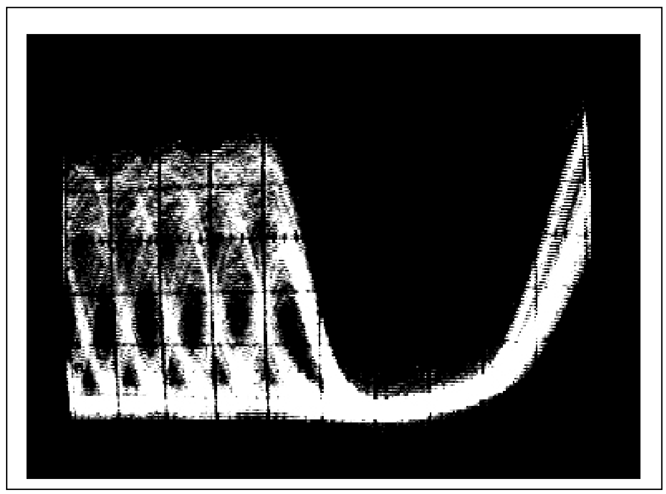
RF Waveform from edge of film to perforation



Expanded view starting from Sync Mark on left.



Expanded view in the middle of a row.



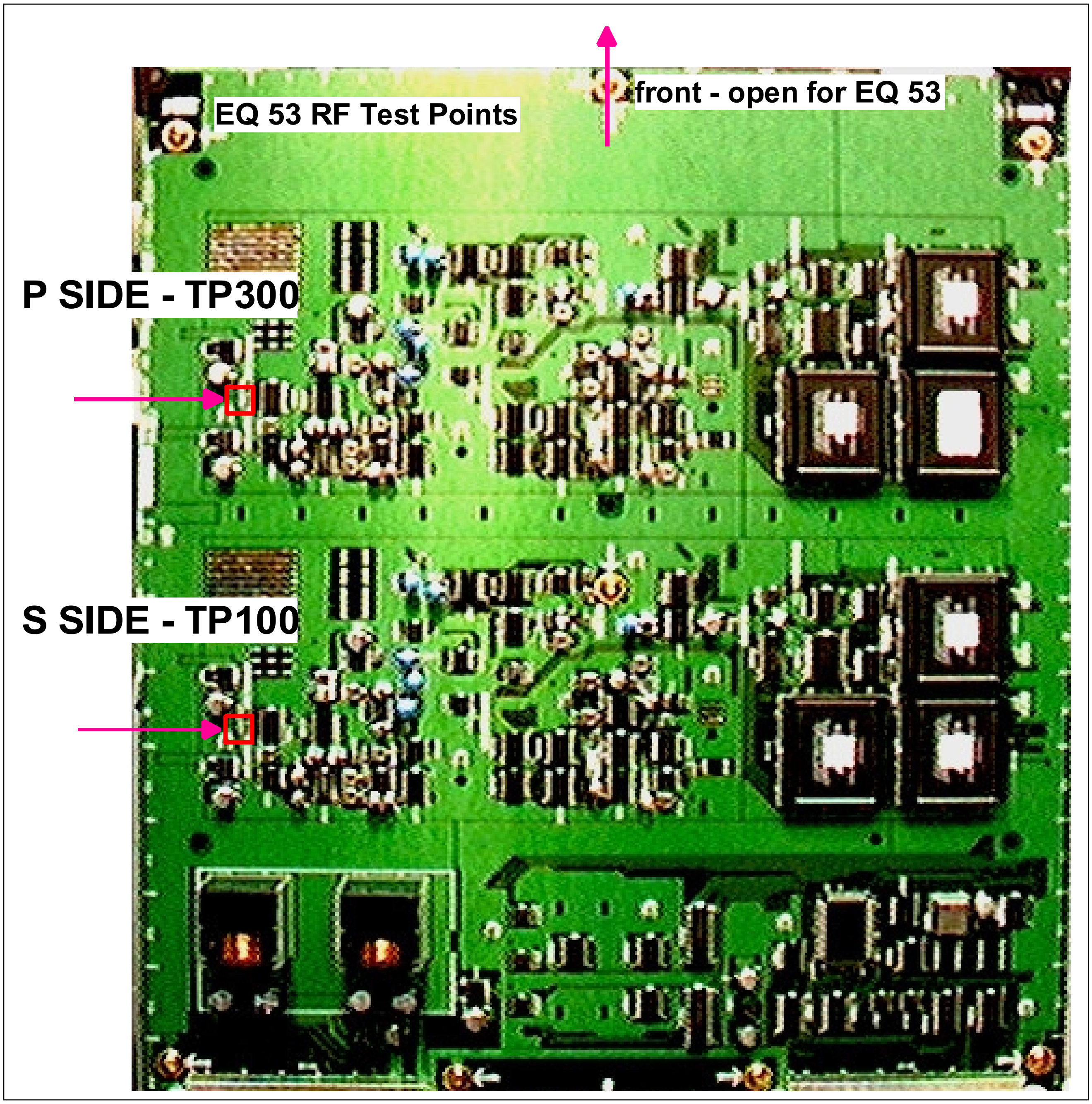
Expanded view near perforation edge.

The Eye Pattern derives its name from the overlay of multiple rows of SDDS data when read as a RF waveform on an analog oscilloscope. The visual persistence of the scope causes the traces of approximately multiple rows to overlap creating the unique eye pattern. A key variable in contact printing is the uniformity of contact between the negative and positive across a row of SDDS data. The individual "Eye's" of a row which are “open and clear” across the row indicates good contact. The current specification states that the Eye Pattern opening will be only 10% less than the average peak to peak amplitude of the Data Area.

5.3. EQ 53 TEST POINTS

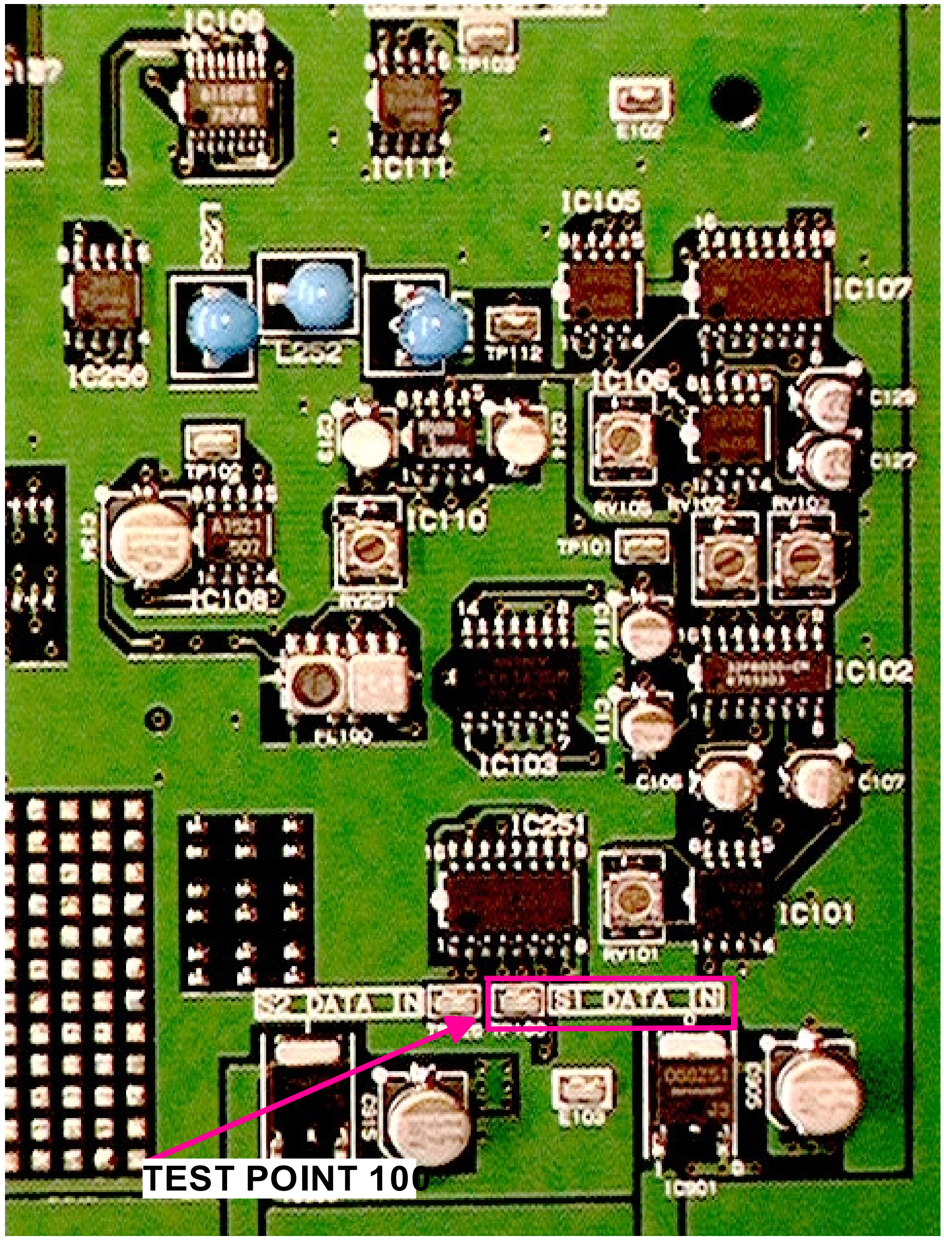
The figures below show the physical connection points on the EQ53 board. The signals are best viewed with a bandwidth below 10 MHz and can be connected with X1 probes for permanent installation.

TEST POINTS FOR S TRACK AND P TRACK RF VIDEO WAVEFORMS



The EQ 53 board is shown as viewed from above. The front door on the DFP-2000 processor would open at the top of this figure. 1X probes or ball-clips can be used to bring the signals to an oscilloscope.

