MULTIDYNE
Video and Fiber Optic Systems

Video and Audio Performance of Digital Fiber Optic Systems

The answers to why Multidyne achieves superior video and audio performance, exceeding the EIA/TIA-250C Short-haul specification.

Written by Jim Jachetta, MS EE,
Vice President

MULTIDYNE Electronics, Inc.

Innovations in Television Testing & distribution

1-(800)-4TV-TEST, 1-(800)-488-8378

191 FOREST AVENUE
LOCUST VALLEY, NY 11560-2132 USA
(516)-671-7278 FAX (516)-671-3362

MULTIDYNE, DVM-2000, DVM-2200, DVM2500 and DVM-3000 are registered trademarks of MULTIDYNE Electronics, Inc.

TABLE OF CONTENTS

INTRODUCTION

Multidyne provides the television, cable, surveillance and transportation industries fiber optics systems of the highest video and audio quality and performance. We provide several digital video and audio fiber optic transport systems using **12-bit video and 24-bit audio encoding**. By using 12-bit digital video, we achieve a typical **Signal to Noise ratio of 75 dBs**. Our 24 bit digital audio provides a typical **Signal to Noise ration of greater than 90 dBs**. The test results below were performed using the industry standard Tektronix VM700A Video Test Set and a Multidyne TS12-10B Test Signal Generator.

The Multidyne **DVM-2000** Stand-alone, Video, Audio and Data Fiber Optic Transport System, the **DVM-2200** Modular, Video, Audio and Data Fiber Optic Transport System, the **DVM-2500** Bi-directional, Video, Audio and Data Fiber Optic Transport System and the **DVM-3000** Video, Audio and Duplex Data Fiber Optic Transport System are examples of products with 12 bit video and 24 bit audio technology.

VIDEO PROCESSING

There are no short cuts to achieve superior video performance. Close attention to signal quality has to be observed from end to end. This starts with the video input.

DIFFERENTIAL INPUT and HUM REJECTION

Most fiber optic systems have a single-ended video input. Multidyne provides a differential video input with superior common-mode noise rejection. This prevents the pick-up of noise and hum into your video signal. The differential input used in Multidyne equipment has an extended input voltage range, permitting the cancellation of larger amounts of hum. In real world studio and field applications all video equipment should have a differential input to cancel hum and noise.

CLAMPING and DC RESTORATION

Our systems include a high-speed clamp or DC restoration circuit. Without proper clamping, a video signal may clip or distort. Our systems have a wide input voltage range permitting operation with large amounts of DC offset voltage present in the video. The DC offset voltage can be caused by ground loops present in every application. This makes a clamping and DC restoration circuit with a wide input voltage range a necessity

CABLE EQUALIZER

Several Multidyne models include a video cable equalizer with a range of up to 3000 feet. In every application there is some length of video cable connected to the fiber optic transmitter.

These systems also include a video gain control and video monitoring port. **This feature prevents the need for an external video distribution amplifier with cable equalizer**.

During installation, a video test signal source is connected to the transmitter. A Multidyne TS12-10B Test Signal Generator or equivalent is used to send a reference test signal. While observing the video monitoring port on the transmitter, the video gain and equalization are adjusted to receive 1 Vp-p video with a flat frequency response. This process ensures that the proper video signal level is applied to the analog-to-digital converter. If the video signal is low, the Signal-to-noise may suffer. If the video level is too high, the video signal may clip or distort.

