

LG-3
Scientific Frame Grabber
PCI Version

Scion Corporation
82 Worman's Mill Ct. Suite H
Frederick, MD 21701
(301) 695-7870

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Communications Regulations

FCC Statement

This equipment has been tested and found to comply with the limits for a Class B digital device in accordance with the specifications in Part 15 of FCC rules. See instructions if interference to radio or television reception is suspected.

Radio and Television Interference

The equipment described in this manual generates, uses, and can radiate radio frequency energy. If it is not installed and used properly, it may cause interference with radio and television reception. This equipment has been tested and found to comply with the limits for a Class B digital device in accordance with the specifications in Part 15 of FCC rules. These specifications are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation.

You can determine whether your computer system is causing interference by turning it off. If the interference stops, it was probably caused by the computer or one of the peripheral devices.

If your computer does cause interference to radio or television reception, try to correct the interference by using one or more of the following measures:

- Turn the television or radio antenna until the interference stops.

- Move the computer to one side or the other of the television or radio.

- Move the computer farther away from the television or radio.

- Plug the computer into an outlet that is on a different circuit from the television or radio.

If necessary, consult Scion or an experienced radio/television technician for additional suggestions. You may find the following booklet helpful: *Interference Handbook* (stock number 004-000-00493-1). This booklet, prepared by the Federal Communications Commission, is available from the U.S. Government Printing Office, Washington, DC 20402.

Changes or modifications to this product not authorized by Scion Corporation could void the FCC Certification and negate your authority to operate the product.

Getting Started

Introduction

The LG-3 frame grabber that you have just received is a high-quality instrument suitable for use in a variety of scientific and industrial imaging applications such as video microscopy, autoradiography, and automatic process inspection. The primary function of the LG-3 is to capture video frames from standard RS-170 (or CCIR) video sources such as CCD cameras. The LG-3 is supplied with Scion Image, a version of the popular image acquisition and analysis software package, NIH Image, developed at the National Institutes of Health. Scion Image is a slightly extended version of NIH Image that supports the PCI version of the LG-3 as well as other Scion imaging boards. The LG-3 also comes with a Photoshop module for use with other software packages that support the Photoshop interface.

The LG-3 has numerous features, besides an exceptionally clear and sharp picture, that are particularly useful for demanding scientific use. The LG-3 is capable of a real-time video display rate of 30 frames per second on a the Macintosh monitor. It is also capable of capturing frame sequences to Macintosh system memory at 30 fps. There is an expandable frame buffer that allows multiple video frames to be stored on-board the LG-3. The frame buffer is implemented using standard Macintosh SIMM memory modules for easy expansion. The LG-3 allows software control of the range of digitization of the video signal, which provides an analog offset and gain capability. The LG-3 has four digital input lines and four digital output lines that allow the monitoring and controlling of external events such as video integration and external shutter control. There are also two digital to analog converter outputs that may be used for process control applications. Finally, the LG-3 has a dedicated open drain output that may be used with Scion Image to control several on-chip integrating cameras.

Please take a few moments to read through this manual before you begin using your LG-3 as it should answer some of the questions that you may have concerning your new frame grabber. Please contact us at Scion Corporation should you encounter difficulty at any time, or if you have any questions.

Contents

You have received in addition to your AG-5 frame grabber: a CD-ROM, and an installation sheet. You may also have received a cable to connect a video source to the frame grabber board. All cables are optional.

The CD-ROM contains a short Read Me file, this manual, the driver file for the frame grabber, a compressed archive containing the Scion Image application program along with complete documentation. Should any items be missing, please contact Scion Corporation so that we can rush you the missing items.

System Requirements

The LG-3 can be installed in any Macintosh with a full-sized PCI slot. This includes all currently shipping PCI Macintoshes - the Power Macintosh 7200, 7500, 8500, and 9500.

Any standard RS-170 (or CCIR) video source can be used with the LG-3. The RS-170 (CCIR) standard is a specification for monochrome video signals. The LG-3 board does not come standard with a cable. An optional cable can be purchased from Scion Corporation. The LG-3 cannot be directly connected to a color (NTSC or PAL) video signal. The color information in a color video signal will produce an unacceptable interference pattern in captured frames. The LG-3 can, however, be connected to RGB video sources using the optional RGB cable. When connected to an RGB source, the LG-3 can capture frames from each of the individual color signals and can capture three-pass color images.

