

# The Story of Optical Sound Recording With 8mm – Type S (Super-8) Film

A TRANSLATION

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**Obstacles to obtaining high-quality sound from 8mm – Type S (super-8) optical soundtracks include the lack of a high-resolution (50 lines/mm) 8mm – Type S sound film, an SNR problem due to the lack of color dye elements that are good absorbers of infrared radiation, variances in the quality of laboratory printers and waveform distortion and high-frequency cutoff due to misalignments and film weaving. Some of these problems are beginning to be recognized and confronted in the industry, but the author still sees a particular need for a high-quality sound film. The multilateral variable-area recording technique is considered superior to both the bilateral and the variable-density techniques for recording on 8mm – Type S. Another definite need is for an official optical sound test film to permit meaningful evaluations of various sound systems and films.**

**T**HE FIRST TIME I ever listened to the playback of an optical sound recording on an 8mm – Type S (super 8)\* soundtrack was when a Technicolor 1000 model projector was demonstrated several years ago. Two films were shown — one produced in Japan, the other in the United States. The sound quality on both, I recall, was of a quality that would hardly make it eligible as a marketable commodity. While it is hard to determine whether the fault lay with the film or the projector, it must be recognized that the Technicolor 1000 was then a novel piece of equipment that used a 30-min film cartridge. It subsequently proved the forerunner for other projectors. The demonstration itself attracted wide attention.

Ever since my first contact with 8mm – Type S optical sound recording, I have been vastly interested in learning more about it. While I fully realized that it would prove extremely difficult to produce good sound quality from a piece of film whose maximum modulation width was 0.51 mm and whose running speed was a mere 10 cm/s (4 in/s), I nevertheless discerned possibilities that no one had as yet discovered. It made me happy simply to think of the day when I would be able to listen to a good piece of sound coming from that line-narrow soundtrack. It wasn't long before I decided to focus my energies on improving the optical sound quality on 8mm – Type S film. I realized at the same time the significance of my research — creation of a good-quality optical soundtrack on 8mm – Type S film would be both a very rational and a commercially desirable development. Four

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\* The 8mm – Type S designation used in this paper refers to what is commonly known as super 8.

years have gone by since I started my project.

## The Sound Quality on 8mm – Type S Will See Improvement

When I first began this research, most remarks from the industry were negative ones. Some individuals were extremely severe in their evaluation. Simultaneously, however, they expressed professional interest in 8mm – Type S film, in light of the then-emerging interest in video packaging devices. Their criticisms may be interpreted as one manifestation of their hopes and dreams in wanting to see 8mm – Type S take its place in the emerging world of video packaging. They had worked all their lives with 35mm and 16mm optical recordings and were fully aware of all the merits and advantages offered by optical recording.

Having acquired 40 years of professional experience as an audio technician in the world of motion pictures, I knew I had to try to fulfill the expectations of my colleagues and others who saw bright prospects for 8mm – Type S optical recording. Although we have come a long way, I must admit, however, that we still have some way to go before we can be fully satisfied with our development results.

Eight-millimeter motion-picture film has been in existence for quite a number of years. For most of these years its use was associated with amateur filmmakers, and except for a few isolated cases it was silent film. With the appearance of the 8mm – Type S format, sound-on-film became feasible and the at-first scattered attention of professional filmmakers has recently become worldwide. It must be admitted that the development of 8mm – Type S sound systems around the world has proceeded in a very haphazard and disorderly fashion. The many elements that make up such systems — the sound film, positive film for printing, the recording equipment, the processing equipment, the sound projector and other necessary material and equipment — have not developed at the same pace, and there have been marked differences in their quality. I personally see this as

the major factor preventing a speedier improvement in sound quality.

While it must be admitted that 8mm – Type S optical recording system development remains uneven, we can at least take some satisfaction in remembering that as far as standards for judging sound quality are concerned, some of the work has already been done: there already exist established standards based on cross-modulation tests to judge 35mm and 16mm optical sound quality. Now we must identify those elements within the entire 8mm – Type S optical sound system which need the most urgent attention, and improve them so as to totally and uniformly upgrade the quality of the entire system.