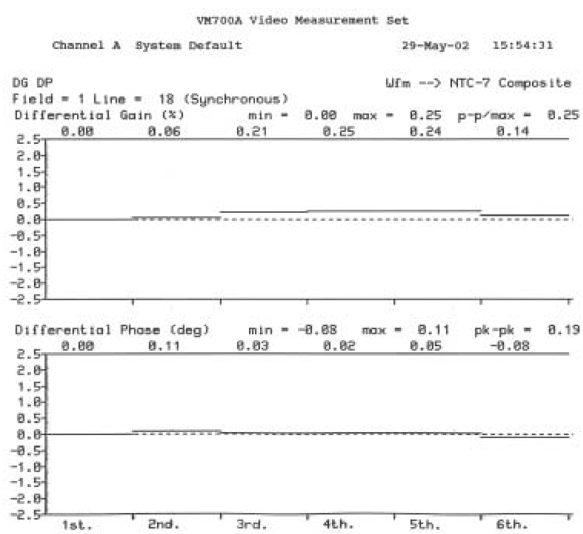
HIGH QUALITY VIDEO OPERATIONAL AMPLIFIERS

Many manufacturers cut costs by using low quality video operational amplifier. The use of low quality amplifiers will distort the video signal and add noise. Multidyne only uses the highest quality video amplifiers.

DIFFERENTIAL GAIN AND PHASE

Low quality amplifiers and components can introduce many types of distortion. One type of distortion is Differential Gain and Phase. Differential Gain, DG, causes distortions in the fidelity and accuracy of the video color contrast level. Differential Gain is expressed as a percentage error in amplitude as the average luminance video signal changes. Differential Phase, DP, causes distortions in the fidelity and accuracy of video color tint or hue. Differential Phase is expressed in degrees of phase error as the average luminance video signal changes. The visual effects of Differential Gain and Phase are color saturation or level distortions and color tint or hue distortions. An example could be that a golf course appears to be yellow in color or the color green is faded. The lower the DG and DP the better.

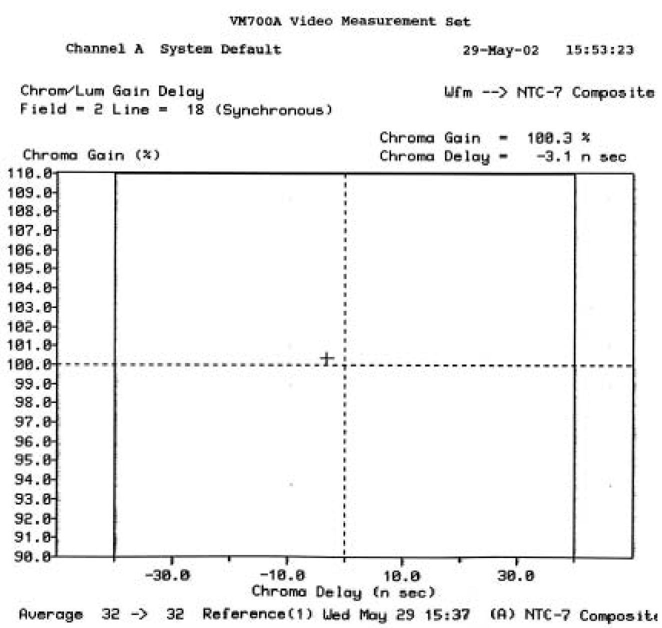
Many systems on the market have Differential Gain and Differential Phase of 2% and 2 degrees, respectively. Multidyne systems typically have **Differential Gain and Differential Phase of about 0.2% and 0.2 degrees**, respectively. The use of 12 bit video encoding also helps in the reduction of DG and DP.

