A ONE-INCH VIDEO CARTRIDGE RECORDER DESIGNED FOR PROFESSIONAL CCTV AND CATV

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The VCR-100 manufactured by International Video Corporation is designed for the professional CCTV and CATV market. Using tape one inch in width, it displays excellent timebase stability, signal-to-noise ratio and horizontal resolution. Because of these features, its color video output can be fed down a cable TV system and received by any of the wide variety of TV sets commonly found in the home with excellent results.

The numerous VCR formats in use today were designed primarily for playback on an adjacent fast-time constant monitor. The resulting picture is excellent, and the conclusion often reached is that these low cost VCR's are suitable as origination devices for cable television, educational dial access systems or even commercial broadcast television.

Further investigation quickly points out the inherent problems. Some of these are timebase instabilities, signal-to-noise ratio, color recording techniques and picture resolution.

The timebase instabilities result from transport design and playback tension errors. These errors do not usually show up on the Trinitron-type fast-time-constant monitors, since these monitors tend to follow the timebase errors.

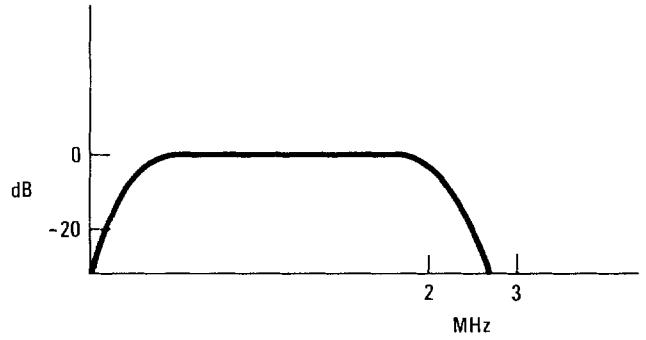
It is possible to mechanically and electronically compensate for these inherent errors, but the cost to do this can be 10 to 15 times the cost of the original VCR.

Signal-to-noise ratio limitations can be attributed to head-to-tape writing speed as well as the type of videotape used. The 1/2-inch EIA-J VCR's have a tape writing speed of 437 ips and are designed to use standard gamma ferric oxide videotapes. The 3/4-inch VCR's have a tape writing speed of only 404 ips and must use either chromium dioxide video tape or cobalt-doped gamma ferric oxide video tape, commonly called Hi Energy tape. The coercivities of these tapes range from 450 to 600 oersteds. As a result of the limited tape writing speed, signal-to-noise ratio can be a problem. Again, the selection of the monitor tends to minimize the noise; but when these VCR's are played back on most American-made receivers or monitors, the problem is evident.

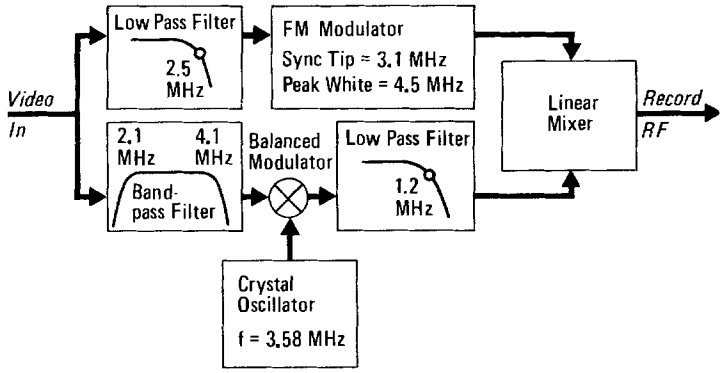
The frequency responses of the 1/2-inch and 3/4-inch VCR's extend to around 2.5 MHZ. This makes it difficult to record color, since the color burst frequency is 3.58 MHz. This difficulty is overcome by a technique commonly called "color under." In this scheme, the chroma information is down converted to around 600 kHz and is directly recorded onto the tape along with the monochrome FM video carrier. Upon playback, the chroma information is up-converted via heterodyne color techniques and recombined with the demodulated monochrome video. Again, this technique works well when the picture is played back on an adjacent Japanese color monitor, but it is extremely difficult to obtain timebase corrected direct color or realize good picture resolution. The maximum monochrome resolution is about 300 lines. Color horizontal resolution is about 240 lines.

