**Some Video History and the Faroudja Approach**

Faroudja Laboratories, located in northern California's Silicon Valley, was founded in 1971 by Yves and Isabell Faroudja to develop state-of-the-art of video processing technology. Over the last 25 years, Faroudja Laboratories and its companion R&D center, Faroudja Research, have developed many advanced electronic processes to improve video enhancement, noise reduction and NTSC encoding/decoding technologies. These processes are used under license by the world's leading electronics companies in a wide range of high performance video products. Faroudja professional video equipment is also online in hundreds of television studios. Thus Faroudja technology is utilized and enjoyed in millions of American homes every day.

Yves Faroudja has devoted his career and his company to the goal of enabling home video systems to achieve the image quality of 35mm motion pictures. In pursuit of this goal, Faroudja Laboratories has made use of techniques from Faroudja professional video equipment and incorporated these in the LD200 line doubler.

This booklet will provide the reader with an overview of the LD200, its operation and benefits, and the proprietary technologies utilized in this extraordinary device with an explanation of the visual improvements it provides in home video playback systems.

First, before we discuss the LD200, let's take a quick look at the history of the current television standard. Today's 525 line TV picture standard was developed in the 1940's when broadcasts were in black and white. Keep in mind that back then, the transistor had not yet been invented! In 1953, the National Television Systems Committee (NTSC) adopted what is still the present method of color TV broadcasting. It was designed to be fully compatible with the older technology of black and white transmission. Unfortunately, this need to maintain compatibility with old technology led to unavoidable compromises in NTSC picture quality.

Today, thanks to the advent of new thinking and new technologies realized by industry pioneer Yves Faroudja, these compromises can be nearly eliminated. Faroudja's unique approach focuses on critical problem areas in the NTSC and PAL broadcast formats. With patented engineering and design work, Yves and Faroudja Laboratories have created an exceptional product that brings new levels of visual reality to the enjoyment of discerning video enthusiasts around the world.

### Licensees Around the World

Faroudja's inventive approach to improving the quality of video imaging has caught the eye of some of the world's greatest high technology companies. The following list represents those that have recognized the value of Faroudja's solutions to imaging problems and incorporate this technology in their advanced video products:

| | |
|---|---|
| Canon | Microtime |
| Conrac | Mitsubishi |
| General Instrument | NAC |
| Grass Valley | NEC |
| Hitachi | Sanyo |
| Ikegami | Sharp |
| JVC | Sony |
| Matsushita (Panasonic) | Toshiba |

### Awards and Achievements

Yves Faroudja and Faroudja Laboratories have garnered worldwide recognition and a number of industry awards. These honors are notable for several reasons. They are in response to the significant impact that Faroudja's technology has made on the serious improvement of video quality. They are also a reflection of his long term dedication to continually improving and optimizing the performance of the NTSC video format.

In chronological order, these awards and their specific focus are listed including an EMMY in 1991 for minimizing artifacts in the NTSC broadcast encoding process.

***1987: SMPTE***
DAVID SARNOFF GOLD MEDAL AWARD
for
"Contributing in Optimizing NTSC Performances"

***1988: MONITOR AWARD***
for
"Excellence in Engineering
NTSC Encoders and Decoders"

***1989: BM/E AWARD***
for
"Excellence in Engineering"

***1991: Technology Executive of the Year from Cable TV Business***

***1991: EMMY***
from The National Academy
of Television Arts and Sciences
for
"Techniques for Minimization of NTSC Artifacts
Through Advanced Encoding Techniques"

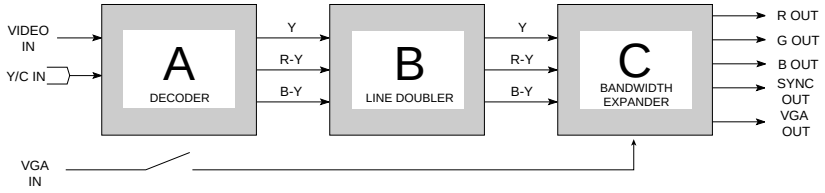
***1992: VIDEO GRAND PRIX AWARD***
Audio/Video International
LD100 Line Doubler "Advanced Technology Award"

