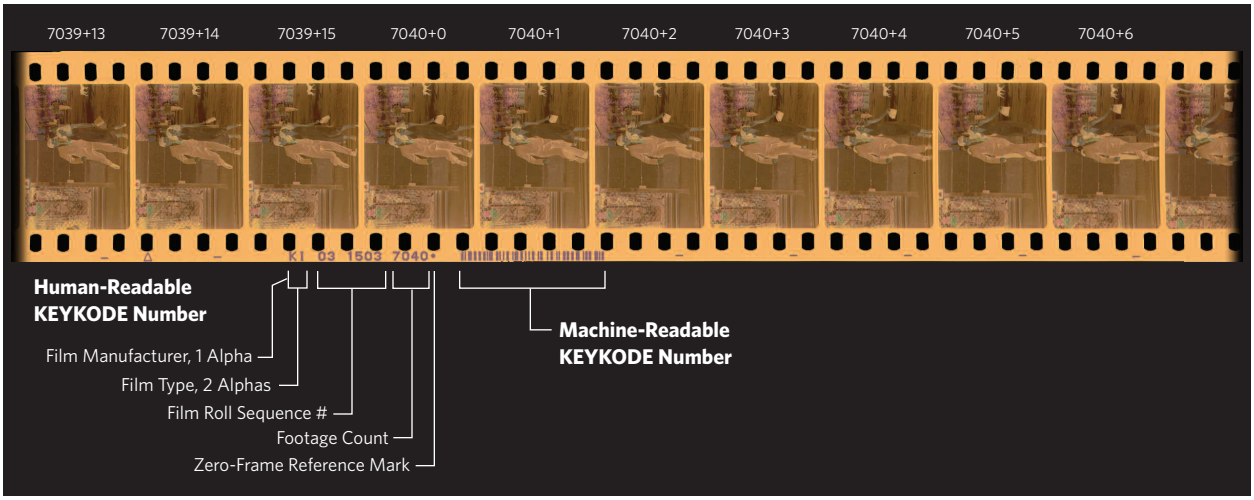
KODAK *KEYKODE* NUMBERS TECHNOLOGY

Consider the amount of film that needs to be managed in a typical feature film. At 24 frames a second, 90 feet of film are running through the camera every minute. That's 10,800 feet in a two-hour movie.

Now consider the same movie with a 30:1 ratio (shooting 30 feet for every foot of film that makes it into the finished picture). That's well over a quarter million feet of film! More than five million frames! How do you keep track of all this film and find the exact frame that's needed when it comes time to match the camera negative to the edited workprint?

It's done with human-readable key numbers and machine-readable KEYKODE Numbers. They're printed on the edge of the film when it is perforated—one of the last steps in film manufacturing.

These numbers are exposed as latent images and they become visible after the film is processed. These numbers provide a unique address for every frame of film.



Human-readable key numbers are comprised of five elements:

1. The **manufacturer's code**—K or E for Kodak.

2. The first K or E, with the addition of the second character, identifies the **film identification code.** Each Kodak film has its own set of letters for identification. For example, KI represents KODAK VISION 5246 Film.

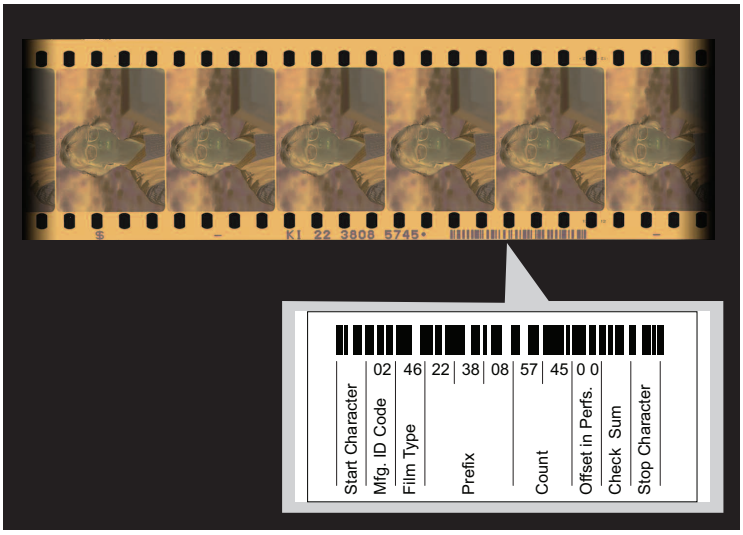
3. The key number consists of a six-digit prefix (roll number) and a four-digit footage count. The prefix gives each roll of film a unique identifier. The **prefix number** remains the same while perforating the entire roll. When the roll finishes, the next roll carries a different prefix in increments by 1.