So, although these imported VCR's produce excellent pictures when played back on their adjacent imported monitors, they are not entirely suitable for transmission purposes.

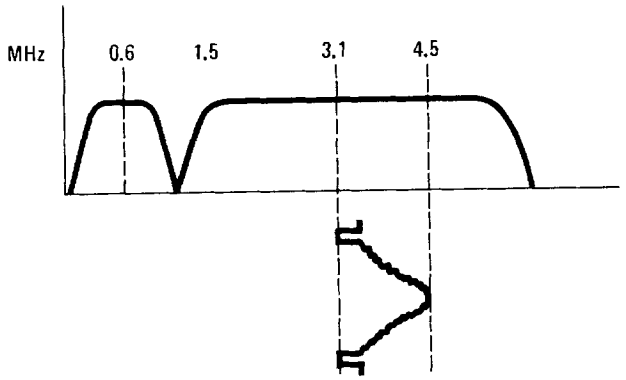
TYPICAL VIDEO FREQUENCY RESPONSE OF 1/2" AND 3/4" VCR'S



TYPICAL COLOR UNDER MODULATION TECHNIQUE



TYPICAL COLOR UNDER TECHNIQUE



What is required to make these pictures suitable for transmission purposes? Alternatives can be expensive; they extend all the way up to 2-inch quadruplex VTR's. Obviously, only a few CCTV and CATV operations can afford this luxury, and in most cases, it isn't necessary.

Engineers at International Video Corporation have come up with a reasonably priced alternative, designed especially for those applications where price is a consideration and where excellent technical performance is required, such as CATV, hotel entertainment systems or any application where it is not possible to control the receiver or monitor. These 1-inch, high-quality video cartridge recorders are called the VCR-100 Series.

The VCR-100 uses the widely-known IVC 1-inch helical-scan format. What does this format have that makes it better for these applications?

A look at the format reveals that a single head is used to record one field of video across the entire 1-inch width of tape. The video scan is relatively short for a single head helical scan machine, and this contributes to ease of tracking and lower tension errors. Since the entire width of the tape is used, coupled with an alpha wrap, the only missing information is "hidden" in the vertical interval. Therefore, no active video information whatsoever is missing. This is extremely important in CATV and broadcast applications.

Audio somehow has to be recorded onto the tape. Since we have used the entire width of the tape for video, how can this be done?

The answer lies with the azimuth difference between the longitudinal audio track and the helical-scan video track. The audio-1 track and the control track are located 100 mils from the top and bottom of the tape, respectively. These tracks, 39 mils wide, are recorded on the tape a second or so before the video is recorded. These two tracks are recorded at an angle of approximately 5° relative to the vertical dimension in the opposite plane. Hence, the angular difference between the two signals is about 30° and the interference or crosstalk between tracks is kept to a minimum.

The audio-2 track is recorded in a more conventional manner at the bottom edge of the tape. This track is 13 mils in width and is not recorded at an angle, but is centered 9.5 mils from the tape edge. The only portion of the video signal recorded here is the "back porch" portion of the vertical sync interval which occurs during retrace.

IVC VCR-100 Series

So, now we have video, audio and control track information on the tape with no interference between them. Wide video guard bands permit easy tracking adjustments, short straight video tracks permit stop action and the entire NTSC color information is recorded without any alteration during the record mode. The reason for this is the wide bandwidth.

All IVC format recorders have a bandwidth of 5 MHz, more than sufficient to record the full NTSC color signal. Since color correction, or stabilization, is required only during playback, all IVC recorders--even those without the playback color board--can record color. And since bandwidth is directly proportional to horizontal resolution, the 5 MHz bandwidth equates to 400 lines of resolution. Not only that, but the signal is capable of being timebase corrected to obtain direct NTSC color.