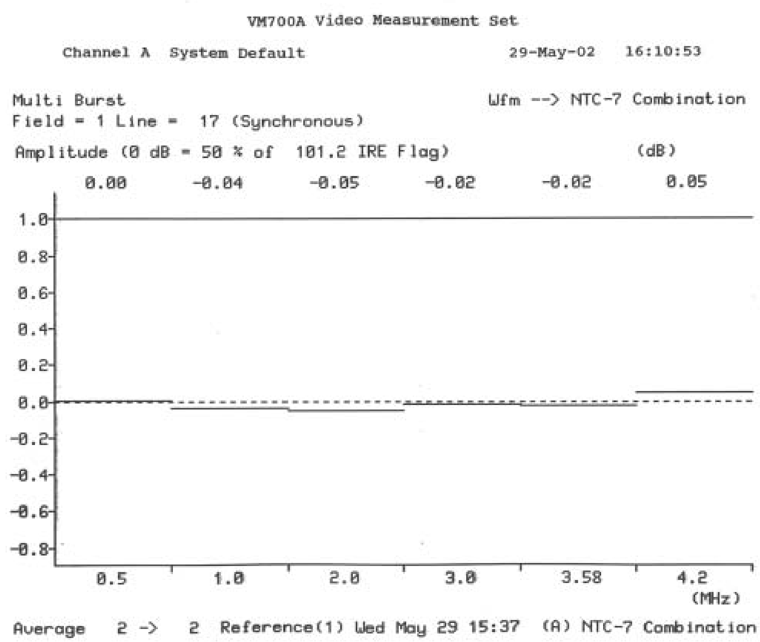


FREQUENCY and PHASE RESPONSE

The next step is to use a high quality low-pass or anti-aliasing filter before the A-to-D process. If a filter is used with poor characteristics, the video quality will suffer. Most system use cheap filters. The filters used by Multidyne have a **frequency response with a flatness of less that +/-0.05 dB.** There are systems on the market with greater than +/-1 dB flatness. Another important characteristic is phase or group-delay response. A good filter should have a constant delay throughout the video signal pass-band. If the phase characteristics are poor, the video color information can be smeared, delayed or miss-timed with respect to the rest of the picture. You may have seen examples of this. Picture a yellow racecar going around a track. You notice that the yellow of the car not exactly on top of the car. The yellow is slightly to the left or right of the car. The color information in the NTSC, PAL and SECAM television system is encoded on a frequency subcarrier. If the system introduces a phase shift or delay at the color subcarrier frequency, you get the effect with the racecar described above.

The **phase or group-delay characteristic** of Multidyne systems is typically **less than +/-5 nano seconds.** There are systems on the market with more than 50 nano seconds delay.

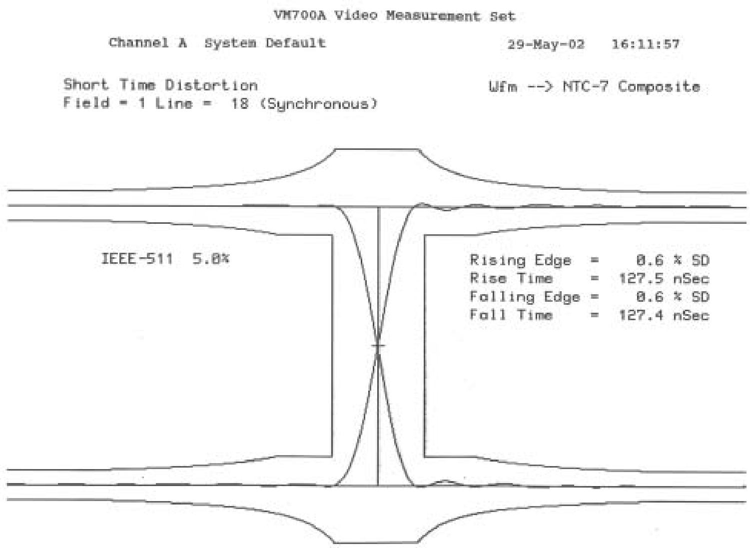




After the video passes though our high quality anti-aliasing filter, the signal is sampled at 15 MHz with our 12 bit analog-to-digital converter. The digitized video, audio and data is multiplexed and serialized. The serial data stream is then sent through the fiber optic link. On the receiver side the digital video, audio and data signals are de-serialized and de-multiplexed.