TEST POINT DETAIL

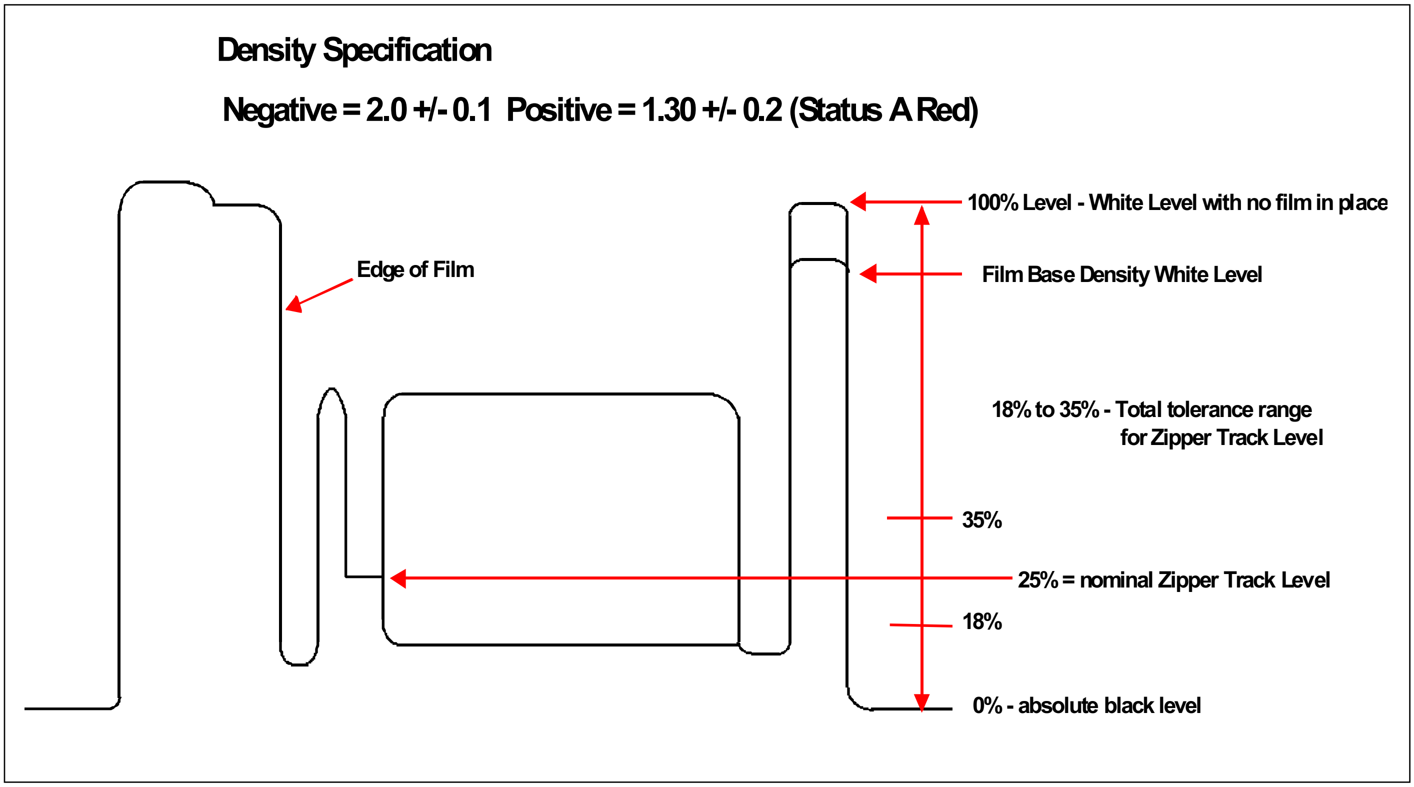


The detail view above shows the S Side TP 100 test point. The drawing is in the same orientation as the overall layout above.

6. PRINTING SPECIFICATIONS GOALS

The following waveform specifications address the various printing issues discussed earlier to provide goals for optimum SDDS print quality. These specifications are goals and are to be used as reference as a lab comes online. It is important to remember that in many cases the achievement of these specifications requires the intervention of the Print Head Manufacturer and is not the sole responsibility of the Film Laboratory.

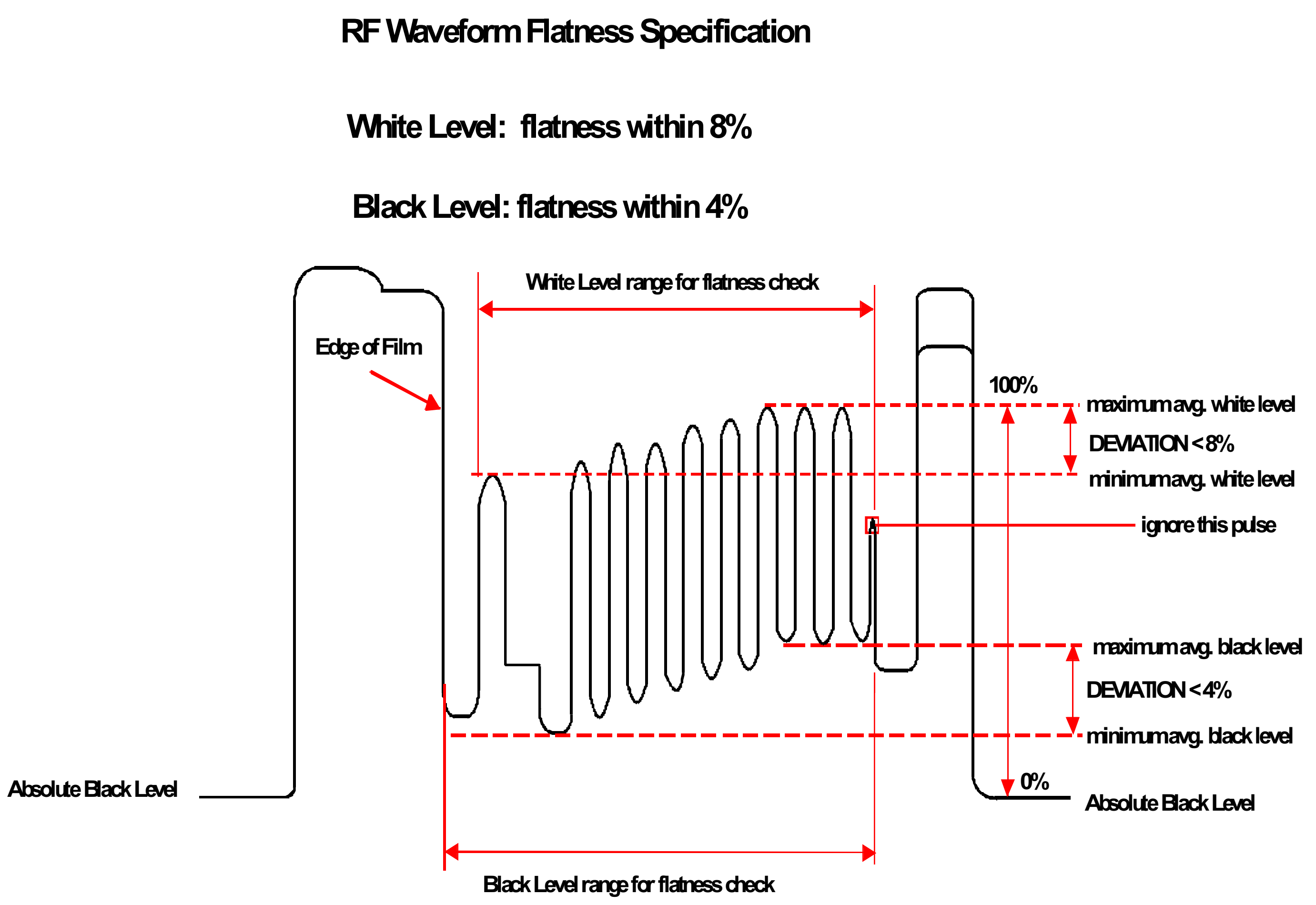
6.1. RF WAVEFORM AND RF LEVEL



The aim densities for the print are restated. Presently the SDDS aim densities are matched to the aim density of the negative (2.0 +/- 0.1) to ensure the Image Spread effects familiar to standard optical analog sound tracks yield a Zipper Track with a 50/50 duty cycle. You will note that the Zipper Track Level is valid between 18% and 35% of its 25% nominal. Keeping the print density below 1.50 will ensure that Image Spread effects will not erroneously effect the Threshold value.

For this measurement 100% is considered to be the level with no film in the illumination to CCD path. 0% is considered to be the absolute black level established by a reference built into the CCD array as shown.

6.2. RF WAVEFORM ENVELOPE FLATNESS



Signal Flatness whether regarding white or black level, is a measure of the average parallelism of the waveform to a level extended through the waveform from the Zipper Track Level.

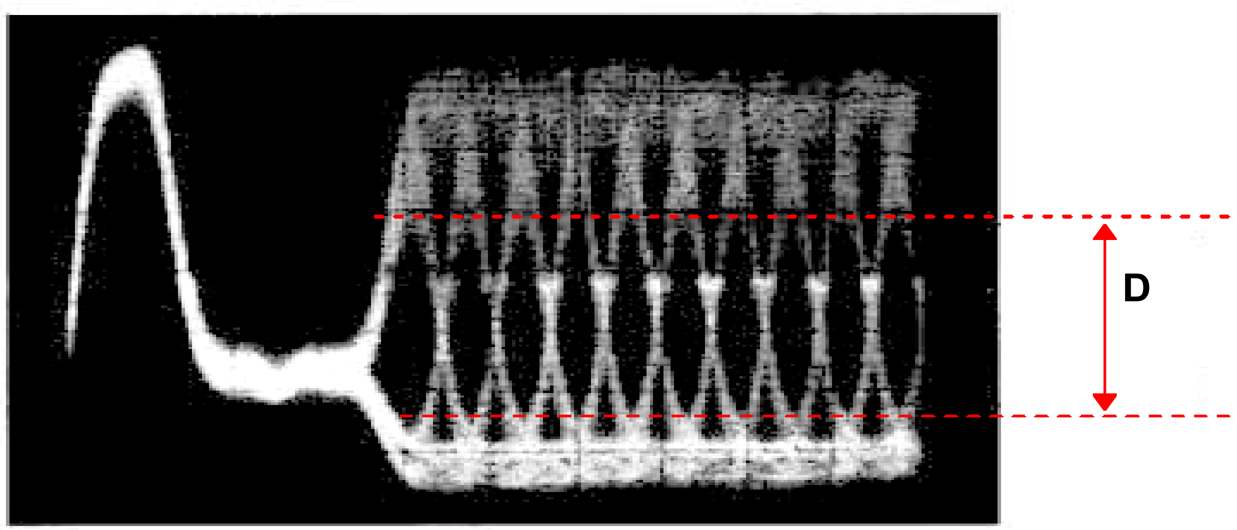
The white level flatness is established by the SDDS Reader LED illumination source passing through the clear areas on the print. It is a measure of the Reader LED's flatness, the possible introduction of Cyan exposure of clear spots from fog, or dirt on the optics of the SDDS reader. The goal is to limit the total variation to less than 8% in the data area of the row. Variation of flatness outside of the 8% spec can come from scratches or printer contact loss in the print.

The black level flatness is established by the print head illumination source and negative to positive contact. The goal is to limit the total variation to less than 4% in the data area since the black level is much closer to the Electronic Threshold than the white level.