## Frequency Range and SNR

In most 16mm optical sound recordings, the frequency range is found to be between 100 Hz and 5 kHz. While they cannot be called Hi-Fi in terms of frequency range, they have little waveform distortion and, if the SNR is within acceptable limits, the quality is generally considered to be satisfactory and to meet practical needs. To people today who are accustomed to listening to Hi-Fi sound, however, this frequency range perhaps borders on the unacceptable. This means that in the case of 8mm – Type S all efforts must be directed toward maintaining the frequency range of 100 Hz to 5 kHz. This is especially evident when we consider that 8mm – Type S film faces stiff competition from other forms of video media. To do well in the marketplace, its capability of carrying an audio signal must be a distinct asset: we must strive continuously to improve its audio-frequency range.

With today's technology, a flat playback between 100 Hz and 5 kHz requires a pre-emphasis of about 15 dB at the time of recording. While this may be satisfactory in terms of frequency characteristics, it is not altogether desirable from the SNR point of view because of the loss of power. Since these conflicting constraints cannot both be satisfied in practice, there is no other recourse but to reduce the higher frequencies and raise the lower ones at the time of recording — in other words to attempt a recording within a narrow frequency range. Relative to improving the sound recording in the upper frequencies, the sound film, the positive film for printing and the optical printers become the main points requiring attention. These elements and the way they affect the photographic processes restrict optical sound recording to narrow-band frequencies for both 8mm – Type S and 16mm film. This area continues to be where the

greatest gains can be made in improving optical recording systems.

Let me touch on the question of the SNR of sound film by referring to the re-development of color soundtrack. The SNR in this case is not uniform because it is affected by the light conversion element of the reproducer. Variations here, in turn, are due to differences in sensitivity characteristics, and are especially dependent on the relative sensitivity to infrared rays. This phenomenon is brought about by the comparative weakness—relative to the silver image—of color dye image as absorbers of infrared rays. It is generally the practice to use elements which are poor absorbers of infrared rays in order to raise the light conversion efficiency. Let me cite an example. Checking the relative sensitivity in a situation where a silicon-blue cell is used together with a light-green filter, it will be noted that the proportion of infrared rays to 100% green light will be less than 5%; blue light in the central region will register around 50% (data by Japan Sharp Company). It is possible to obtain signals of good quality in terms of SNR through the use of reproducers which employ such light conversion elements. Regarding color positive film, film especially designed for 8mm – Type S and having ultrafine grain and high resolving power has come into general use. Noise originating from grains has been decreased so it has become feasible to keep the level of overall SNR above 30 dB. On the other hand, there is still room for improvements in the design of projectors to reduce noise originating from dust and scratches on the film.

#### Sound Film

The proper sound film to use obviously would be one with characteristics matching the requirements of 8mm – Type S optical recording. It is a fact, however, that no film manufacturer yet has such a film available for the market. What is in use today is the same type of film as that available in 35mm and 16mm sizes but which has been altered and classified as 16/8mm – Type S. Because the resolving power of this particular type of film is 30 lines/mm maximum, it is unsuitable for 8mm – Type S sound film where a resolution of more than 50 lines/mm is required. As long as we remain tied to the use of 16/8mm – Type S film, any improvements we may achieve in other areas of the system will fail to yield any marked improvement in the sound quality.

I began my research on ways to improve the quality of 8mm – Type S sound recording by first searching for the type of film most suited for this purpose. I gathered all available data published by several film manufacturing companies, but was unable in the end to find what I was looking for. I did choose, however,

three types which I thought might have some possibilities. Of the three, I selected a Fuji film known as 16/8mm – Type S Type 72366, a positive film for printing purposes. I found the film to possess greater resolving power than that found in current sound films, and it provided a power output increase of 5 dB at 5 kHz. It proved poor in sensitivity, however, and I was disappointed to find that I could not use a UV filter.