The LG-3 is designed for use primarily with RS-170 (or CCIR) CCD cameras and RGB output CCD cameras. The LG-3 does not perform time-base correction on the incoming video signal. This means that the LG-3 may have sync difficulties with some consumer quality VCR's and camcorders that exhibit large time-base errors.

Installation

Frame Buffer Memory

The LG-3 comes with four 256 Kb memory modules installed. This amount of memory is adequate for most purposes. For applications requiring more frame buffer memory, the amount of memory on the LG-3 can be easily increased by replacing the provided memory modules with higher capacity modules. Each SIMM slot on the LG-3 can accept a standard 30 pin Macintosh SIMM rated at 80 ns or faster. The capacity of the SIMM's may be 256 Kb, 1 Mb, 4 Mb, or 16 Mb. All four memory modules must be the same capacity. Note that the composite type of 16 Mb memory module may not be used with the LG-3 because of their large form factor. It is advisable, when removing or installing SIMM's, to be in a static safe environment.

To remove memory modules from the LG-3, begin with the right most module and work to the left. For each module, insert a pen or a small screwdriver into the two holes of the SIMM and slide it out of the socket. To install memory modules, begin with the left most module and work to the right. Slide each module into its connector making sure that it is seated fully.

The architecture of the LG-3 allows it to store two video frames per Mb of installed memory. For example, an LG-3 with four 4 Mb SIMM's installed can store 32 frames on-board.

LG-3 Circuit Board

Installing the LG-3 in your Macintosh is an easy process that should only take a couple of minutes. The first step is to remove the cover from your Macintosh. If a PCI card retainer is present, swing it aside so that the PCI slots are accessible. If you are unsure of the proper method for removing the cover from your particular Macintosh, consult your Macintosh user's manual. Once the PCI slots are exposed, select the PCI slot that you wish to use and, if necessary, remove the cover from the opening in the rear of the Macintosh case that corresponds to the slot.

At this point, make sure that you have discharged all static electricity from your body. A good way to discharge static electricity is to touch the Macintosh power supply. Remove the LG-3 frame grabber from its static shielding bag. Holding the LG-3 by its top edge, align the rear edge of the circuit board with the card guide corresponding to the selected slot. At the same time, align the LG-3's connector bracket with the slot opening. When the circuit board is aligned, carefully lower the LG-3 into the slot until the edge connector on the bottom of the board rests against the PCI connector. Check to insure that the board and the connector are appropriately aligned. Then press firmly on the top edge on the circuit board until the board mates with the connector. If excessive force is required to mate the connectors, remove the LG-3 from the Macintosh and try again. Once the LG-3 is inserted in the PCI slot, replace the PCI card retainer, if present, then replace the cover of your Macintosh.

Cables

If you bought the Single Source cable then insert the nine pin connector of the cable into the nine pin connector of the LG-3. When the connectors are mated, tighten the two screws on

the single source cable connector. Connect the BNC end of the single source cable to your camera. If you are using the RGB cable, it connects to the LG-3 in the same manner as the single source cable. Connect the nine pin connector to the nine pin connector of the LG-3. The other end (or ends) of the cable connects to your video source. If you have a video source with a non-standard connector, please contact Scion for assistance.

Scion Image Software

To install the Scion Image software package, insert the Scion CD-ROM and double click the Scion Image folder. To decompress the archive, double click on the archive icon and follow the directions. The archive will decompress into a Scion Image folder containing the program as well as documentation, sample macros, and convolution kernels.

There are four Adobe PDF documents describing the Scion Image package. 'NIH Image Manual' is the user's manual for the standard version of NIH Image. 'NIH Image Engineering' is a brief introduction to some of the technical aspects of imaging. 'Inside NIH Image' describes some of the structure of the standard Image program and discusses ways to modify it for custom applications. All of these documents apply to Scion Image as well. The final document, 'Mods to NIH Image' describes the extensions to the standard Image that are available in Scion Image and how to use them.