6.3. RF WAVEFORM EYE PATTERN TO DEFINE PRINTING CONTACT

Defocus Specification

Defocus due to loss of contact during printing



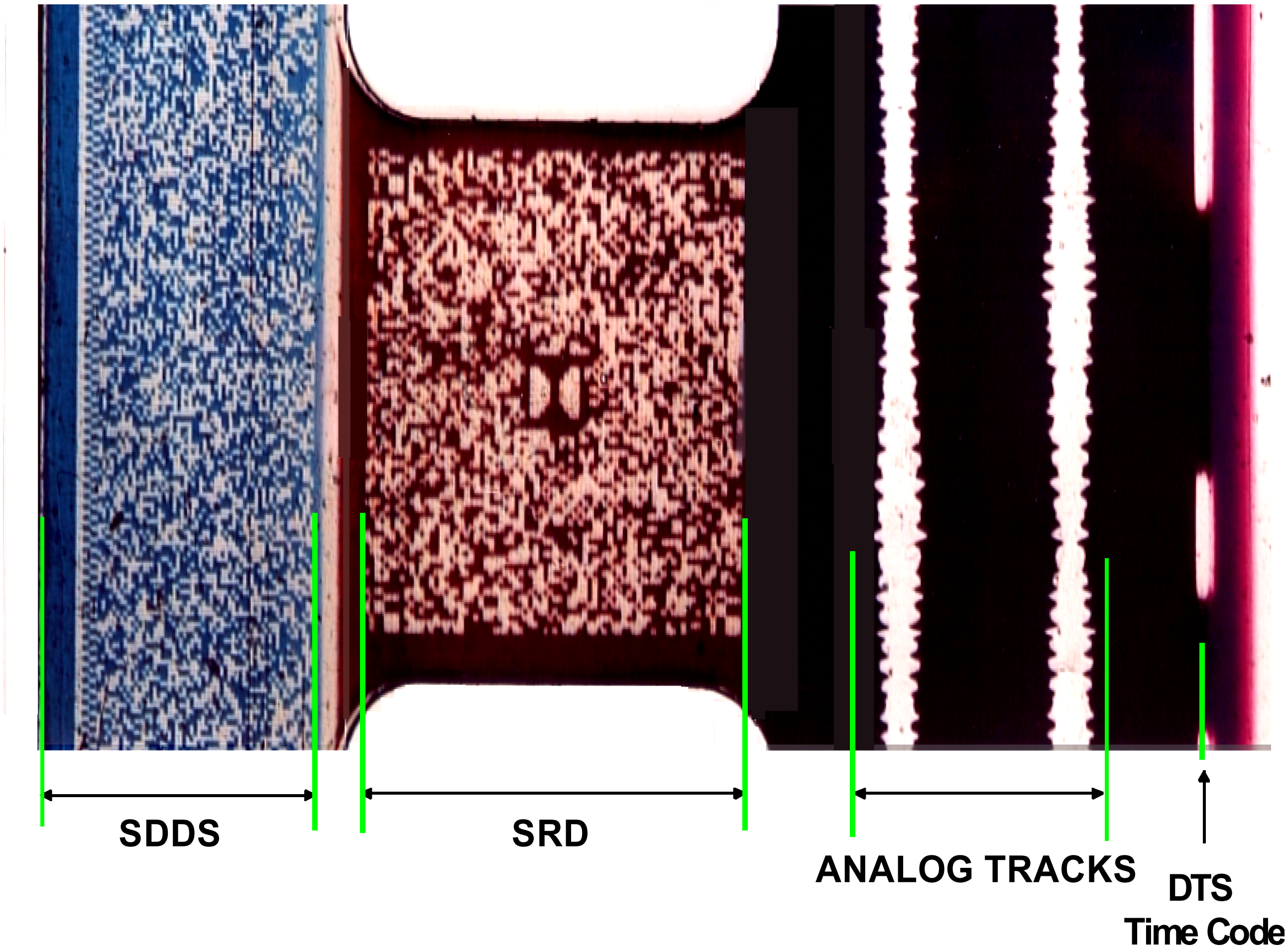
D Mininimum / D Average x 100 > 90%

D is defined as Amplitude of 1T wave of Eye Pattern

The RF Eye pattern across the row can be used to establish the quality of contact between the negative and the positive during printing. The figure above states that the open “Eyes” (D Minimum) should be no less than 10% of the average envelope amplitude of the data pattern (D Average).

7. PRINTING EXAMPLES

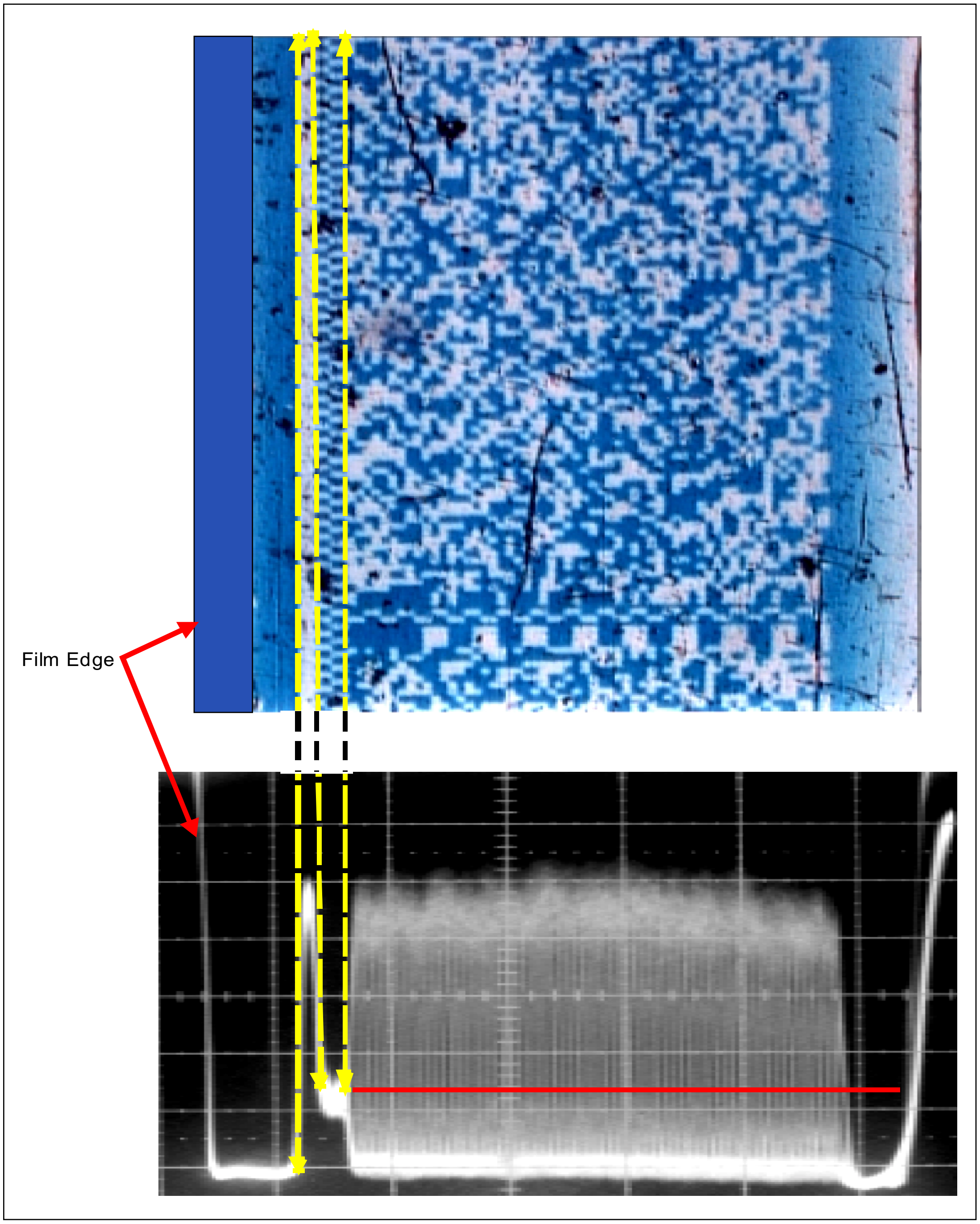
7.1. QUAD FORMAT SOUND TRACK FROM RELASE PRINT



The Quad Sound Format for the current Motion Picture Release Print is shown above. Starting at the film edge on the left, the S Side of the SDDS format is shown followed by the Dolby Laboratory's SRD format. The standard stereo analog optical track and the DTS time code track follow. The P side SDDS track would be on the other side of the image on the opposite side of the film.

This daunting array of digital and analog formats each have their own printing requirements such as aim density, wavelength of illumination, mechanical tolerances, etc. It is easy to see that the Film Laboratory faces many technological issues while still maintaining image quality and enormous delivery requirements.