The photographic range demanded of 8mm – Type S sound recording film must be comparable to that of microfilm—one of the obvious reasons being that its soundtrack area is only 5.8% of that of a comparable piece of soundtrack on a 35mm film. I keep hoping for the appearance of a high-quality soundfilm to permit a dramatic improvement in 8mm – Type S sound quality.

#### The Effect of the Printer

The printer exerts a large influence over the sound quality of optical recordings. Even in the event we should see the development of a special sound film for 8mm – Type S use and obtain recordings in the 6-kHz range, if the printer inefficiently allows slippage of film and other poor contact between the printer and the film surface, then the resolution suffers and the good characteristics of the sound recording film will be lost.

I once recorded a piece of sound negative film with a 5-kHz signal, sent it to three separate commercial film laboratories for processing and printing and then compared the three sound positive prints. I immediately detected evidences of great variance in the quality of the printers used at the respective laboratories. Lack of data prevents me from expressing this in graph form, but I was able to discern the good and bad characteristics of the individual printers by studying the sound modulation through a microscope. One of the prints showed evidences of slippage as well as the effect of loose film-printer contact; the second showed the modulation to be “foggy” throughout; and the last showed clear photographic signals at 5-kHz with hardly any slippage. I also detected marked differences among the three prints during playback.

I wish that all film laboratories would understand that printers to be used with 8mm – Type S sound film must be far more efficient than those customarily used for printing 35mm and 16mm sound film. I am glad to note that there are moves to introduce printers of higher efficiency.

#### Waveform Distortions Attributable to the 8mm – Type S Format

I have discussed in general some of the factors which are directly related to efforts to improve sound quality. One other factor, that of waveform distortion,

needs to be discussed. Waveform distortion is a factor here because the overall format of 8mm – Type S is extremely compact and also because the soundtrack is of the bilateral variable-area type (or simply the “bilateral type”).

Cross-modulation distortion is peculiar to variable-area recording. Today, however, thanks to the wide use of cross-modulation tests and to more advanced techniques employed at film processing laboratories, it has become possible to expect stable and relatively distortion-free prints. These developments have tended to minimize the problem of waveform distortion. The question arises then of why the 8mm – Type S bilateral type is so affected by distortion. One reason is that when the film is passing through the reproduction system, the center of the soundtrack often deviates from the center line due to certain mechanical problems. The extreme narrowness of the 8mm – Type S soundtrack and the very narrow margin of error permitted in terms of scanner alignment compound the problem to cause distortions of this kind. Because the width of the track at 100% modulation is a mere 0.51 mm even a slight cut in the higher ranges of the modulation results in considerable distortion.

I once examined the track on a print to see how much it was off center. Repeated testing showed that offsets of 0.1 mm are not uncommon. I then placed a soundtrack whose center was off by 0.1 mm on a reproducer which had the fault of causing the film to weave off center by 0.03 mm. When the soundtrack was passed through a standard width scanner of 0.64 mm, it was found that about 13% was cut off from the higher ranges of the modulation. Depending on the amplitude, however, this figure would vary.

Furthermore, where changes occur in the sound applicator of the color positive developing equipment due to the film running through irregularly, uniform redeveloping of the entire modulation is difficult because color sound image partially remaining without silver image can cause distortion.

#### The Merits of Multilateral Variable-Area Recording

The effects we have found to be a disadvantage with the variable-area type do not apply in the case of variable-density type recordings, except to cause some slight power loss. But even the variable-density type, not having these disadvantages and therefore considered by some to be the very salvation of 8mm – Type S sound recording, has its weakness. The processing of the variable-density type is essentially a more exacting or critical process than the variable-area type because of certain photographic characteristics. And because 8mm – Type S is normally processed in relatively large

print orders, the variable-density type of recording is hardly ever seen today. Thus, because the bilateral variable-area and variable-density types of recording both have disadvantages, we shall consider a third technique known as the multilateral variable-area type of recording or simply the "multilateral type." See Fig. 1.