4. The **footage count numbers** increase at precise intervals throughout the roll—every foot for 35 mm film, and every half-foot for 16 mm film. On 65 mm film, the interval is 120 perforations, a little less than two feet. This increment was chosen as the lowest common denominator for the four different 65 mm frame-formats: 5-, 8-, 10-, and 15-perforations.

5. The **zero-frame reference mark,** the dot following the key number, indicates the specific frame of film identified by the human-readable key number and the machine-readable KEYKODE Number. Subsequent frames are identified by their offset—the number of frames they precede or follow the zero-frame. For example, KI 03 1503 7040+06 identifies the sixth frame of film after the zero-frame, KI 03 1503 7040.

KEYKODE Numbers

As mentioned earlier, all the information in the human-readable key number is replicated in the KEYKODE Number—the machine-readable barcode. The following chart shows the barcode detail.

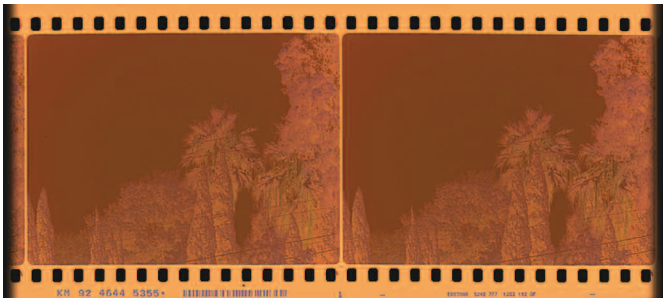


35 mm *KEYKODE* Numbers

There are also intermediate, mid-foot key numbers along with the full-foot key numbers on 35 mm films. These are useful for identifying very short scenes—those quick cuts where the frames the editor selects may not include a main key number. Key numbers are displayed as large font. Mid-foot key numbers are printed midway (32 perforations) between the main key numbers. The mid-key numbers will be smaller font and contain a (+32), making them easy to recognize as mid-foot numbers.

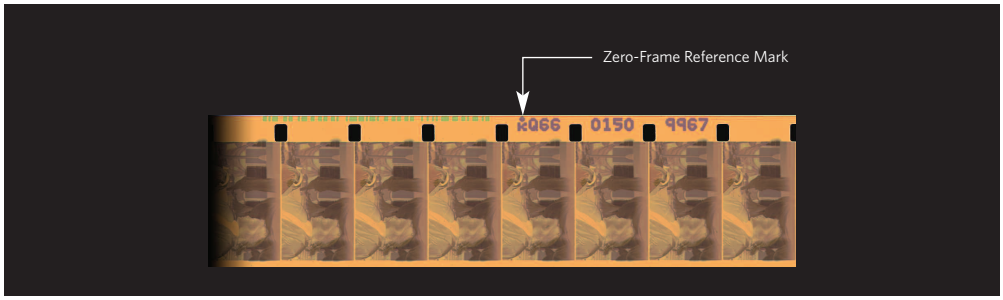
65 mm *KEYKODE* Numbers

On 65 mm film, there are two intermediate-key numbers between the key numbers—the first at (+40) perforations, the second at (+80) perforations. They serve the same purpose—to identify very short scenes that may not contain the main key number.