Using the LG-3

Introduction

Once the LG-3 circuit board has been installed, the supplied single source cable connected to the LG-3 and your camera, and the Scion Image archive copied to your hard disk and decompressed, you are ready to begin using your LG-3. This section will describe some of the capturing capabilities of the LG-3 and Scion Image – such as normal grayscale capturing, frame averaging, grabbing frame sequences, color capturing, and using the external trigger.

Once the Scion Image software has been started, by double clicking on the program icon, the Scion Image menus and windows will be presented. The commands that deal with the LG-3 and image capturing, such as basic grayscale capturing, frame averaging, capture of frame sequences, and color capturing, are contained in the 'Special' menu and the 'Stacks' menu.

Grayscale Capturing

When the 'Start Capturing' command, under the 'Special' menu, is selected, the program will continuously capture and display video frames. The display rate on all current Macintosh models is 30 frames per second. On some Macintoshes, it may be necessary to move the cursor out of the image window to achieve the maximum display rate. You may stop the continuous capture process at any time by either choosing the menu command again (which has changed to 'Stop Capturing') or by clicking in the 'Camera' window with any of the tools except the magnifying glass or the grabber. Once the capturing process has stopped, the captured frame is available for analysis or saving to disk.

The 'Video Control' dialog box, also under the 'Special' menu, allows you to change various parameters of capture. The 'Offset' and 'Gain' fields allow you to adjust the range of digitization of the LG-3's analog to digital converter. 'Use External Trigger' enables the LG-3's external trigger capability. 'Separate Sync' should be enabled when the LG-3 is connected to an RGB video source using the optional four source cable. It instructs the LG-3 to look for video sync information on the sync channel of the four source cable. The 'Channel' radio buttons select which of the LG-3's four video sources is to be digitized.

Frame Averaging

The 'Average Frames' command is useful for reducing random video noise. This command is also found under the 'Special' menu. The number of frames to average can be specified, though if more than 128 frames are specified, there is a possibility of overflow in the arithmetic buffer. Frames can also be integrated (summed) using this command with the results scaled to the range 0 to 255.

When the 'Video Rate' option is selected in the 'Average Frames' dialog box, the frames to average will all be captured to the LG-3's expandable frame buffer. This means that all the frames will be captured at video rates and then averaged after the capturing is complete. This feature is useful, for example, when the specimen being imaged can only be subjected to illumination for a short amount of time, or when the specimen is moving very slowly. When 'Video Rate' is enabled the software will limit the number of frames that may be averaged to the number that will fit into the LG-3's frame buffer memory.

The 'Integrate on-chip' allows the use of integrating cameras. The specified number of frames will be integrated on the imaging sensor of the camera and the resultant image will then be captured by the LG-3. Please contact Scion for a complete list of currently supported integrating cameras. Optional cables will be required for all integrating cameras, please contact Scion for the correct cables.

Sequence Capture

The 'Make Movie' command is found under the 'Stacks' menu. It is used for capturing sequences of frames. Before the command is invoked, a region of interest must be drawn in the 'Camera' window using the rectangular selection tool. When the command is invoked, a dialog box will appear. This box will request the number of frames in the sequence and the time interval between frames in the sequence. When both values have been specified, the software will instruct the LG-3 to capture the specified number of frames at the specified time interval. After the command has completed, the sequence will be presented on-screen as a stack of frames.

Color Capture

The 'Capture Color' command, under the 'Stacks' menu, will capture a three-pass 24 bit color image using the LG-3. To capture color, you must have the optional four source cable connected to an RGB video source and the 'Separate Sync' box checked in the 'Video Control' dialog box. When the command is selected the software will capture three separate frames using the LG-3. The first frame will be captured from the red video signal, the second frame from the green video signal, and the third frame from the blue video signal.

After the 'Capture Color' command has completed, there will be a three slice stack on the screen and an 8 bit indexed color image. This stack will contain the three color slices – red, green, and blue. The 8 bit indexed color image represents the captured 24 bit color image. The 8 bit color look-up table used to display the 8 bit indexed image may be selected using the 'RGB to 8-bit Color' command.