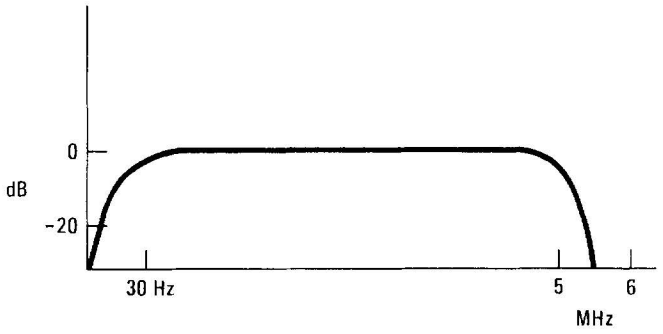
The writing speed of the VCR-100 is 723 ips, approximately 300 ips faster than other VCR's. This, coupled with ferrite heads and Hi Energy tape, results in a signal-to-noise ratio of 45 dB. However, regular gamma-ferrite oxide tape can be used and the resultant signal-to-noise ratio is a healthy 43 db.

The modulation technique used is a patented Pulse Interval Modulation, not Frequency modulation. PIM (as it is more commonly called) provides significant improvement in the signal-to-noise ratio and frequency response. Integrated circuits, which are particularly adaptable to the PIM technique, permit excellent carrier balance in the recorder's modulator and limiter circuitry, thus reducing moire' effects.

Videotape recorder timebase errors can be caused by capstan servo instability, capstan eccentricity, scanner instability and tape tension variations. These errors can be minimized by careful mechanical design as well as by electrical means.

The VCR-100 scanner is directly driven by a printed circuit dc motor. A printed circuit motor servomechanism offers much faster response time, has a lower mass, and provides generally better operating characteristics than a hysteresis synchronous motor. The scanner assembly is rigidly supported at both the top and the bottom. The combination of a fast-response printed circuit motor and a rigidly mounted scanner significantly reduces timebase errors.

VCR-100 VIDEO FREQUENCY RESPONSE



The VCR-100 utilizes a capstan servo, which further reduces timebase errors. The VCR-100 capstan uses a hysteresis synchronous motor, since motors of this type have smoother dynamic characteristics at the low speeds required for tape speed control.

The control of the supply and take-up reels is by means of another dc printed circuit motor. A dc printed circuit motor is ideal for this application as it has the extremely high-torgue capability required for rapid tape acceleration in the wind and rewind modes.

TTL logic circuits are used for all tape motion control circuits, and the control logic controls are all electrically operated. Remote control simply consists of a panel of momentary contact switches connected to a Jones-Cinch plug on the rear of the VCR. Control voltage is only 5 volts. This also means that the VCR can be used for numerous automation applications.

The VCR-100 also features a uniquely safe tape transport mode control. It is possible to go from fast forward or rewind directly into play without danger of tape breakage. Memory and timing circuits in the VCR ensure that it is impossible to damage the tape or VCR by switching between any two transport modes.

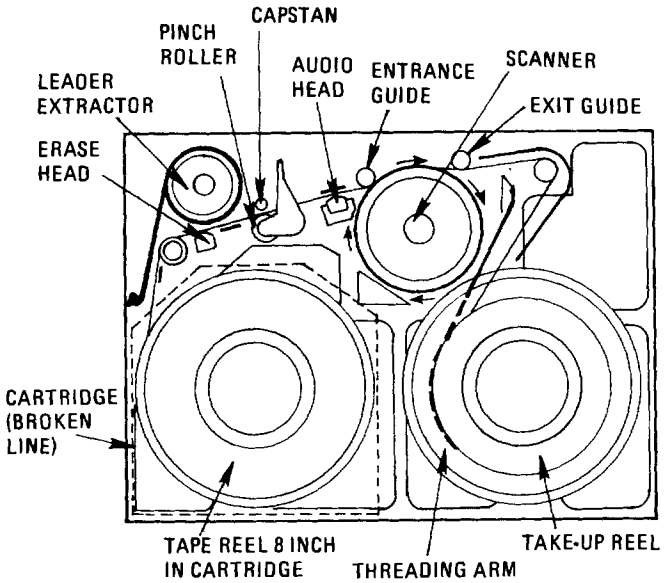
Since the VCR-100 utilizes the same IVC 1-inch format currently used on over 11,000 reel-to-reel VTR's already in the field, complete interchange between these VTR's and the VCR-100 is guaranteed.