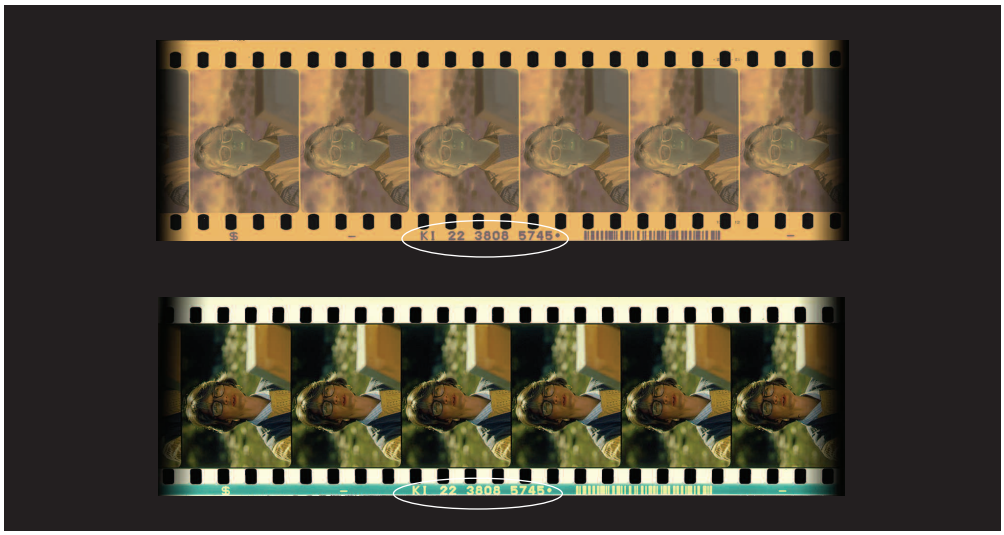
16 mm *KEYKODE* Numbers

Key numbers and KEYKODE Numbers on 16 mm, 35 mm and 65 mm films all follow the same format, except that the zero-frame reference dot on 16 mm film is directly above the letter that identifies the film manufacturer, instead of between the key number and the barcode.



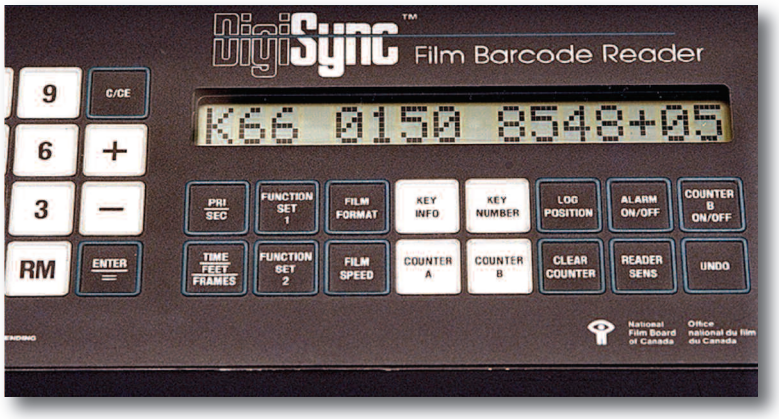
USE OF *KEYKODE* NUMBERS IN NEGATIVE CONFORMING

When a workprint of the camera original is made, the key numbers are printed from the camera film to the workprint, exactly matching the original film. The negative cutter can use these numbers to conform (match) the camera film or the optical intermediate to the edited workprint.



KEYKODE Numbers contain machine-readable barcodes that replicate the human-readable key numbers on the edge of the film. You will notice, when scanned, the film type will display the last two digits of the film code only, not the two digit alpha as visually seen on the film. For example, "KI" represents 5246 35 mm and 65 mm or 7246 for 16 mm. The barcode printout will only read as "46" under the film type.

There is no need to use a loupe or magnifying glass. Sequence and footage numbers, including frame information, are displayed below on a digital readout. But much more important, the output of the reader can be connected directly to a computer to generate a database.



Once the beginning and ending key numbers of each negative roll have been recorded in the database, the cut list will tell the negative cutter precisely where each scene is located within its designated roll. This reduces film handling and saves a lot of search time.

Footages can be indexed from the head or the tail of each roll, further reducing the amount of winding and unwinding needed to locate and pull selected takes for matching.

So far, we've talked mainly about human-readable key numbers and machine-readable KEYKODE Numbers—what they are and the purpose they serve in film editing and negative matching.