External Triggering

The LG-3 has an external trigger capability that allows the synchronization of frame capture to external events. The external trigger feature is enabled in the 'Video Control' dialog box as discussed above. When this feature is enabled, the LG-3 will wait for a trigger event on its external trigger input before capturing a frame. A trigger event is defined as a falling TTL edge (that is, a transition from 5 volts to 0 volts). The trigger input is pin 9 of the 9 pin video connector. Once the trigger event has occurred, this input must be brought back to 5 volts before another trigger event can be recognized.

Architectural Description

Overview

The hardware architecture of the LG-3 is designed to provide advanced features and maximum flexibility, combined with a simple programming interface. Such features include separate multiplexors for video information and for sync information, 8 bit digital to analog converters for controlling the range of digitization, eight input look-up tables, up to 128 individual frame buffers, and digital and analog I/O capabilities.

The programming interface of the LG-3 consists of seven Control Registers and one Status Register. The Control Registers, Status Register, and the frame buffers are available to the programmer at all times, even during digitization. Hence software can be transferring one frame from the LG-3 to system memory at the same time that a new frame is being digitized.

The sections that follow describe in detail the various components of the LG-3. These are the video and sync multiplexors, the analog to digital converter, the input look-up tables, the frame buffers, the Control and Status Registers, and the digital and analog I/O capabilities. The Programming Information section of this manual will present details of controlling the LG-3 and taking advantage of all the LG-3's features.

Video and Sync Multiplexors

The LG-3 accepts up to four video sources via its 9 pin D shell connector. The individual sources are terminated with 75 ohm resistors upon entering the board. After termination the video signals are routed to two separate four to one multiplexors. The first multiplexor determines which of the video signals will be digitized, while the second multiplexor determines from which of the video signals the necessary video sync information will be obtained. The source selections for digitization and sync are determined by bits in Control Register 3.

Allowing the sync information to be selected from any source provides for capturing flexibility using a simple standard cable assembly. Grayscale video can be captured from any source by selecting the same source for both digitizing and sync information. Color cameras can be connected to the LG-3 using either a separate sync or a sync on green format with the same cabling. Additionally, the LG-3 can be easily integrated into systems that are driven by one or more external sync signals.

Analog to Digital Converter

The selected video signal is next DC restored by clamping the video sync tips to 0 volts and amplified by a factor of three. The video signal is then fed into the analog to digital flash converter. The flash converter converts the incoming video signal into an 8 bit digital value. The analog to digital converter has two analog inputs – top of range and bottom of range – that specify the limits of digitization. If the incoming signal is greater than or equal to the top of range voltage, it will receive a digital value of 255; conversely, an input less than or equal to the bottom of range voltage will receive a digital value of 0.

The top of range and bottom of range voltages are set by two digital to analog converters. These converters have a resolution of 8 bits and are specified by Control Register 4 and

Control Register 5, respectively. Each range voltage can be set from 0 volts to 4 volts. The variability of the range of digitization of the analog to digital converter allows the LG-3 to be adjusted to differing input signals by changing the range voltages. For example, if the input signal is low, the range voltages can be lowered to brighten up the captured image. Similarly, if the video signal has poor contrast, the range voltages can be squeezed closer together to increase the contrast in the captured image. Thus control of the range of digitization provides an analog offset and gain capability.

Look-up Tables

Once the video signal is digitized, the digital data is immediately passed through an input look-up table. The look-up table affords an opportunity to perform some processing on the digitized image such as image inversion and histogram equalization. The look-up table consists of a memory array which maps each of the 256 possible pixel values to a new value (also one of 256).

The primary purpose of the look-up table is to invert the pixel values so as to make the incoming image compatible with the Macintosh. The video is digitized by the analog to digital converter with white receiving a digital value of 255 and black receiving a value of 0. The Macintosh, however, interprets grayscale values in the opposite manner with black as 255 and white as 0. Hence the look-up table inverts each pixel (subtracts it from 255) to convert it to the Macintosh representation.

There are eight look-up tables provided on the LG-3. Each may be read, written, and used for processing the incoming video. However, only one look-up table may be active at any one time. The active look-up table is selected by the lower bits of Control Register 1.