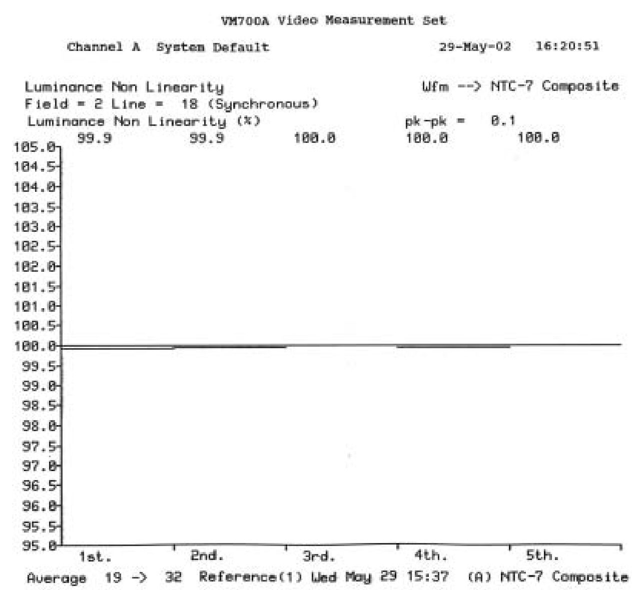
RINGING and RISE-TIME DISTORTION

Another important characteristic of video filter design is pulse response. When a filter is not calibrated or designed properly, the pulse response characteristics will cause signal ringing and rise-time violations. The permitted amount of signal ringing is less than 1%. Many systems have ringing in excess of 2%. Multidyne systems have **ringing of about 0.5%.** The permitted rise-time is 125 nano-seconds. Many systems have rise-times that are too fast or too slow. Multidyne systems have **rise-times** very close to **125 nano-seconds**. The result of ringing and rise-time violations is distortions around edges in a video image. Ringing can be observed as multiple or busy edges. Long or slow rise-times can be seen as blurry or smeared edges.



VIDEO LINEARITY

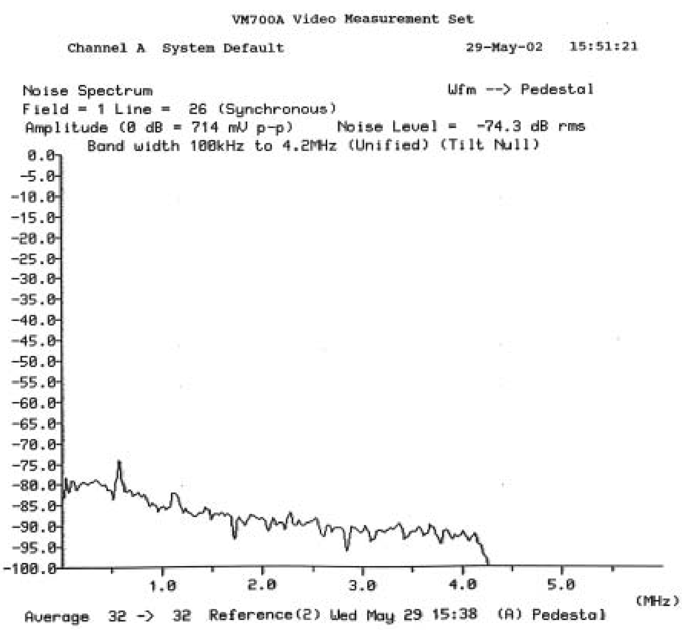
The use of a 12-bit video encoding process reduces many types of distortion and noise. One parameter is linearity. Linearity most affects the video contract level. The use of low quality video analog to digital and digital to analog converters will drastically affect the linearity. Many systems on the market have linearity distortions of greater than 2%. By using highly linear, 12 bit encoding, Multidyne is able to achieve **linearity deviations of less than 0.1%.**