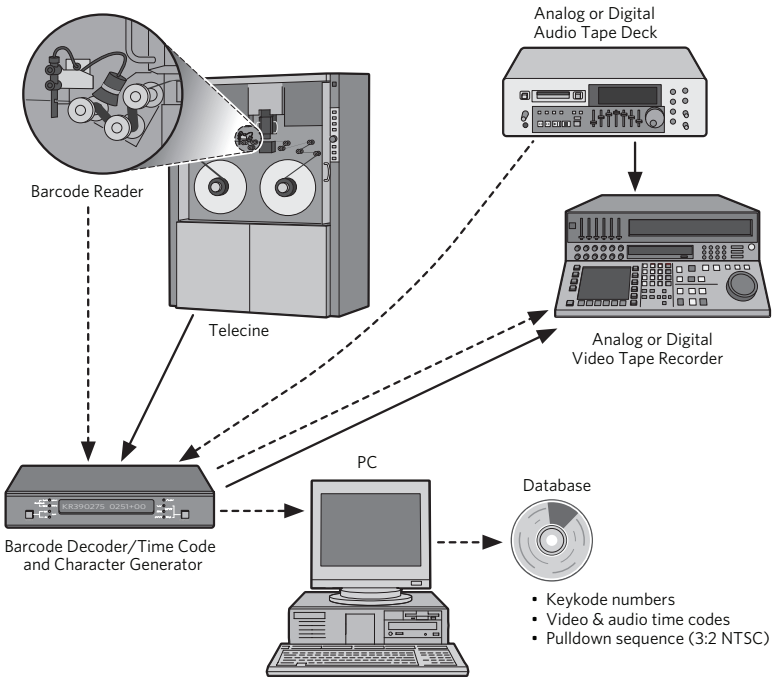
KEYKODE Numbers and related technology have had a positive impact on traditional postproduction. More film is now edited and conformed with the aid of KEYKODE readers and computers.

ELECTRONIC POSTPRODUCTION

Where KEYKODE technology has really made an impact is in digital electronic postproduction, such as telecine transfer and nonlinear video editing. It has meant greater efficiencies and more options to release in film or digital or both.

The dotted lines indicate the data paths for KEYKODE Numbers, video and audio time codes and production data. The solid lines are the pathways for video and audio signals.

Film is transferred on a telecine to video dailies for editing. Sound may be transferred at the same time or separately in another session. The KEYKODE Numbers are read from the film with a barcode reader on the telecine and correlated with video time code generated during the transfer. If audio is also transferred, its time code can be correlated as well.



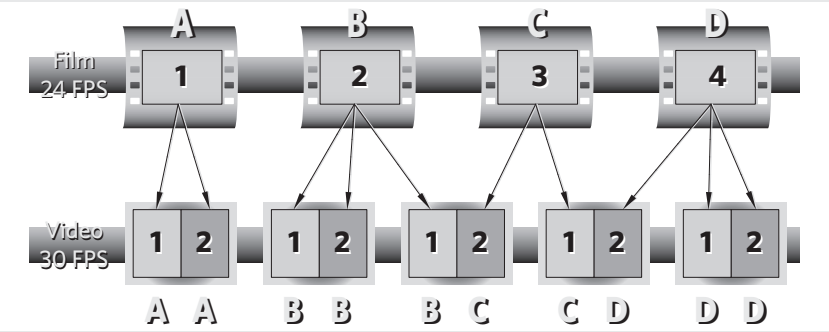
In this system, the barcode decoder/time code and character generator is a multi-task device. Given the input from the barcode reader and the telecine, it correlates KEYKODE Numbers with video and audio time codes and sends this data to the video recorder. It also sends film/video transfer data to a PC. A built-in character generator provides the KEYKODE Numbers and time code burn-in windows for the video dailies.

With this approach, any generic PC can be used to create a comprehensive database. Another popular approach is to combine all the functions of the barcode decoder/time code and character generator into a proprietary PC, thus eliminating a separate piece of equipment.

The feature that makes film origination and electronic post-production such close partners is the relationship between time code and KEYKODE Numbers, and the database that can be easily created when the film is transferred to video. This database will always include these essentials: KEYKODE Numbers, video and audio time codes (if different from one another) and the pulldown sequence—3:2 for NTSC video.

3:2 Pulldown for NTSC

The 3:2 pulldown is used to make up for the difference of frames between the frame rates of film and NTSC video.



Each frame of video is comprised of two fields. The electron beams make two passes to produce the complete picture. The first pass scans every other line of video. The second pass fills in the remaining lines. Each scan creates half the picture, 60 times a second in NTSC and 50 times a second in PAL. This type of video display is called "Interlaced." Two interlacing fields make one frame of video.

Beginning on an "A-frame" sequence, the first frame of film is transferred to 2 fields of video—one complete frame. The next frame of film transfers to 3 fields of video—a frame-and-a-half. The third film-frame goes to 2 video fields – the last half of frame 3 and the first half of frame 4. And the fourth frame of film fills 3 fields of video. This is the process by which 30 frames of video are made from 24 frames of film every second.

If we look at the transfer starting on an A-frame (the usual start point), the sequence reads 2:3:2:3 and so on. However, the sequence is generally called 3:2.