Frame Buffers

After the data has passed through the input look-up table it is stored in one of the LG-3's onboard frame buffers. The frame buffers are implemented as standard 30 pin Macintosh SIMM's. The standard LG-3 allows two full 640 x 480 (768 x 512 for CCIR) pixel frames to be stored per Mb of installed RAM. The LG-3 576 allows one full 768 x 576 CCIR pixel frame to be stored per Mb. Thus for the standard LG-3 each buffer uses 512 Kb of RAM and the LG-3 576 has a buffer size of 1024 Kb of RAM. The maximum SIMM size is 16 Mb for a total of 64 Mb. A standard LG-3 with the maximum amount of memory installed can hold 128 frames onboard, while the LG-3 576 can hold a maximum of 64 frames onboard.

For the standard LG-3 the individual frame buffers are configured as an array of 512 rows of 1024 bytes. As each line of video contains only 640 (768 for CCIR) pixels, each one byte, each row of the frame buffer will contain video data padded at the end with 384 (256) bytes of unused data. Similarly, the last 32 (0) rows of each frame buffer will be unused. The individual frame buffers of the LG-3 576 are configured as an array of 576 rows of 1024 bytes. As each line of video contains only 768 pixels, each one byte, each row of the frame buffer will contain video data padded at the end with 256 bytes of unused data. Similarly, the last 448 rows of each frame buffer will be unused.

The frame buffers can be addressed through one of two PCI addresses, corresponding to two separate base address registers in PCI configuration space. Address Space 0 contains a single logical frame buffer into which any of the physical frame buffers may be mapped. Control Register 2 determines which physical frame buffer will be accessed in Address Space 0. The same register also determines which buffer will be used to store a captured

frame. Address Space 1 contains all of the available frame buffers. It is recommended that all frame buffer operations take place through Address Space 1, as memory caching can be enabled for this space. Enabling caching to a PCI address space in a Power Macintosh will enable PCI burst transactions to that address space, speeding up all frame buffer operations.

Control and Status Registers

The LG-3 has seven Control Registers and one Status Register. As the names imply, the Control Registers set the parameters for frame capture while the Status Register reports the results of capture and also properties of the video signal. Each of the registers is eight bits wide. The Control Registers are write only; the Status Register is read only.

Control Register 1 controls the capture process. It contains bits for enabling capture, for setting which field is to be digitized first, for switching between field capture mode and frame capture mode, and for enabling the external trigger feature. This register also determines which of the eight input look-up tables is currently in use. Control Register 2 determines which of the LG-3 frame buffers is currently active (and can be accessed in Address Space 0). Control Register 3 specifies which of the video sources is to be digitized and which of the sources is to be used for sync information. It also sets the LG-3's four digital outputs.

Control Registers 4 through 7 set the four digital to analog converters on the LG-3. The DAC which determines the top of range voltage for digitization is set by Control Register 4. The DAC which determines the bottom of range voltage for digitization is set by Control Register 5. Control Registers 6 and 7 set the LG-3's analog output voltages.

The LG-3's Status Register contains a bit which reports when frame capture has been completed. It also contains two bits which represent timing characteristics of the video sync signal. One bit tells when the video signal is in a vertical sync period. The other bit reports whether the video signal is currently transmitting the even or odd video field.

Digital and Analog I/O

The LG-3 provides facilities for monitoring and controlling external events through its digital and analog I/O capabilities. It has four digital inputs, four digital outputs, and two analog outputs. As discussed above, the digital output lines are accessed through Control Register 3 and the digital input lines are accessed through the Status Register. The analog outputs are accessed through Control Registers 6 and 7.

The digital inputs and outputs are TTL compatible. The analog outputs have a range of 0 to five volts with 256 steps. The digital and analog I/O signals connect via the LG-3's 15 pin high density D shell connector.

Programming Information

Introduction

The LG-3 is designed to be easy to program. This section sets forth the details of the LG-3's programming interface and hardware interfacing - it's name registry classification, address spaces, register descriptions, and I/O connections. The material presented here should be sufficient to enable an experienced Macintosh programmer to utilize the LG-3 in a custom application.