***1993: VIDEO MAGAZINE***
Video Visionary
LD100 Line Doubler "10 Best Products"

***1995: Broadcast Engineering***
VP400 10 Best Products

## TECHNICAL HIGHLIGHTS

**LD200 TECHNICAL HIGHLIGHTS** – The LD200 is far more than simply a "line doubler". It is a truly unique product in the world of high performance video. **The LD200 is actually a complex image processor that consists of three distinct elements – all utilizing patented Faroudja technologies and engineered into one chassis; *the decoder , the Faroudja proprietary line doubler, and Faroudja's innovative bandwidth expansion circuit that allows for the sharpening of image details.*** Line doubling by itself is simple and inexpensive to achieve. But simply doubling the lines of information is worse than doing nothing at all because the visual result is a picture of lesser quality. To achieve film-like quality, a great deal more is required than just doubling the lines. The block diagram below provides a simple view of Faroudja's multi-faceted solution for perfect pictures. The technical and visual benefits of each of these special circuits are explained more fully below.




LD200 BLOCK DIAGRAM

**SECTION A** – The LD200 SuperNTSC Decoder: Eliminates ***COLOR BLURRING*** – The engineers of the 1940's (and the 1950's, before and during the development of color broadcasting), had no idea that video images would one day be presented as large as they are today. They therefore designed the color section of the NTSC standard with severe bandwidth restrictions. This causes colors in various video images to "blur" and "smear". These effects are further aggravated by storage media, such as VHS tapes, that further degrade the chroma or color signal. e.g. – note how deep reds smear on VHS tape images.

The Faroudja LD200 utilizes proprietary circuitry to recreate and correct color details. Technically, this is accomplished by making use of the sharper black and white transitions to develop a correction signal that is then used to sharpen the color transitions. The result is colors that are restored with sharp details and video images that retain their original crisp look.

***RAINBOW PATTERNS*** – When you notice the fine detail of a striped referees shirt rippling with colored rainbows as the camera pans by, you've seen video cross-color interference.

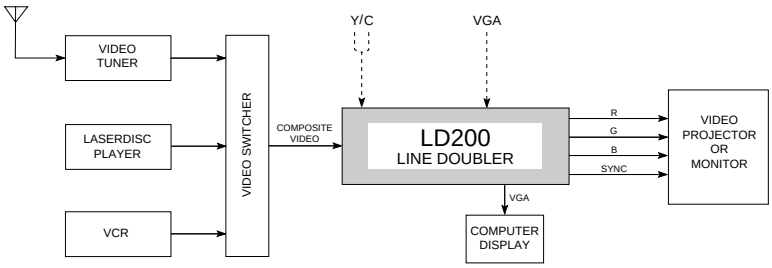
This annoying artifact is caused by imperfect separation of the color (chroma), and black and white (luminance) signals by the color decoder circuitry. Simple techniques used commonly to separate the two signals can be effective most of the time, but occasionally are fooled by finer pitch detail areas like the referees shirt. The decoder in the LD200 has patented digital adaptive comb filter circuitry that eliminates decoding errors of this type and enables the reproduction of sharper, cleaner color images.

***DOT CRAWL*** and ***HANGING DOTS*** – This phenomena is easily seen with large, highly saturated, stationary graphics like titles and credits. Dot crawl is a rapid upwards movement of colored dots on sharp vertical transitions. Hanging dots lie underneath all the colored horizontal transitions. Both of these color aberrations are artifacts that appear due to an imperfect color decoding process. The LD200 has two separate and patented correction circuits that work to eliminate both of these distortions. The impact is color transitions that are clear, sharp and natural.

**SECTION B** – THE LD200 Patented Line Doubler: eliminates ***VISIBLE SCAN LINES*** – The secret of the LD200's uncanny ability to double the lines of information without adding digital artifacts is in its unique ability to detect motion and interpolate correctly to "fill in the blank lines". The Faroudja LD200 does this better than other line doublers thanks to its proprietary, patented circuitry. It can detect the difference between a film image that has been transferred to video or video image that emanates from a video camera. After detecting the image type, the LD200 selects its algorithm to compensate accordingly.

This is critical because today's home theaters are primarily used to show films that were transferred to video whether on tape, laserdisc or off the air (virtually all prime time programs are film transferred to video). The inability of other line doublers to detect motion correctly is what causes most of them to be unwatchable due to digital artifacts. The LD200 offers sharper, uniquely clean, artifact-free film-like images without visible scanning lines.