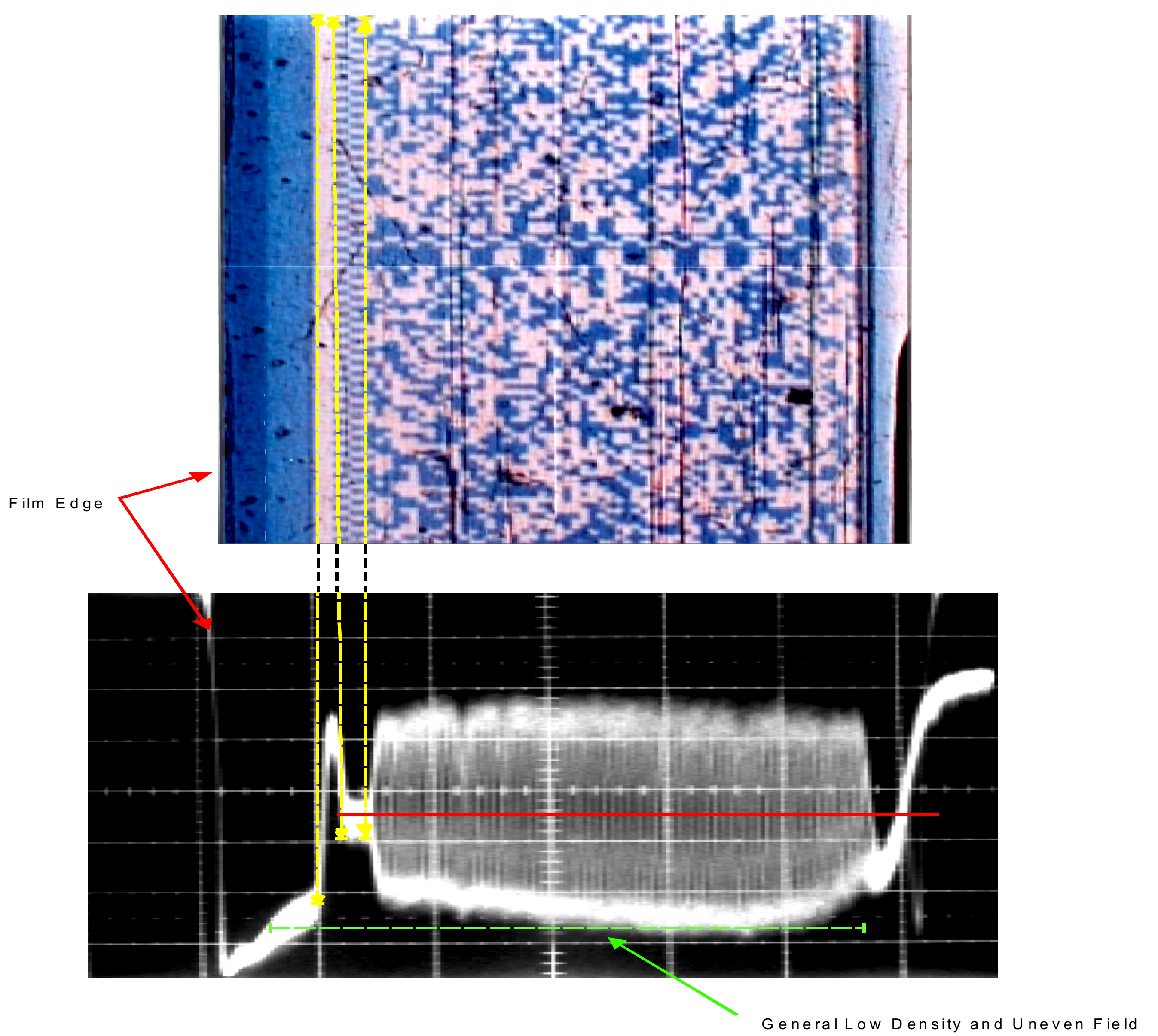
7.2. POSITIVE IMAGE AND RF WAVEFORM WITH OPTIMAL PRINT QUALITIES



The figure above shows the relationship between a static image of SDDS track and the resultant RF video waveform when the track is read by a CCD array. The two images are scaled to show the equivalent SDDS format features visually and electronically.

In this optimally printed example, notice the flat black level (Cyan print density) across the row (flat illumination); clear and open eye pattern (good print to negative contact); no positive level activity from edge of film to Sync Mark of SDDS track (No Edge Artifacts).

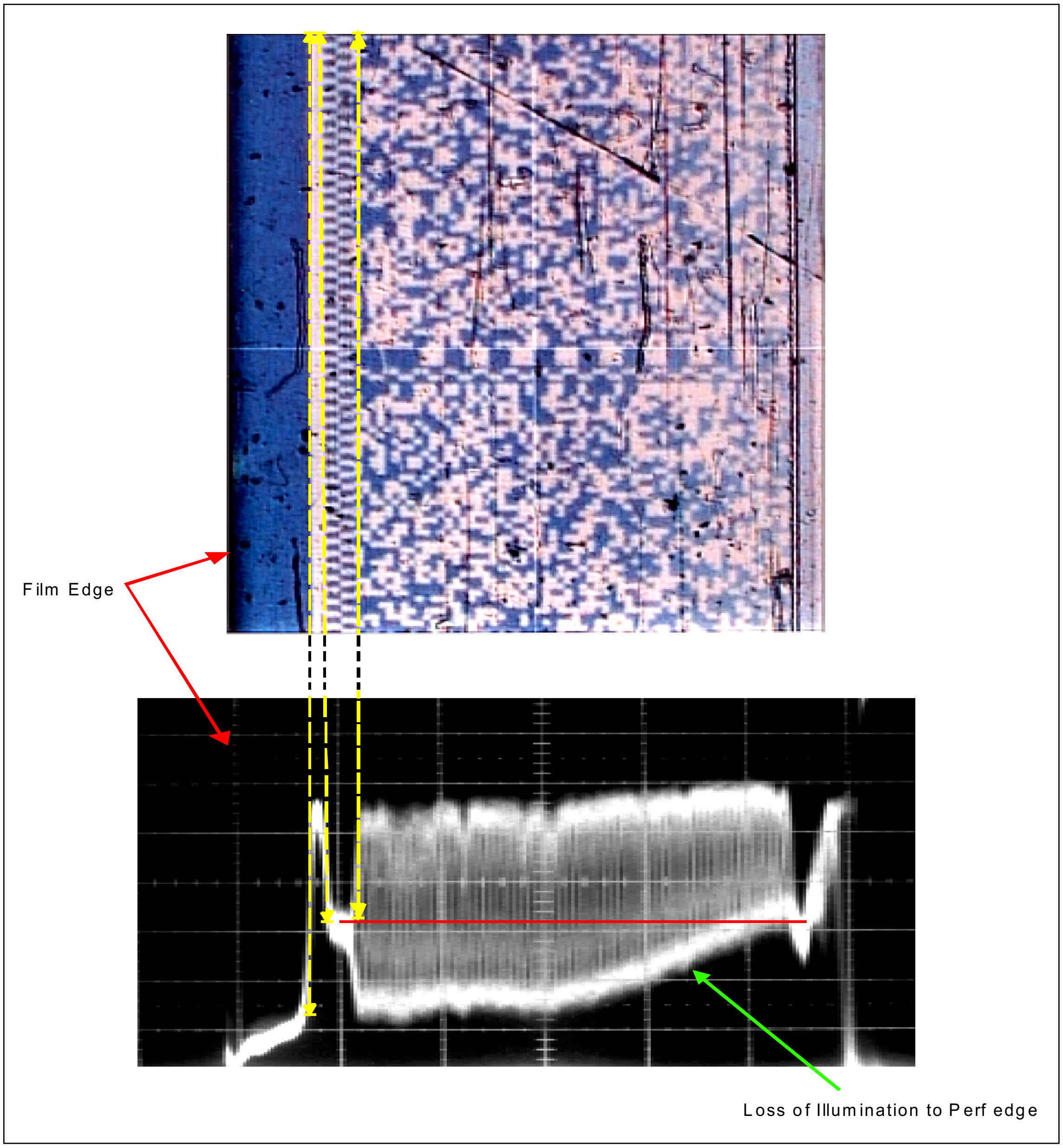
7.3. POSITIVE IMAGE AND RF WAVEFORM WITH LOW AND UNEVEN DENSITY



The figure above shows the relationship between a static image of an SDDS track and the resultant RF video that was printed with uneven illumination from film edge to perforation and a general overall low density.

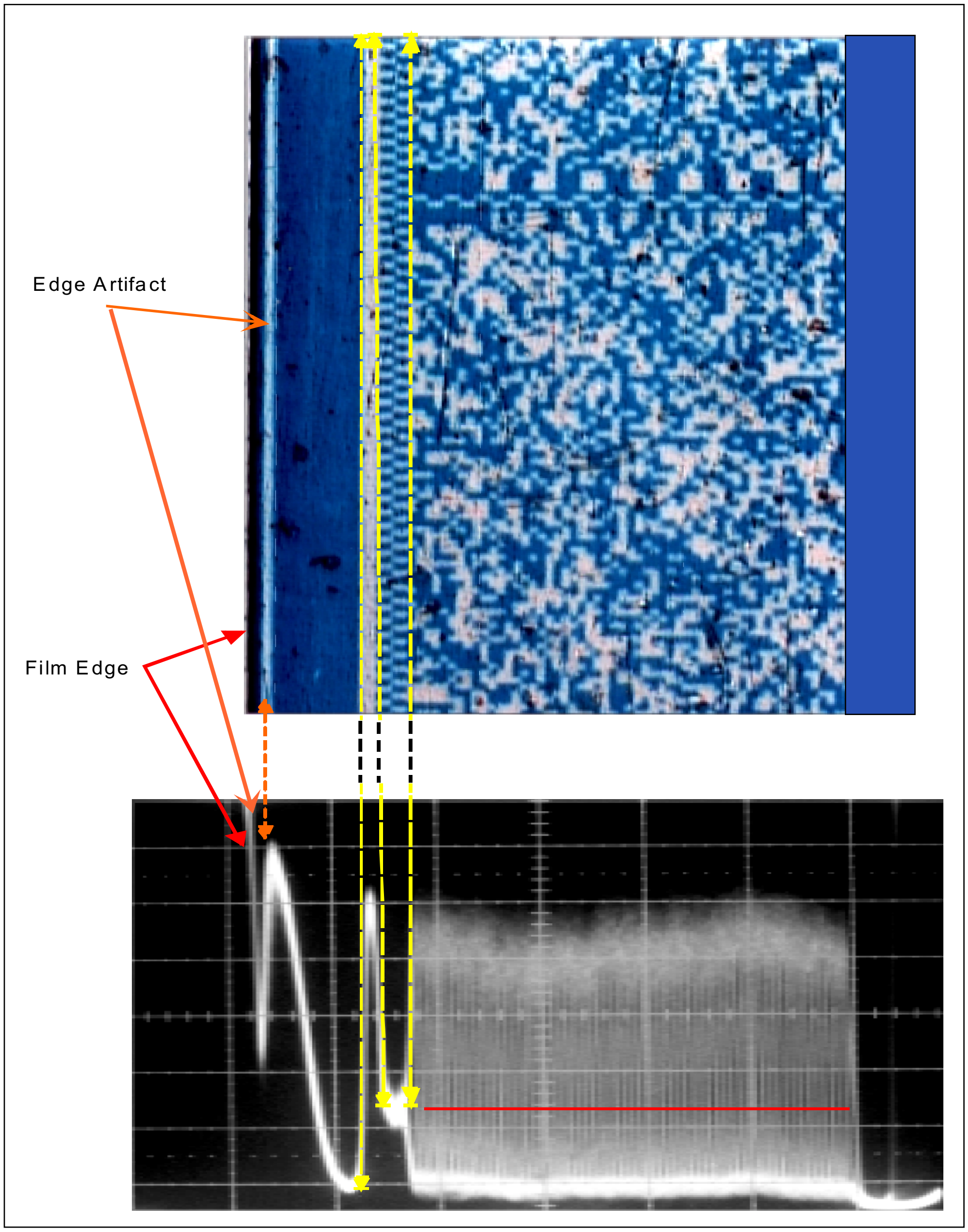
Notice the uneven black level from the edge of film to perforation and an average level that is 1 to 1.5 graticules higher than the film edge density (black level from edge of film to Sync Mark). The density change is evident in the static image above the waveform. The example still has a clear and open eye pattern (good print to negative contact) and no Edge Artifacts. The SDDS reader would attempt to read this waveform but margins for signal recovery with the black level relatively close to the Zipper Track Level would be severely compromised resulting in heavy ECC activity and little margin for scratches and dirt that would result in the field.