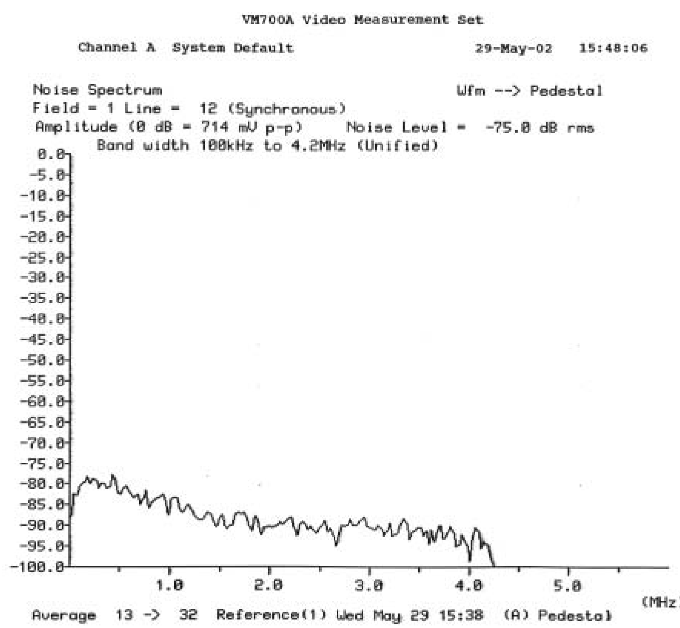


SIGNAL-TO-NOISE AND SIGNAL-TO-QUANTIZING NOISE

The use of 12-bit video encoding most affects the Signal-to-noise and Signal-to-quantizing Noise. When more bits are used to encode information, the dynamic range from the smallest signal to the largest signal is increases. By increasing the signal dynamic range, the Signal-to-noise, S/N, is also increased. This is why a 12-bit system has better S/N than an 8 bit system.

When using a VM700A to measure S/N ratios, the analog contributions to the over-all system noise are only measured. This method is fine when measuring noise on an analog system. When measuring noise in a digital system, there are significant noise contributions from the digital encoding process called quantizing noise. When using a special Shallow Ramp test signal available with the Multidyne TS12-10B, the Signal-to-Quantizing noise can be measured. A Signal-to-Quantizing noise measurement is a more complete noise measurement for digital systems. **You should always ask for the Signal-to-Quantizing noise measurements results.** There are some systems on the market with good Signal-to-Noise results, but have very poor Signal-to-Quantizing noise. Any EIA/TIA-250-C Short-haul or broadcast quality system on the market should have a S/N and S/Q of greater than 67 dB. Many systems will have a S/Q of 62 dB. **The Multidyne systems typically have a S/N of 75 dB and a S/Q of 74 dB.** Even though a S/N and S/Q of 67 dB is the minimum requirement, there is a great benefit using a 75 dB S/N system. A video signal can be encoded and decoded several times with 12 bit technology and still maintain a 67 dB S/N and S/Q.





VIDEO RECONSTRUCTION

Once the digitized video, audio and data reach the receiver it is de-serialized, de-multiplexed and ready for reconstruction. A 12 bit digital to analog converter is used to convert the digital video back to an analog signal. A reconstruction or low-pass filter is required to restore the video back into the original form. Again the same rules apply. If a filter is used with poor characteristics, the video quality will suffer as stated above.

AUDIO PROCESSING

There are no short cuts to achieve superior audio performance. Many of the same principals used for the video section are used for the audio section. Close attention to signal integrity has to be observed from end to end. This starts with the audio input.

DIFFERENTIAL INPUT and HUM REJECTION

Most fiber optic systems have single-ended audio inputs. Multidyne provides a differential audio input with superior common-mode noise rejection. This prevents the pick-up of noise and hum into your audio signal.

24 Bit AUDIO ENCODING

The use of 24-bit audio encoding most effects the Signal-to-noise. The Multidyne systems have **S/N ratios of greater than 90 dB** with a Total Harmonic Distortion or **THD of less than 0.05%.** Many systems on the market use 16 bit technology and have THD of greater that 1%.

REFERENCES

EIA/TIA-250-C Electrical Performance for Television Transmission Systems, published by the Electronics Industry Association and the Telecommunications Industry Association, February 1990.