Historically speaking again, electrical engineers back in the 1940's knew the resolution of a picture tube depends on




TYPICAL LD200 SYSTEM UTILIZATION

two different mechanisms. Horizontal resolution is a function of bandwidth (frequency response) of the circuitry while vertical resolution is a function of the scanning frequency (the number of scan lines in each picture). Given these mechanisms and the average size picture tube being 8-10", they designed the 525 line broadcast standard so that viewers would not see the scan lines when watching TV. They had no idea that someday people would be projecting home theater video images with diagonal screen sizes of 10' and more.

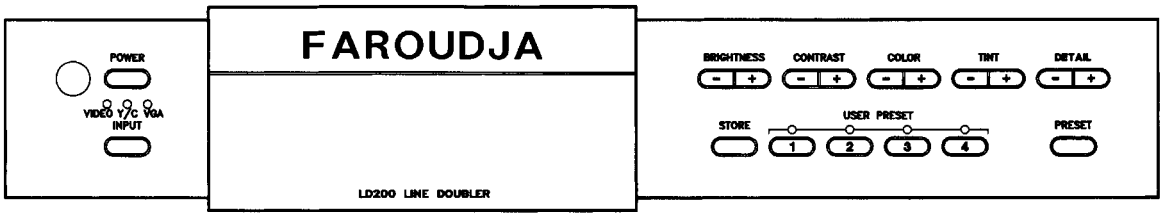
Based on those original NTSC parameters, using a 10 ft. diagonal screen, would require the viewer to be located more than 45 ft. from the screen to see the picture as it was intended, without scan lines! Unfortunately, today's large screen installations have scan lines that are quite visible, especially with some of the latest high resolution monitors and projection televisions. The LD200 eliminates this problem by scan doubling, or digitally doubling the 525 lines to become 1050 lines. The result is the elimination of visible scan lines. The image produced by the LD200 is clearer, continuous and virtually film-like.

**SECTION C** – The LD200 Bandwidth Expansion Circuitry: ***SHARPENING OF THE IMAGE DETAILS*** – There is a major limitation with most contemporary NTSC program sources — lack of frequency response. The best video sources such as satellite dish reception and laserdiscs can provide acceptable resolution (400 plus lines of horizontal resolution). Other more common sources however, such as VHS tapes (230 lines), are clearly deficient. The problem is compounded when one doubles the scan lines and performs other signal processing. The lack of high frequency detail becomes very obvious with almost all sources. The resultant picture is free of scan lines but dull, with a serious loss of definition. The solution is to expand the high frequencies without producing annoying and picture degrading artifacts.

The bandwith expansion circuitry in the LD200 is unique, using Faroudja's double differentiation techniques to sharpen the edges of both horizontal and vertical details. The result is a sharply detailed line doubled image that appears crisp and three dimensional with no visible negative side-effects. This process increases the apparent bandwidth and therefore the resolution of the incoming signal.

**FAROUDJA LD200 APPLICATIONS** – While the technical accomplishments of the LD200 represent years of intense research and development, its use is straightforward and direct. The block diagram (above), illustrates a typical home theater system configuration and shows how the LD200 would be inserted in the signal path. Many entertainment sources benefit greatly by the LD200's unique attributes; laserdisc, VHS video, S-VHS video, cable TV, broadcast TV, etc. The LD200 has proven to be an invaluable tool in other presentation disciplines where image quality is important – computer data displays, professional installations in boardrooms and media rooms, military installations, government agencies and academic uses in schools and colleges. From the quality of its individual parts to its state-of-the-art patented circuitry, the LD200 is truly in a class by itself. There is simply no finer video processor available.

## SYSTEM DESCRIPTION




**Front Panel**

**Figure 1**

The Faroudja LD200 digital line doubler is a precision video instrument used to convert NTSC composite or Y/C (S/VHS) interlaced signals into a high resolution 525 line, progressively scanned outputs. The LD200 processor produces pictures with increased details, while removing unwanted picture artifacts. When used with large screen projection systems, the results are a very “cinema-like” experience.

The list of features for the LD200 include composite, Y/C (S/VHS) inputs, a VGA pass-through, infrared and RS-232 remote control, on-screen graphics and up to eight custom presets (four per channel). Front panel controls include Power, Input Select, Brightness, Contrast, Color Level, Tint, Detail, User Presets 1-4 and Factory preset. Four custom presets can be stored for the composite and four for the Y/C inputs. All settings are stored in a nonvolatile memory to prevent a loss in the event of a power failure. The infrared remote controls Power, Input Selection, Custom or Factory Preset Selection, Function Selection and Function Adjustment.