7.4. POSITIVE IMAGE AND RF WAVEFORM WITH DENSITY LOSS NEAR PERFORATION



The figure above shows a static image of an SDDS track and the resultant RF video with an uneven and progressive loss of illumination energy from the middle of the row to the perforation. Notice the black level rise from the middle of the track fully 2 graticules at the perf end of the row. It is important to note that the example still has a clear and open eye pattern (good print to negative contact) and thus illumination flatness rather than film contact could be assumed. The overall print density should be higher which would reduce the rise in black level. The SDDS reader would attempt to read this waveform but would find the black level crossing at the Zipper Track Level for the last third of the row. This would generate constant raw data errors, resulting in heavy ECC activity and most certainly a NG rating for print quality in this track.

7.5. POSITIVE IMAGE AND RF WAVEFORM WITH EDGE ARTIFACT

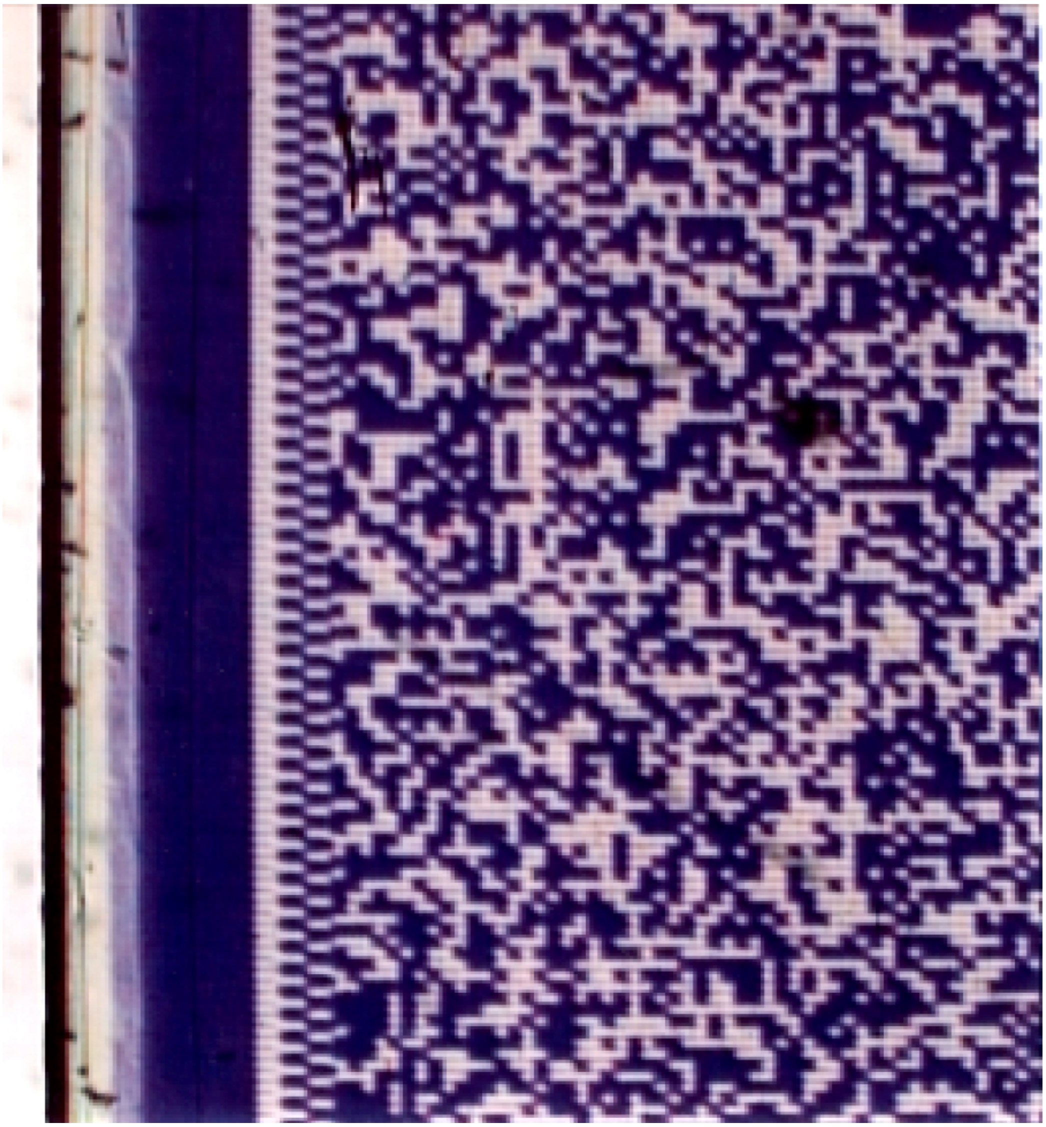


The figure above shows the relationship between a static image of an SDDS track and the resultant RF video with film containing an Edge Artifact.
Notice the flat black level (Cyan print density) across the row (flat illumination); clear and open eye pattern (good print to negative contact); and a single positive level pulse in between the edge of film and the Sync Mark. A view of the static image shows this "printed-in" line and is called an Edge Artifact. The SDDS reader would attempt to ignore this Edge Artifact. However, the amplitude and width of the artifact is sufficient to confuse the SDDS Tracking Circuitry as to the correct starting point of the row to be scanned. An otherwise excellent print would lead to confusing results since the QC software would report many DCM's due to tracking loss rather than poor data spot resolution.

7.6. POSITIVE IMAGE WITH EDGE ARTIFACT FROM MECHANICAL DAMAGE

The above static image shows the ravages of possibly a single roller with a burr along the film edge. The uneven mechanical damage creates the ragged clear line before the Sync Mark. The SDDS Reader would ignore this particular example, however this represents a marginally acceptable condition.

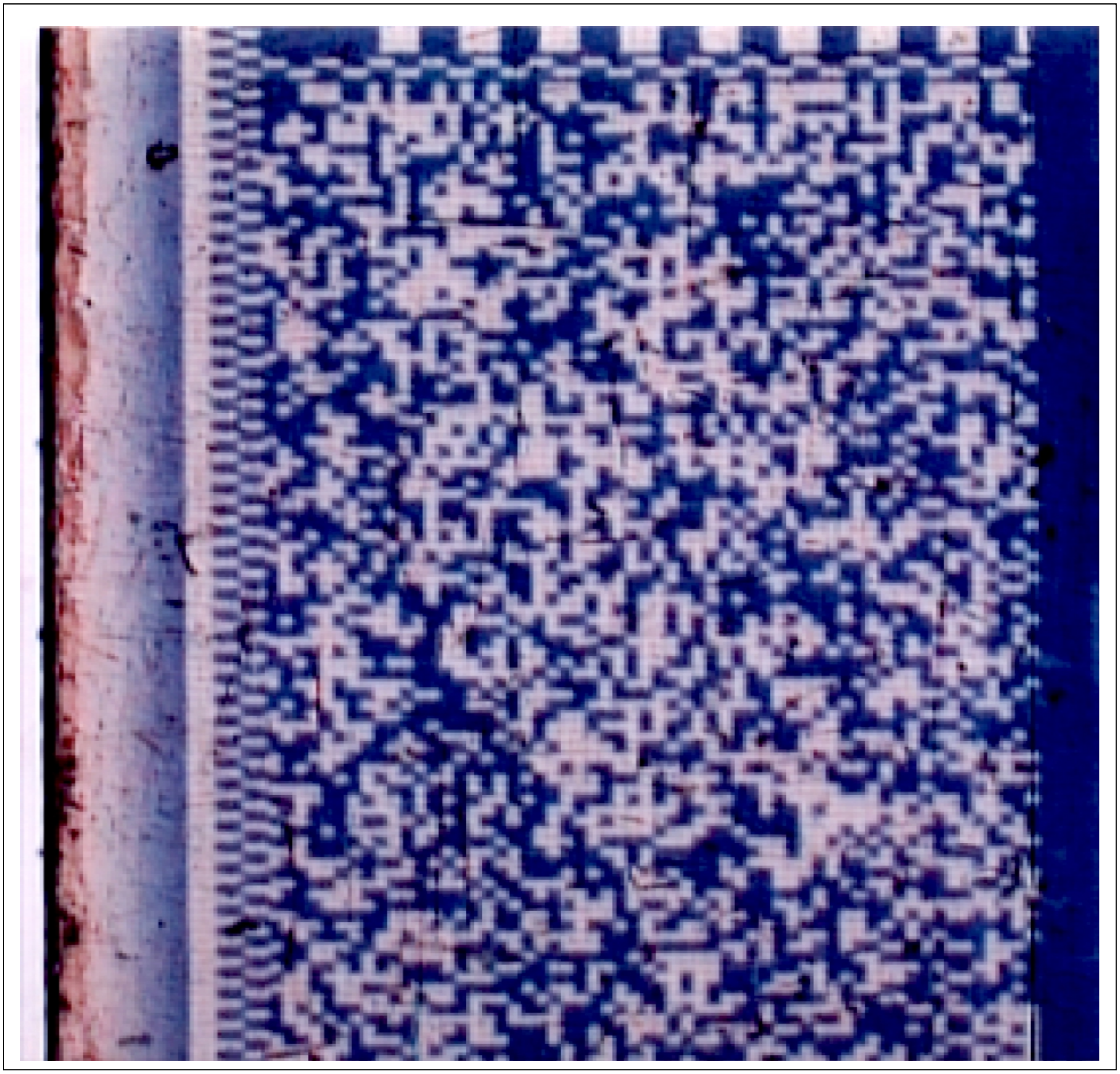
7.7. POSITIVE IMAGE WITH EDGE ARTIFACT FROM MECHANICAL SKIVING



This example print image suffers from the scalloping or skiving of the film edge due to improper guide alignment. The edge of the film rides up the edge of the guide and the emulsion is peeled off as if one was carving a stick with a sharp knife.

The SDDS Reader would most certainly fail in the presence of this false Sync Mark and again we note an excellent sync and data area in the actual SDDS printed area.