Programming the LG-3 to capture a video frame is essentially a 7 step process:

- 1) Find the LG-3 using the supplied library routine
- 2) Load the input look-up table
- 3) Set the top and bottom voltages for the digitization range
- 4) Set the Grab bit in Control Register 1
- 5) Wait for the Done bit in the Status Register to come on
- 6) Clear Grab bit
- 7) Read out the video data from the frame buffer

Note that for simple applications, it is not necessary to set all parameters, such as selecting the video and sync channels, the look-up table, and the frame buffer, as the Control Registers all default to zero on power-up.

For those who need additional guidance in programming with the LG-3, the supplied source code for the Scion Image application software provides a wealth of example code for controlling the LG-3. The source code is written in Pascal using Metrowerks Code Warrior development environment. Below is a short list of instructive functions and the files they reside in:

LookForFrameGrabbers:	Init.p
SetupFGPort:	Init.p
ResetScionLG3:	Utilities.p
GetFrame:	Camera.p
CaptureAndDisplayFrame:	Camera.p

There are other routines in these files that perform more specialized functions with the LG-3; a few hours examining the code should prove helpful in learning how to program the LG-3.

On the diskette is a C library, ScionLib, which contains a routine that will find the LG-3 in a PCI Macintosh, and return the base addresses for the two address spaces, as well as the number of frame buffers installed on the LG-3. The routine has the form

LookForPCIFrameGrabbers(short model, long* base0, long* base1, long* buffers).

The routine should be passed 1 as a model parameter (this specifies searching for an LG-3), and will pass the base address for the two address spaces and the number of buffers in the other parameters. The routine will return true if a board is found, false otherwise. The routine also enables memory space accesses to the LG-3 and enables memory caching to Address Space 1.

Name Registry Classification

Upon startup a PCI Power Macintosh will create a Name Registry entry for the LG-3. This entry will have a name property value of 'pci11ff,1'. The LG-3 can be located in the Macintosh by searching for a registry entry with this name property. However, this information is not necessary to work with the LG-3 as the library routine discussed above will take care of locating the board.

Address Spaces

Let us denote the base addresses for the address spaces base0 and base1. Address Space 1 of the LG-3 contains the frame buffers, while Address space 0 contains an alias of the selected frame buffer, the selected input look-up table, the Control Registers, and the Status Register.

The frame buffers are arrayed in Address Space 1 at 512 Kb intervals. If 256 Kb SIMM's are installed, there will be 2 frame buffers at

base1
base1 + \$80000.

If 1 MB SIMM's are used, then there will be 8 frame buffers at the following locations:

base1
base1 + \$80000
base1 + \$100000
base1 + \$180000
base1 + \$200000
base1 + \$280000
base1 + \$300000
base1 + \$380000.

The case for 4 MB and 16 MB SIMM's is similar except that there will be 32 and 128 frame buffers respectively. When a frame is captured into one of the frame buffers, it is stored as a pixel map with a row length of 1024 bytes. There is an alias of the selected frame buffer (determined by Control Register 2) at address base0.

The selected input look-up table (determined by Control Register 1) appears at address base0 + \$80000. The LUT uses only byte lane 0, hence the 256 bytes of the look-up table are addressed at

base0 + 80000
base0 + 80004
base0 + 80008
.
.
.
base0 + 8003fc.

The lowest address corresponds to the lowest digitization value; i. e. address base0 + 80000 maps \$00 (black) pixels, while base0 + 8003fc maps \$ff (white) pixels.

The Control Registers are eight bit wide write-only registers at the following addresses:

CR1: base0 + c0000
CR2: base0 + c0004
CR3: base0 + c0008
CR4: base0 + c000c
CR5: base0 + c0010
CR6: base0 + c0014
CR7: base0 + c0018

The Status Register is an eight bit wide read-only register located at address base0 + c0000.

Control and Status Registers

The format of Control Register 1, from most significant bit to least significant bit, is as follows:

CR1_7: Grab Enable
CR1_6: Single Field Select
CR1_5: Starting Field Select
CR1_4: Trigger Enable
CR1_3: Open Drain Output
CR1_2: LUT Select MSB
CR1_1: LUT Select
CR1_0: LUT Select LSB.