Adjusting the LD200 for optimum performance is simple using the on-screen graphics. The graphics list the available picture controls while allowing the video signal to continue on the screen. This allows for accurate adjustments to the viewer’s taste. By using the custom presets, variations of signal levels between sources or cable channels can be compensated to insure optimum image quality.

Inputs to the LD200 are: composite video, Y/C (S/VHS or Hi-8) and a VGA pass-through. The composite and Y/C inputs can be looped through to another piece of equipment.

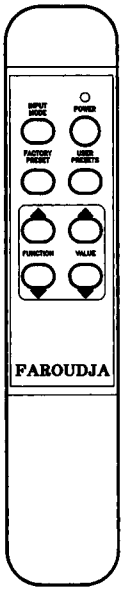
Output from the LD200 is provided on six BNC connectors as well as one 15 pin “D” VGA connector. The BNC outputs provide Red, Green, Blue; Horizontal, Vertical and Composite Sync. The LD200 is capable of driving a monitor/projector using the BNC outputs as well as a VGA monitor using the 15 pin “D” connector.

### Operation

Your new LD200 processor may be controlled by three different methods: 1. Front Panel Controls, 2. Infrared Remote or 3. RS-232. The front panel controls (see figure 1) are Power, Input, Brightness, Contrast, Color, Tint, Detail, Store, User Presets 1-4 and Factory Preset. The controls on the infrared remote (see figure 2) are Power, Factory Preset, User Preset, Function and Value.

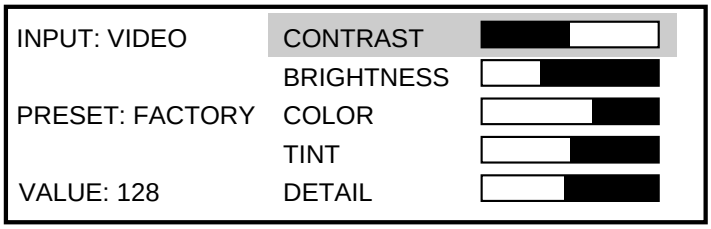
### On-Screen Graphics

Whenever an adjustment of the picture is activated from the remote control, an on-screen graphic (see Figure 3) will appear listing the various control options. When using the front panel controls only the graphic for the function selected will appear.




**Remote Control**

**Figure 2**




**On-Screen Graphics**

**Figure 3**

The graphics are displayed at the bottom portion of the screen so most of the video being viewed can be seen while fine tuning the settings. When using the infrared remote pressing the FUNCTION keys up or down toggle through the different control functions. The function is active when highlighted. Pressing the VALUE keys up or down will increase or decrease the function selected. In addition to the bar graphs, there is also a value readout to provide a more accurate adjustment.

(Note: Picture Functions do not operate when VGA input is selected.)

### Inputs

The on-screen graphics also tell you the status of the input type and presets. The input will list either Video, Y/C or VGA. If Video or Y/C input is selected but not connected, the image will be blank. If VGA is selected but not connected, an on-screen prompt will state “VGA Not Detected” and will switch to the Video input.

The VGA input is a “pass-through” connection, meaning that the signal goes straight from the input to the output, bypassing any internal processing by the LD200. This feature is beneficial for installations that use both video and computers as sources. Connecting the VGA output of the computer to the LD200 saves the installation problem of having to run separate cables to the projector and the need for an external switcher.