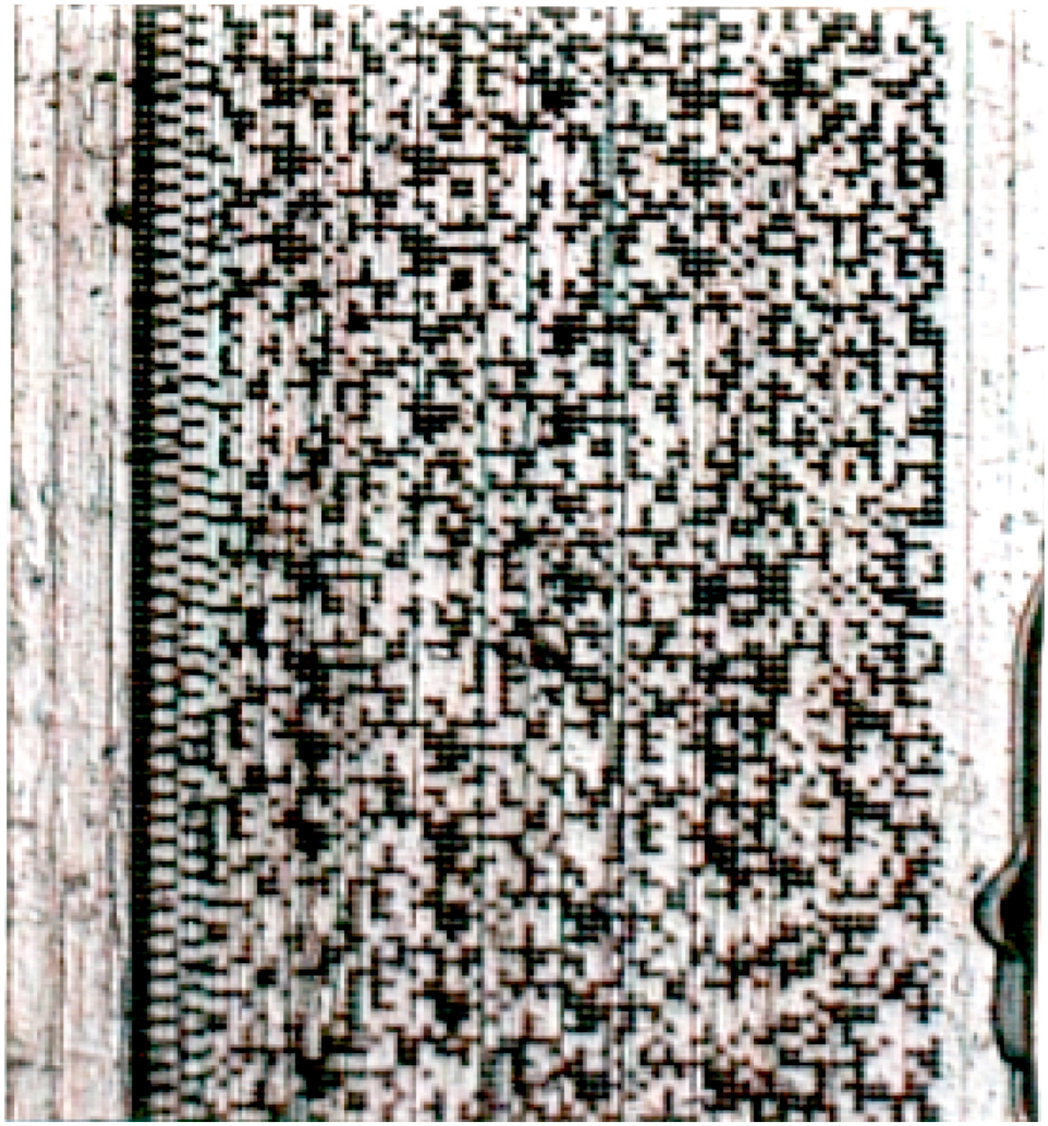
7.8. POSITIVE IMAGE WITH EDGE ARTIFACT FROM EXPOSURE AND PROCESSING DAMAGE



The film image above has a combination of problems. First the film edge was not properly exposed during the contact printing process. Mechanical damage has also occurred either in printing or the developing process that follows. The red tint to the mechanical damage implies pre or during processing occurrence since the emulsion layer exposure densities where modified by the pressure created during the mechanical damage.

The SDDS Reader would not track the actual data properly and this example can be considered as No Good (NG).

7.9. NEGATIVE IMAGE WITH MECHANICAL DAMAGE



The above negative is badly damaged. Often a Film Laboratory receives the master sound negative for contact printing from a distant source. The Film Lab would not have anyway to confirm that the received negative was not damaged prior to full production printing. The SDDS QC system can be configured to read a negative and establish the quality prior to full release printing (refer to SDDS QC Options).

In general base scratches on the negative do not appear on the resultant contact print. This fact should be included in the Film Labs visual evaluation of a negative prior to release printing.

8. SDDS QC SOFTWARE OVERVIEW

The SDDS QC version (3.03) is designed to operate in the PC Windows environment. The DFP-2000 processor provides an RS-232 null modem serial port that can be connected to an IBM PC. The software program when activated will electrically "connect" with the DFP-2000 processor. The processor is evaluating the data recovered by the DFR-2000 reader. This data evaluation can be monitored through the serial interface and be presented to the operator as real time and printed information about the quality of the SDDS positive or negative film under test.

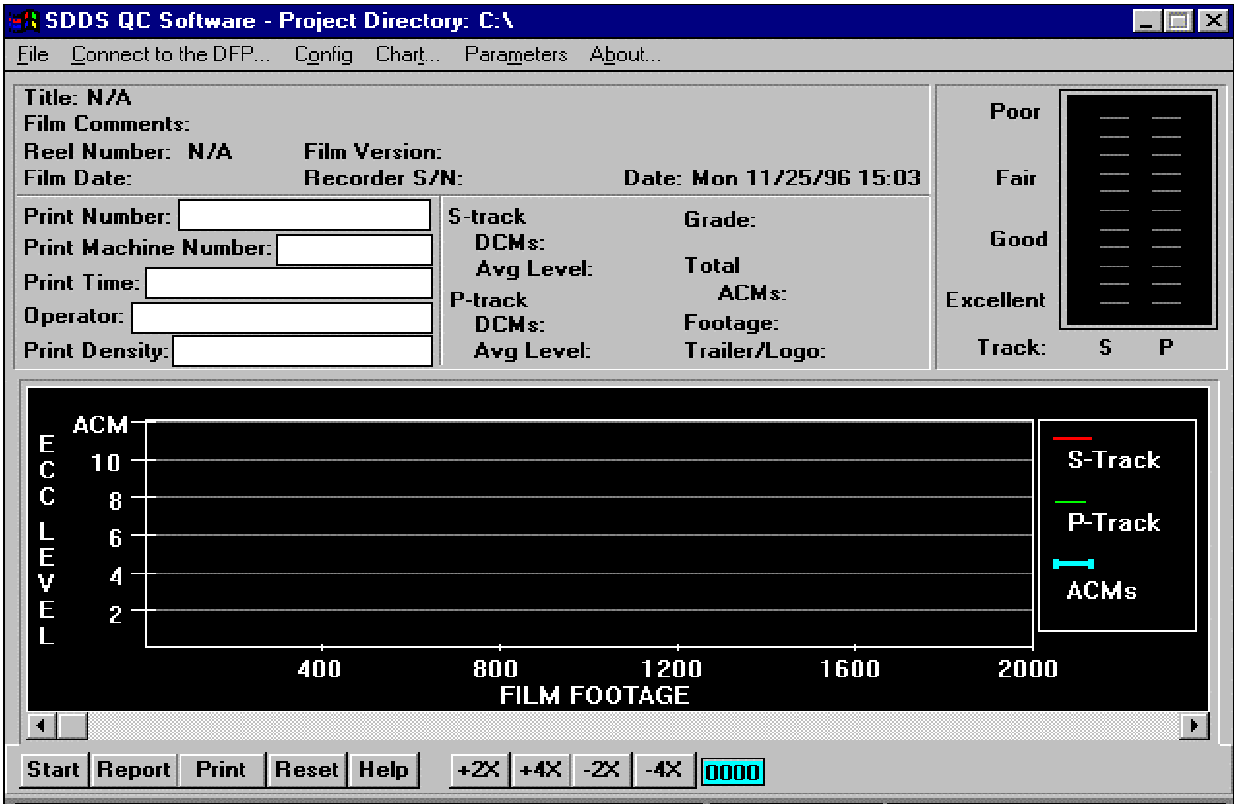
NOTE: THE SDDS QC SOFTWARE MEASURES THE ACTIVITY OF THE SDDS ERROR CORRECTION CIRCUITRY. THIS EXTREMELY NONLINEAR MEASUREMENT SHOWS HOW OFTEN THE ERROR CORRECTOR FAILS TO CORRECT A 4.3 FRAME ECC BLOCK. THE NUMBER OF ECC FAILURES PER TRACK ESTABLISHES THE GRADE OF THE REEL. THIS GRADE PROVIDES MARGIN FOR THE REEL PRIOR TO ITS INTRODUCTION INTO THE THEATER. HOWEVER, THE SDDS QC SOFTWARE DOES NOT IDENTIFY THE TYPE OF PHYSICAL PROBLEM THAT CAUSED THE ERROR CORRECTION TO FAIL. IT IS CRUCIAL TO COMBINE THE RESULTS OF THE SDDS QC SOFTWARE WITH AN OSCILLOSCOPE AND MICROSCOPE TO DEFINE THE PHYSICAL PROBLEM CAUSING THE ERROR CORRECTION FAILURE FOR PRINTER ADJUSTMENT

With the above caveat, the QC software still serves a major role in Film Laboratories. Many variations and applications have emerged since the creation of this software. Laptops loaded with this software can be quickly attached to the DFP-2000 processor in the field to assess and reassure nervous customers prior to premiere's and special events. Separating a problem from the SDDS playback hardware and the print being played back is always an imperative if complaints are received concerning the SDDS sound reproduction. As mentioned earlier, prints may be assembled by the film laboratory with as many as 6 to 7 reels. These reels have been printed in bulk on various days. If a theater operator or technician states that the entire print is failing to reproduce properly, the issue is with the SDDS hardware not the actual printed film. Individual reels can have printing problems but it is almost impossible to have a complete print judged bad. The QC software could answer the above example. Another scenario is the use of the laptop in the viewing room as the movie is playing. This is particularly important when nervous directors, film editors, etc. are trying to approve the image and sound negatives for production printing. The laptop can be monitoring the performance of the SDDS Error Corrector as these people listen. A difference in opinion concerning sound artifacts can be settled by referring to the QC readout. Ultimately, the normal use of the QC software is to identify areas on film where the Error Correction circuitry simply could not repair the data. If the technician combines this knowledge with the techniques discussed throughout this manual, he can provide correction strategies to the printing equipment.

A failure to repair a single ECC block by the error corrector in the DFP-2000 for each track results in a Digital Concealment (DCM) for the track. An Analog Concealment (ACM) results if error correction fails on both tracks with the ECC Block of one track bad and its 17 frame offset backup ECC block on the opposite track also bad.

The following graphics are copied directly from the SDDS QC software and a brief highlight of software features is provided.