Film frames in the transfer sequence are designated A, B, C and D. Starting with an A-frame, people know the frame and field sequence they're dealing with. For instance, a C film-frame is always split between two video frames. If the editor cuts on a B-C video frame, and it isn't flagged, there can be a problem in the cut-list for the negative cutter.

NTSC video editing systems running at 30 fps do not provide film cut lists with better than ±1 frame accuracy. This is due to the mathematical relationship between 24 and 30 (the 4:5 frame-ratio between film and NTSC video).

Digital nonlinear video editing systems that provide frame-accurate film cut-lists solve the problem this way: they digitize only one field of each video frame and ignore the mixed "B-C" frame. For the video editor, there's now a frame-for-frame relationship between film and video. The negative cutter gets a frame-accurate cut-list from which to conform the negative.

In addition to KEYKODE Numbers, time codes, and the pulldown sequence, the database may also include other useful information. For instance, source-reel information such as camera roll, sound roll, frame rates and transfer rates. Film footage, the script supervisor's production notes, and information for the editor may also be included in the initial database when the film is transferred, or added later during editing.

Providing a comprehensive database gives the greatest value. It could even include contractual agreements about additional use of the footage, all keyed to a single frame by a KEYKODE Number or a time code.

Data can be modified and information added any time—in the editing system or with a personal computer, just as you would with any database.

After the film has been transferred and the sound takes synchronized, the audio and video are digitized for nonlinear editing. The KEYKODE Number/time code database from a floppy disk or other transferable data device, made during telecine transfer, can be loaded into the editing system automatically. This eliminates the need to enter the data manually, saving time and greatly reducing the chance of human error.

The video editing system produces an edit decision list (EDL), and, if the system includes the capability, a film cut list.

The EDL is a list of IN and OUT time codes for all the scenes in the show. It controls the online auto-assembly. This is where the electronic master is recorded with final color correction and final sound.

The source time codes are the IN and OUT edits and the sequence in which all the source material is assembled to record the master. The record time codes are the IN and OUT points for all the edits in the master.

The film cut list is what the negative cutter uses to conform the camera original to a video edit decision list. It indicates the key number and frame offset of the first and last frames for every scene in the film.

Edit Decision List (EDL)			
Source Time Code		**Record Time Code**	
04:36:03:00	04:36:25:10	01:00:00:00	01:00:23:10
04:35:51:25	04:36:03:00	01:00:23:10	01:00:34:15
04:35:39:20	04:35:51:25	01:00:34:15	01:00:46:20
04:35:25:15	04:35:39:20	01:00:46:20	01:01:00:25
04:35:13:25	04:35:25:15	01:01:00:25	01:01:12:15

Film Cut List				
Clip	**Man**	**Pref**	**Start**	**End**
1	KA74	1893	5342-06	5345+02
2	KA74	1893	5346-17	5360+11
3	KL66	3248	8344+14	8344+14
4	KL66	3248	8345-05	8348+18
5	KA74	1893	5364+17	5364+18

To summarize and put it all together:

- Film is transferred on a telecine to a video daily.
- The KEYKODE Numbers are read and correlated with video and audio time codes.
- Sound recordings are synchronized and transferred in the telecine suite, or later in a separate session.
- Key numbers and frame counts are generally burned into the video dailies along with the corresponding time codes. This information can also be recorded in the vertical interval time code (VITC) of the video daily.
- A database, created automatically during the film-to-tape transfer, provides the greatest source of information. It can include a wide variety of production and postproduction data along with the essential KEYKODE Numbers, time codes and transfer specifications. This database can remain with the production throughout its life. It can be copied and distributed as needed. Indexed to a KEYKODE Number or a time code, any note in the database can be referenced to a single frame.
- Entering data automatically into the editing system directly from the transferable data device is simple, fast and accurate—much better than typing all those key numbers by hand.
- The video and audio are digitized for nonlinear editing.

- After editing, a tape of the finished show is recorded, generally with key numbers and time code windows for reference.
- An EDL is produced for the online auto conform, and if the system has the capability, a frame-accurate cut list for conforming the film.

Machine-readable KEYKODE Numbers have brought film origination and electronic postproduction much closer together. Modern film scanners and nonlinear editing systems combine the strengths of both media.

"... Resolution and contrast of video can't deliver that classic feeling. If you do big wide open shots, you feel you have an extreme loss of quality... film holds every detail and is beautiful."

—Oliver Bokelberg, Cinematographer