### Presets

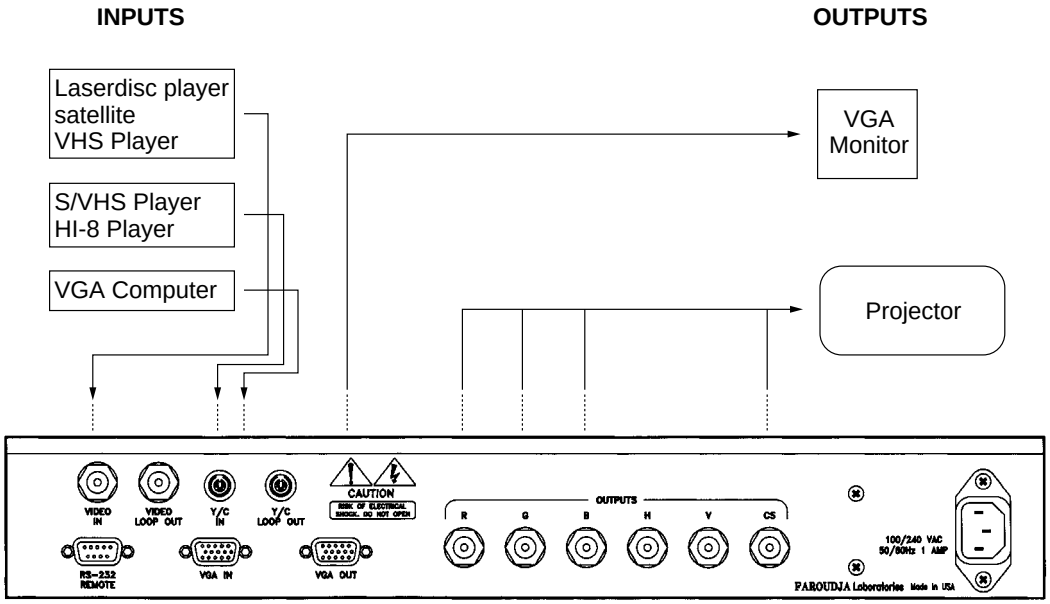
The LD200 offers eight user defined presets; four for the Video input and four for Y/C. To store a preset, adjust the picture to optimum performance. Then press the STORE button located on the front panel and then one of the four USER PRESETS within two seconds (the store request will stop after three seconds if a preset is not selected). The information is now stored for that preset.

## Caution Notes

Do not connect the LD200 to a Monitor/ Projector not capable of the correct scan rate. (31.5KHz)

High Voltages are present inside. Opening the unit will void all warranties.

No user serviceable parts inside.




The LD200 is designed to accept the video sources found in most projection applications. The composite input should be used with sources such as laserdisc players, VHS tape players and satellite systems. The Y/C input should be used with S/VHS and HI-8 tape players. The VGA input will “pass-through” the VGA output from a computer to the projector and monitor outputs eliminating the need to run separate cables (the VGA signal by-passes any processing by the LD200 circuitry).

The composite and Y/C inputs provide a loop-through connection that allows the input signal to be looped to another processor. This is an active loop so the LD200 needs to be ON. The looped output cable should never exceed six feet. Use a distribution amplifier for longer cable runs.

The LD200 is designed to be mounted either on a shelf or an equipment rack. A minimum of 1.25” (one rack height) ventilation space needs to be provided above and below the unit.

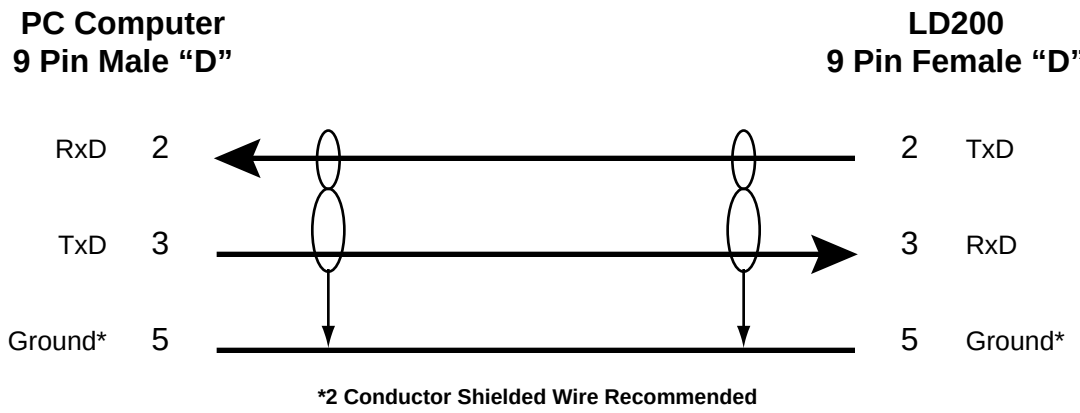
**Projector Setup** – To get the maximum benefit from the LD200, the projector or monitor must be set to exact specifications. The LD200 should be set to the factory preset postion while adjusting the projector or monitor. Adjustments should be made using either a test generator or a test disc that contains the appropriate setup patterns. These test signals should pass through the LD200 to the projector or monitor. Follow the adjustment proceedures as outlined by the projector or monitor manufacturer.

Once this is accomplished, the projector settings should be saved and not changed. Any changes to the signal should now be made at the LD200. This proceedure insures that if the LD200 controls are misalinged, pressing the factory preset will restore the image to a reference level.