SDDS QC SOFTWARE, MAIN SCREEN



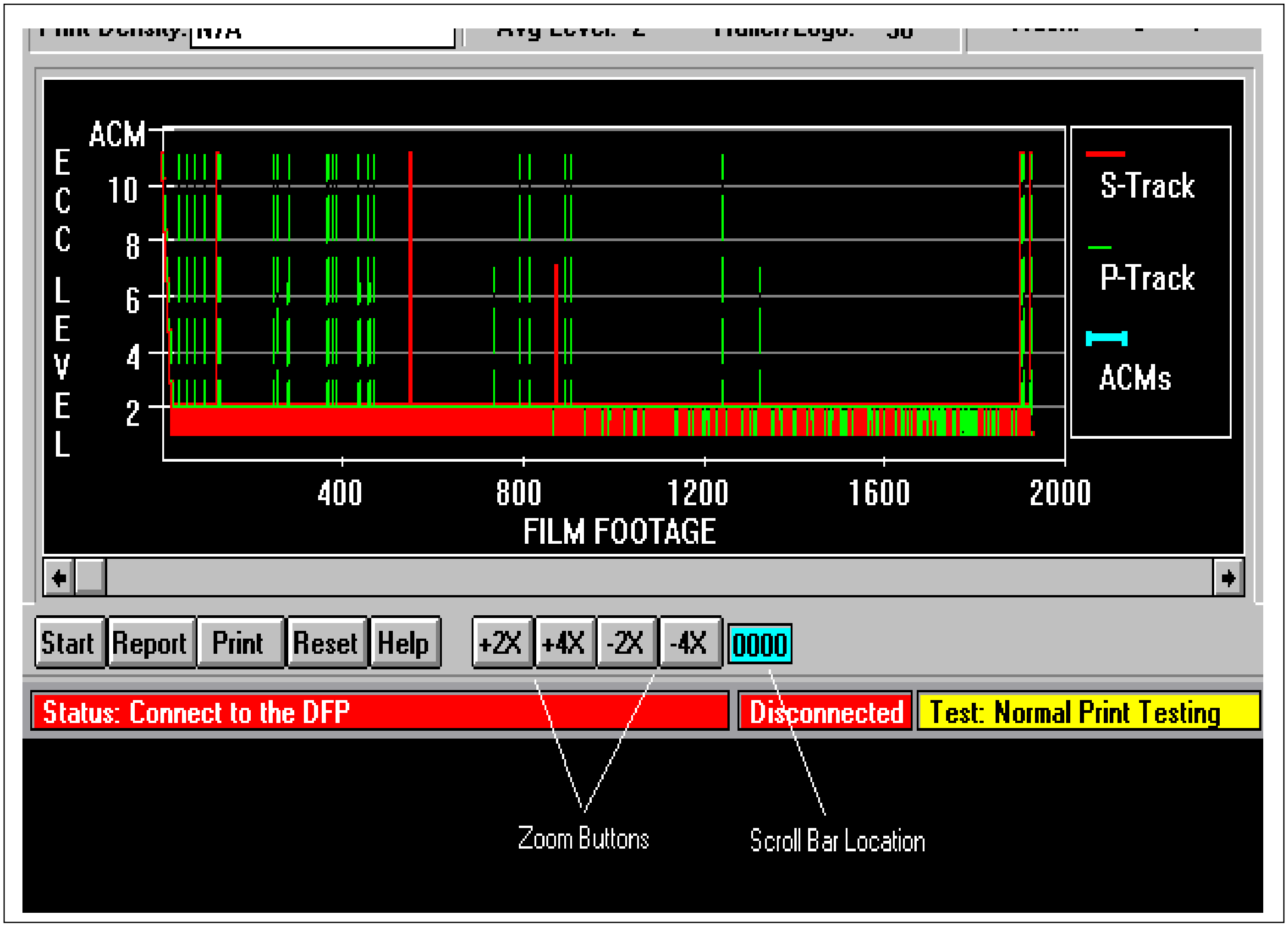
The operator will be presented with a screen that provides command, status, and various data readout displays. After successful null-modem connection between computer and DFP-2000 is established, the operator can activate the Start button as the SDDS Reader reads the SDDS tracks. He may wish to enter data into the fields available such as Print Number, Operator, etc.

As the software operates, a plot of P and S track data will be presented on the X-Y display. The X axis is expressed in footage, the Y axis in Error Corrector activity. The display in the upper right corner reflects the Y axis for each track on a ECC Block by Block basis.
After the reel under test is completed, the summary results of DCM's per track and total ACM's will be published above the chart display.

A summary grade will also be published. The grading system follows the conventions of normal Film Lab practice which is A, B, C, or NG. This grading system is provided as a general guideline. The use of this software is predicated on the operator's judgement in relationship to the program material. For example a sound track with very little surround activity and much dialog may measure as an NG print for the number of DCM's counted, however, the digital concealment algorithm makes these errors invisible to the listener.

There are, however, certain constants. The reversion to analog, an ACM, should always be considered as a NG rating. Continuous DCM's in a given channel indicating the loss of one of the SDDS tracks should be given an NG rating for the ACM is sure to follow when the reel reaches the field.

Other features include the automatic display in the upper left hand corner of the reel number read from the SDDS User Data block created when the sound negative was generated.

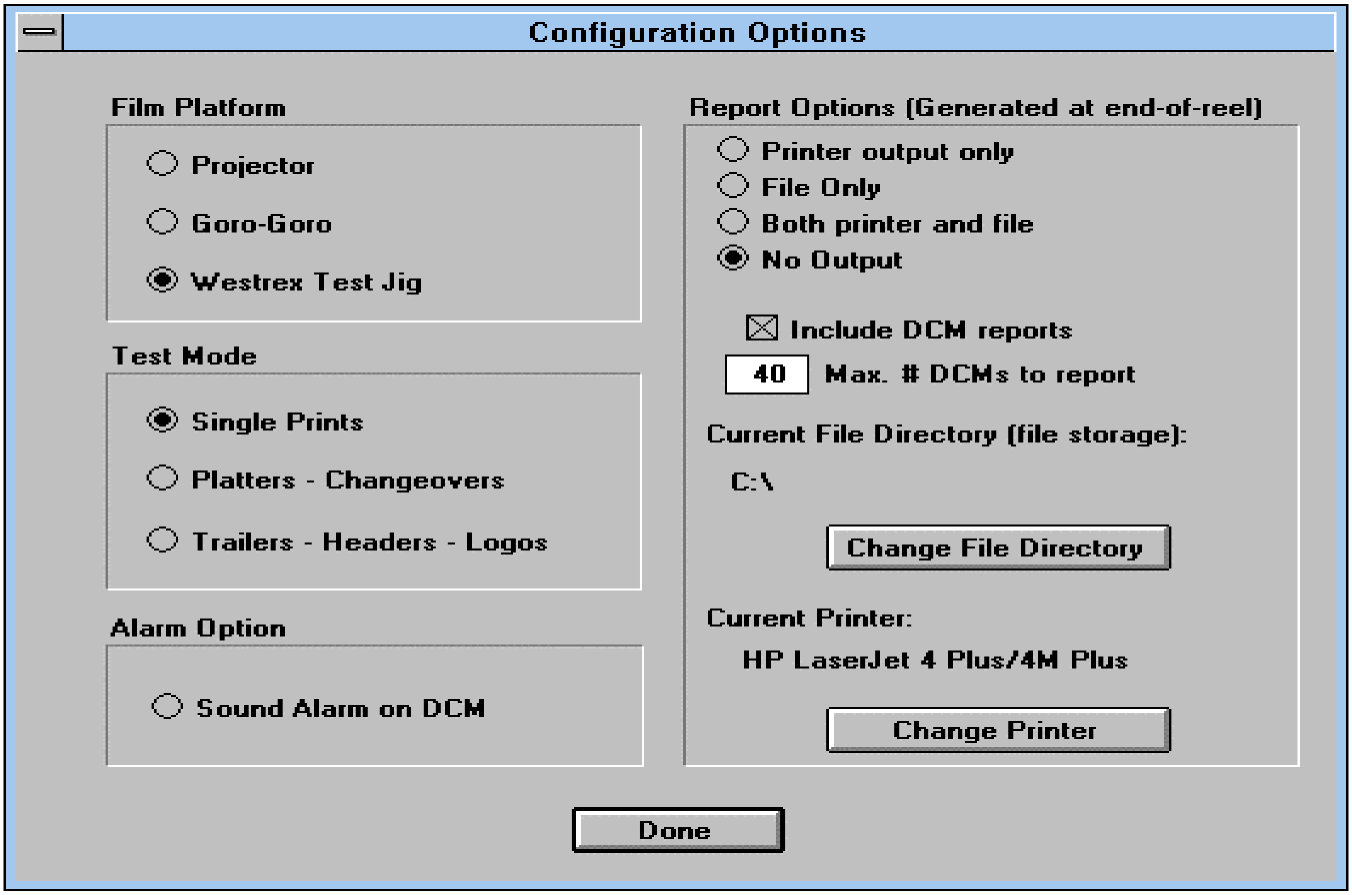


As the software operates, a plot of P and S track data will be presented on the X-Y display. The X axis is expressed in footage, the Y axis in Error Corrector activity. **<u>The operator should confine his observation to levels 1, 2, and 11 on the vertical axis. The Error Correcti algorithm is highly non-linear and levels 3-10 have no physical information to impart</u>** A stage 11 event can be considered a DCM on a given track at the film position noted. After the reel under test is completed, the operator can employ the chart zoom controls to expand and examine activity in a selected region. This feature can also be employed by a zoom box that is placed around the area of interest in the chart.

Status information highlighted in various colors gives the operator information about what stage the DFP-2000 is in as film is run such as Connect to the DFP, Film Running, and SDDS Data being Processed. The type of test is also shown.

This chart data can be saved to disk as the test is performed and called up later for analysis using the same viewing tools.

SDDS QC SOFTWARE, CONFIG SCREEN



The Config button on the main screen opens a dialog box that allows the operator to select various setups for the testing to be performed. The selection for storing the test data to disk and its default directory location is available along with combining the operation with an automatic print out of the test.

Selections are available for the various test jigs that are moving the film under test. In a two projector screening room employing changeovers, the software will detect the new reel at changeover, store the current data or print it as the new reel is processed. Mixes of different reel numbers or a series of the same reel will not confuse the software. If the reel is made up of many trailers (usually 100 to 150 feet in length), selecting the trailer mode will allow a printed report which has all trailers on one sheet of paper. Examples of the reporting quality follow.

The options menu with the file handling capability of the QC software allows for unattended operation.