When we compare the multilateral type with the bilateral type, we see that the former has the advantage when there is a problem in proper alignment between scanning beam and the soundtrack in that it acts to reduce the rate of distortion; the more multilateral it is, the less distortion. Also, when the scanner is incorrectly aligned, the bilateral type tends to produce a high degree of distortion, while with the multilateral type, this is not as pronounced. In addition, other types of distortions traceable to uneven scanner beam intensity and uneven modulation density are less apparent in the multilateral type. Those who are familiar with variable-density systems will see immediately that these advantages match those of the variable-density type recordings. In other words, the multilateral variable-area type possesses the advantages of both the variable-density type and the bilateral variable-area type. Accordingly, I consider the multilateral type most suitable for meeting the stringent requirements of the 8mm - Type S soundtrack.

Several years ago I took a 16mm modulator manufactured by J. A. Maurer Inc. and converted it to fit an 8mm - Type S film having a 4-track area type modulation. After repeated experiments, I was able to achieve some good results in terms of frequency characteristics, SNR, and waveform distortion. I subsequently came to use it on a commercial basis, and have recorded a

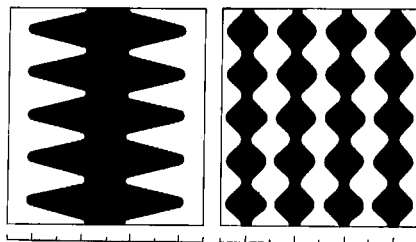


Fig. 1. A bilateral soundtrack (left); and a multilateral soundtrack (right).

number of programs with it. I have also used it to project a number of completed prints, and noted with satisfaction that no audible distortion could be detected and that, with respect to SNR and frequency characteristics, it was possible to record up to 5 kHz in a perfectly satisfactory manner. Indeed, it would have been difficult to choose between the sound quality of this 8mm - Type S soundtrack and that of a 16mm soundtrack.

#### 8mm - Type S Optical Sound Test Film

It is the fate of all motion-picture films to be evaluated through the medium of the film projector. This being the case, the evaluation of a film is influenced for better or worse by the mechanical condition of the projector. In this sense, the projector is a vital piece of equipment. While it is important that the projector be a highly efficient make and model it goes without saying that it must meet all of the required standards and specifications. The problem we face in connection with the 8mm - Type S sound projector is that there still is no officially certified optical sound test film. On the other hand, we see a number of projector manufacturers mass producing 8mm - Type S projectors. Since there is no sound test film with which to calibrate

them, their compatibility must be open to question. Several times I have been totally dissatisfied with the sound reproduced on one projector when, just before that, the same film had sounded perfectly normal on another projector. If we remain heedless of this situation, then I am afraid that the great advantage that film has over other types of medium of more recent development — the great asset of interchangeability — will come to suffer.

I earnestly hope that steps will be taken expeditiously to introduce the first official optical sound test film and that it will have all the necessary standards and specifications to assure uniformity of sound. Once these standards have been set, my organization (Tanaka Sound Recording Laboratories) is prepared to produce optical sound test films for the industry.

It should be noted that Fuji Film Company has established its own standards and specifications on the basis of ANSI PH22.182-1972. Hence Tanaka Sound has contracted to produce a number of these test films that include buzz tracks, focusing, signal level, wow and flutter, multi-frequency, etc. All of these test films are being used in connection with the production of projectors which are manufactured by Fuji Film affiliates.

Tanaka Sound Recording Laboratories is prepared to participate in developing the official test film that is needed. Buzz and focusing tracks which we have developed for test purposes are now available and could be put to good use on such a film. We hope that the views we have expressed, based on our substantial experience in the field, will spur development and promote understanding of optical recording using the 8mm - Type S film medium.