### OUTPUTS

The LD200 offers two types of outputs. Six BNC connectors are used to output Red, Green, Blue plus separate or combined horizontal and vertical sync signals to the projector or monitor. There is also a D-15 VGA plug that allows for connection of a computer monitor. Both outputs can be used simultaneously.

(NOTE: When using the VGA Pass-Through to a projector, separate horizontal and verticle sync output must be used.)




**LD200 RS-232 Cable**

### RS-232 PROGRAMMING INSTRUCTIONS

The LD200 can communicate with other controllers that provide an RS-232 interface. Adjustable baud rates are 19,200, 9,600, 4,800, 2,400 and 1,200 with 9,600 as factory default. (Contact factory for details if baud rate needs to be changed.) Communication settings are 8 bits, N parity and 1 stop bit. A terminal emulator program, like the one found in Windows, can be used to control the LD200.

All RS-232 commands require the header of 'LD200' to be used at the beginning of each new command string, followed by any of the commands listed below. Commands may be of either upper or lower case characters. All commands are terminated by a carriage return (13H).

**RS-232 Commands:**

The following commands can be listed a a multiple command separated by a comma:
B = Brightness ( 0 to 255 )
C = Contrast ( 0 to 255 )
K = Color ( 0 to 255 )
T = Tint (0 to 255)
D = Detail (0 to 15)
Example: LD200,B100,C75 (ENTER)

The following commands must be entered individually:
HELP = Displays a help menu
P0 = Factory Preset ( not user changeable)
P1 = User Preset 1
P2 = User Preset 2
P3 = User Preset 3
P4 = User Preset 4
L1 = Store User Preset 1
L2 = Store User Preset 2
L3 = Store User Preset 3
L4 = Store User Preset 4
ON = Turn On the LP200
OFF = Turn Off the LP200
ST = Return current settings status to controller
V = Select Video Input Mode
Y = Select Y/C Input Mode
X = Select VGA Input Mode
E0 = Echo Off
E1 = Echo On (default)

The On-Screen-Display (OSD) location on the monitor can be changed using RS232 commands. The OSD can also be disabled by RS232.
OSD ON = Enable the OSD
OSD OFF = Disable the OSD
OSD xxx,xxx = (Where xxx = 0 to 152) Select placement of OSD (factory default: 0,35)
OSD can also be changed by moving a jumper located inside the unit. Contact factory for details.

## APPENDIX A

**VGA Connector Pinout**

| Pin | Function |
|---|---|
| 1 | Red Video |
| 2 | Green Video |
| 3 | Blue Video |
| 4 | Not Used |
| 5 | Ground |
| 6 | Red Return (Ground) |
| 7 | Green Return (Ground) |
| 8 | Blue Return (Ground) |
| 9 | Composite Sync |
| 10 | Composite Sync Return (Ground) |
| 11 | Not Used |
| 12 | Not Used |
| 13 | Horizontal Sync |
| 14 | Vertical Sync |
| 15 | Not Used |

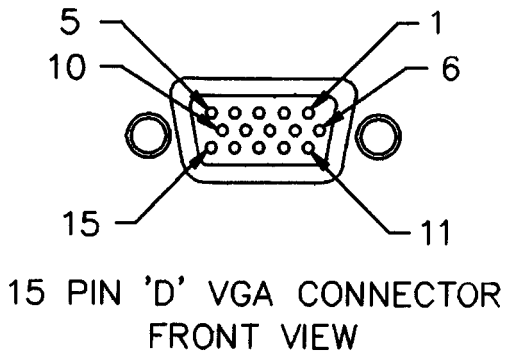



Figure 8

## APPENDIX B

**Cable Lengths and Distribution Amplifiers**

To achieve the best results from your installation, we suggest the following minimum standards for cable runs when an LD200 is used.

To preserve the video quality of the LD200, the signal path should be no more than –3db down at 25 MHz through a 75 ohm cable. Any distribution amplifier should have a bandwidth no less than –3db down at 25 MHz.

The following cable lengths are the maximum recommended continuous lengths of 75 ohm coax cable and 15 pin VGA cable (when using the VGA output).

| Cable Type | Maximum Length |
|---|---|
| Mini BNC cables, 75 ohm 1.15nS/Foot propagation | 100 Feet |
| RG-59/U type cable, 75 ohm | 150 Feet |
| 75 ohm precision video cable Belden 8281 | 200 Feet |
| 15 pin, high resolution VGA cables utilizing individual high resolution mini-coax cables for each signal from LD200 to monitor. | 25 Feet |