SDDS QC SOFTWARE SINGLE REEL REPORT

SDDS QC Report - ECC Mode 1 Polling

QC Test Date: Tue 11/19/96 Time: 10:50

Raw Data File: N/A

Film Data

Title: WAGONS EAST 8/18/94 p 42 s 44
Comments: No comments
Reel: 1
Date: 08/18/94
Version: 01
Recorder: 00000001

Print Information:

Print Number: ____________

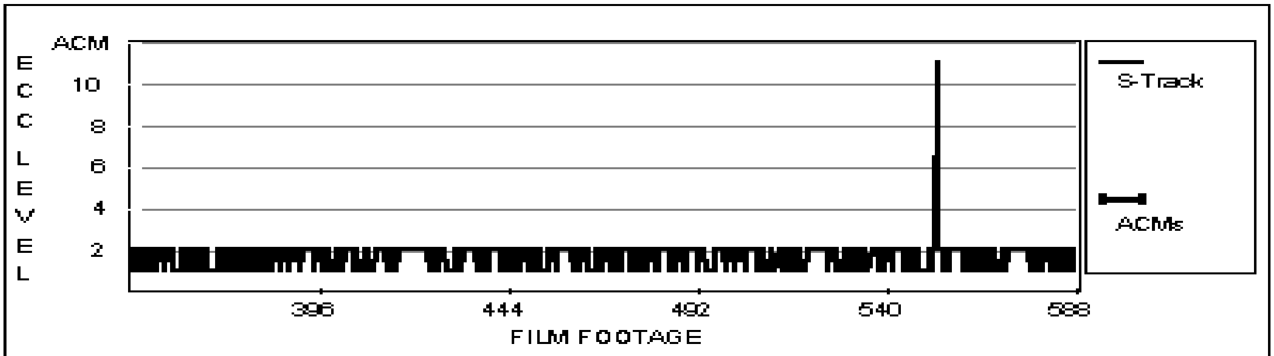
Print Machine Number: ______________

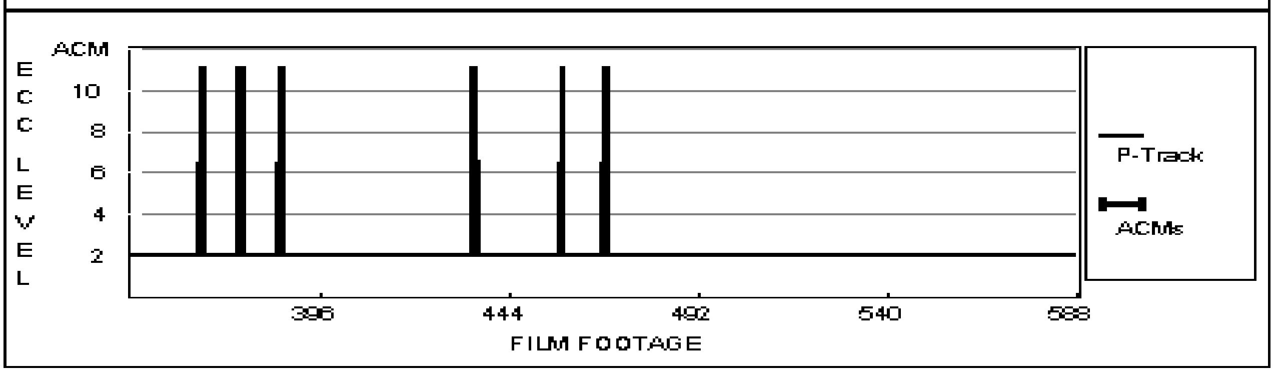
Print Time: ____________

Operator: ____________

Print Density: ______________

REEL RATING: NG S-Track DCM: 9 P-Track DCM: 56 ACM: 0





The report shown above is a typical single reel QC report that can accompany the actual physical reel of film. A print preview function in the software allows a quick check of fields that may need further elaboration prior to printing.

SDDS QC SOFTWARE TRAILER REPORT

SDDS QC Report - ECC Mode 1 Polling

QC Test Date: Tue 11/19/96 Time: 18:24

Raw Data File: N/A

Film Data

Title: S.D.D.S. LOGO <Vers. #2 > Rev. #2 1-25-95 (T-55)

Comments: Comments
Reel: 1
Date: 01/31/95
Version: 01
Recorder: 00000000

Print Information:

Print Number: ____________

Print Machine Number: ____________

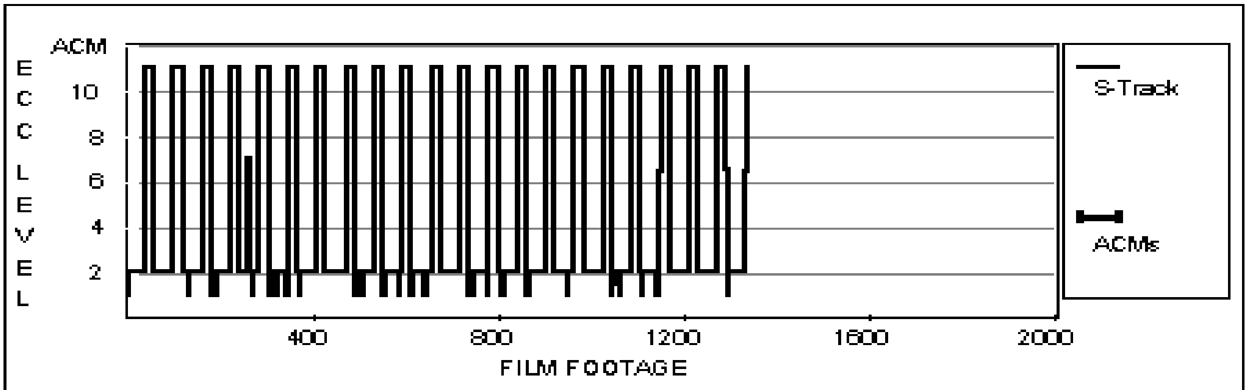
Print Time: ____________

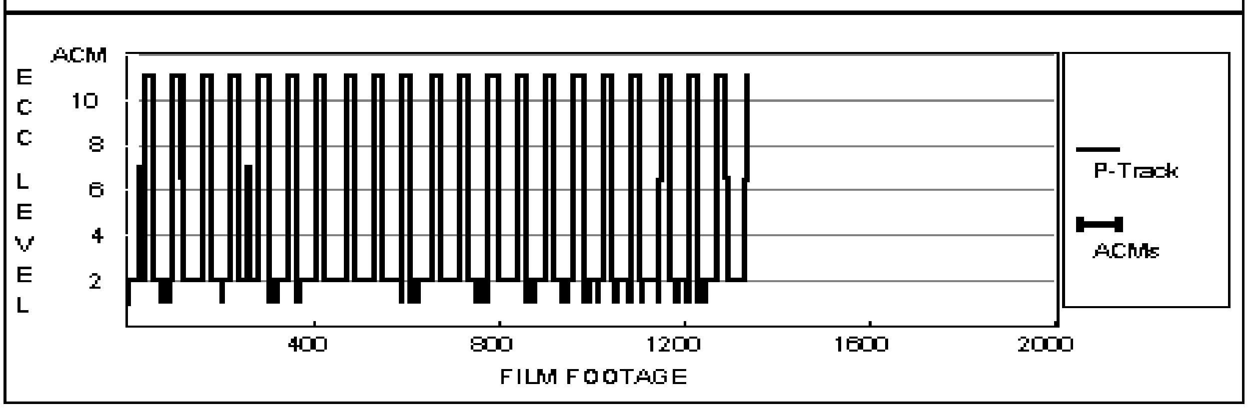
Operator: ____________

Print Density: ____________

Trailer Grades

Name	S	P	Grd	Name	S	P	Grd
Trailer-01	00	00	A	Trailer-17	00	00	A
Trailer-02	00	00	A	Trailer-18	00	00	A
Trailer-03	00	00	A	Trailer-19	00	00	A
Trailer-04	00	00	A	Trailer-20	00	00	A
Trailer-05	00	00	A	Trailer-21	00	00	A
Trailer-06	00	00	A	Trailer-22	00	00	A
Trailer-07	00	00	A				
Trailer-08	00	00	A				
Trailer-09	00	00	A				
Trailer-10	00	00	A				
Trailer-11	00	00	A				
Trailer-12	00	00	A				
Trailer-13	00	00	A				
Trailer-14	00	00	A				
Trailer-15	00	00	A				
Trailer-16	00	00	A				





The report shown above is for a typical reel containing trailers. A single report shows the status of each trailer on the reel.

The Future of SDDS QC Software

The SDDS QC software will continue to develop. Future versions will contain a full file management shell that allows for a paperless QC configuration, all results easily accessible. The ultimate goal of the QC software is to combine this reporting structure with the RF waveform information. Stay tuned!

9. AVAILABLE SONY QUALITY CONTROL OPTIONS

9.1. SDDS CERTIFICATION PROGRAM

SCPC, Engineering Services Division will supply 400 foot Test negatives accompanied with a sample print made from the negative to any laboratory interested in printing SDDS. This test negative should be printed at the respective lab and the resulting print should be shipped back to SCPC. The submitted print shall be tested and a written report shall be issued within two weeks. The report will include electronic, photo-micrographic, and computational analysis with overall suggested diagnosis. Please request SCPC part # CKT-266 Certification Kit.

6 MONTH UPDATE

SCPC will request an update print sample from the above Certification Kit every 6 months in order to maintain a high level of quality from the Film Lab, The SDDS engineering team will also visit the Labs every 6 months to update with current improvements in QC and documentation practice.

SDDS QC SOFTWARE AND HARDWARE

This software is provided free of charge. It is written for the Windows operating environment. It communicates with the SDDS DFP-D2000 processor through serial interfaces. The DFP-D2000 gathers error data from the connected DFP-R2000 Reader, reading the film under test. Various configuration options allow storage of error reports, hard copy printout, and trailer data gathering. Please refer to the SDDS QC (Quality Control) Software User's Manual Version 3.00 Rev 2.

POSITIVE QC SYSTEM

SCPC can provide a DFP-D2000 and DFP-R2000 system with SDDS software that will allow real time quality control of SDDS color positive prints. The QC system can be a part of a change-over system in a screening room or a dedicated test stand in the QC laboratory. Please contact SCPC sales for further information.

NEGATIVE QC SYSTEM

SCPC can provide a modified DFP-D2000 and DFP-R2000 system with SDDS software which will allow real time quality control of SDDS sound negatives. Please contact SCPC sales for further information.

OSCILLOSCOPE CONFIGURATION

It is imperative that when SDDS QC software is recording activity that an oscilloscope be hooked up to show the real-time RF Waveform. An ideal setup would have 2 oscilloscopes, one for track P and one for track S for continuous and simultaneous observation. SCPC has researched a number of low cost oscilloscopes (< $500 per pair) that have sufficient bandwidth and display to meet this requirement.

QC ROOM FILM TEST JIG

SCPC recommends for Quality Control departments the use of the Talian Industry's Electronic Test Fixture to mount the DFP-R2000 reader. This computer controlled film transport is ideal for testing yet robust enough to protect valuable show prints. Please contact Talian Industries at:

Talian Industries, inc.
Attn: Stephen Talian
194 Railroad Ave
Northvale, New Jersey 07647
Tel: 201-784-4090 Fax: 201-784-8227

Printed in Japan
DFP-R2000 (UC, EK) E
9-976-888-01

Sony Corporation
Communication System Solutions Network Company

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