The VCR-100 tape cartridge contains a standard reel of tape 8 inches in diameter. This tape can be recorded in the cartridge on the VCR-100, or recorded on an IVC reel-to-reel VTR and then placed in a cartridge for playback on the VCR-100.

If a recording is made on the VCR-100, the reel can be removed from the cartridge and played back on a standard IVC reel-to-reel VTR. This means that the IVC 1-inch format can be used for all VTR applications including the new, convenient, self-threading approach but without compromising picture quality.

The tape cartridge consists of a plastic enclosure which houses the standard 8-inch tape reel. To facilitate loading, a plastic adaptor ring is pressed into place on the NAB reel hub. A clear plastic leader is spliced onto each end of the tape. The head end leader has a small hole located about 4 inches from the front of the leader.

When the cartridge is loaded into the VCR-100 and the door is closed, the reel inside the cartridge rotates in a rewind direction, taking up any loose pack and rotating the leader. A motor driven arm with a hook on it is simultaneously moved into the cartridge. As soon as the hook engages the hole in the leader, the engagement is sensed and the direction of the arm is reversed, pulling the leader faster than the arm. The leader is then channeled past the audio heads and around the scanner. A shroud around it guides the leader in a circle. From the scanner it moves onto the take-up reel. As soon as the clear leader passes a photo cell and the opaque tape is sensed, the threading action stops and the VCR-100 goes into a standby mode.



IVC VCR-100 Tape Threading Path

Once this threading procedure is completed, the machine is ready to be controlled in any of the normal tape modes. Inhibit circuitry in the controller does not allow any tape mode to be engaged during the threading process. If, for any reason, the recorder has not achieved complete threading within 20 seconds, the video tape is rewound and the cartridge is ejected, thus notifying the operator that there is a fault in the system.

It is not possible to run the recorder all the way to the end of the take-up reel and completely off of the cartridge. This is because a piece of transparent leader is also spliced at the end of the tape. The same photoelectric sensor at the scanner exit, that notified the control logic that the tape was threaded, also acts to place the recorder in Rewind at the end of tape.

To protect the video head from possible damage by the leader during the thread mode, the scanner is run at half speed except during record or playback. The video head is spring loaded in such a way that it is always retracted whenever the scanner slows to half speed. Normal run speed extends the head to a

preset position by centrifugal force. This feature extends the life of the video head, since it is never in contact with the tape during the fast wind modes and an unprecedented 2000-hour head life is guaranteed.

Although the 3/4-inch VCR's are designed to use only Hi Energy tapes and the 1/2-inch EIA-J VCR's are designed to use only gamma ferric oxide tapes, the VCR-100 is designed to use both. A lock-out plug on the cartridge automatically selects the proper record current for either type of tape. Another lock-out plug on the cartridge prevents accidental erasure of pre-recorded material.

The IVC VCR-100, with its convenient automatic threading, can easily be used in CCTV and CATV automation systems.

A cablecaster can tape his program on any IVC 1-inch recorder with the assurance that the reproduced picture will have the best resolution, signal-to-noise ratio and stability available. This tape can be played back on the VCR-100 with the assurance that it will look good on any home receiver. If the cablecaster is concerned with the cost of retaining a full-time technical staff, a bank of VCR-100's with automatic sequencing electronics can solve that problem. The prerecorded programs can be loaded into the VCR's throughout the origination day. This system could pay for itself within a few months after its installation.

A review of some of the pertinent specifications will show that this VCR can do a superb job in all CCTV and CATV applications, especially when the signal must be fed to a variety of different receivers or monitors.

The video bandwidth is 5 MHz. This equates to 400 lines of horizontal resolution. Video signal-to-noise ratio is 43 dB with standard gamma ferric oxide tape and 45 db with high-energy tape. Timebase stability is extremely low, about 10 to 15 microseconds with reference to horizontal sync. Other VCR's have a timebase stability of about 30 microseconds.

Add to this the convenience of automatic cartridge threading and interchangeability with other high-performance 1-inch VTR's, and it is evident that this VCR offers the industry a useful tool for CCTV and CATV.