When Grab Enable is set, the LG-3 will capture the next incoming video frame. Note that this bit must be reset by software before any additional frames can be captured. It acts as a trigger for a single frame capture. Capture begins at the trailing edge of vertical sync. When Starting Field Select is set, frame capture will begin with the odd field; when it is clear, frame capture will begin with the even field. When Single Field Select is set, only one field will be captured — that specified by the Starting Field Select bit. Single fields are captured into the frame buffers as if they were a component of an entire frame; that is, they will load into every other line of the buffer leaving the remaining lines unaltered. When Trigger Enable is set, the LG-3 will wait for a trigger event on the external trigger pin of the video connector before capturing a frame. A trigger event is defined as a falling TTL edge. The Open Drain Output is available for custom use. The LUT Select bits determine which of the look-up tables to use for reading, writing, and frame capture.

The format of Control Register 2, from most significant bit to least significant bit, is as follows:

CR2_7:
CR2_6: Frame Buffer Select MSB
CR2_5: Frame Buffer Select
CR2_4: Frame Buffer Select
CR2_3: Frame Buffer Select
CR2_2: Frame Buffer Select
CR2_1: Frame Buffer Select
CR2_0: Frame Buffer Select LSB.

This register has two purposes: it determines which frame buffer a frame will be captured into, and it determines which frame buffer will be aliased into Address Space 0. Hence a

frame that has just been captured will always be aliased into Address Space 0. Lower values in this register correspond to lower frame buffer addresses.

The format of Control Register 3, from most significant bit to least significant bit, is as follows:

CR3_7:	Sync Select MSB
CR3_6:	Sync Select LSB
CR3_5:	Source Select MSB
CR3_4:	Source Select LSB
CR3_3:	Data Output Bit 3
CR3_2:	Data Output Bit 2
CR3_1:	Data Output Bit 1
CR3_0:	Data Output Bit 0.

The Source Select bits determine which of the four video sources will be selected for capturing, while the Sync Select bits determine which of the four video sources will be used for sync information. In most cases the same source will be selected for both fields. The four data output bits are available for custom use.

Control Registers 4 through 7 control the four digital to analog converters on the board. They accept an integer in the range 0 to 255. The functions of each converter and its voltage range are as follows:

CR4:	Top of Digitization:	0 to 4 volts
CR5:	Bottom of Digitization:	0 to 4 volts
CR6:	Analog Output A	0 to 5 volts
CR7:	Analog Output B	0 to 5 volts.

In each case the lower voltage corresponds to register value \$00, while the higher voltage corresponds to register value \$ff. When setting the digitization range, note that the sync tips of the incoming video are clamped to 0 volts. Also, for proper operation, the top of digitization voltage must be higher than the bottom of digitization voltage. The two analog outputs are available for custom use.

The format of the Status Register, from most significant bit to least significant bit, is as follows:

SR_7:	Grab Done
SR_6:	50 Hz
SR_5:	Vertical Sync
SR_4:	Field Status
SR_3:	Data Input Bit 3
SR_2:	Data Input Bit 2
SR_1:	Data Input Bit 1
SR_0:	Data Input Bit 0.

The Grab Done bit indicates that a capture has been completed. This bit will be cleared when the Grab Enable bit in Control Register 1 is reset. The 50 Hz bit indicates that the LG-3 is a 50 Hz board, compatible with CCIR video. If this bit is cleared, then the board is intended for 60 Hz RS-170 video. The Vertical Sync bit will be clear during the vertical sync period of the selected video sync source and set otherwise. The Field Status bit will be set during the odd field of the selected video sync source and clear during the even field. The data output bits are available for custom use.

Connector Pin Assignments

There are two external connectors on the LG-3: a 9 pin video connector and a high density 15 pin utility connector. The pin-out of the video connector is as follows:

Pin 1:	Video Source 3
Pin 2:	Open Drain Output
Pin 3:	Video Source 2
Pin 4:	
Pin 5:	Video Source 1
Pin 6:	
Pin 7:	Video Source 0
Pin 8:	Ground
Pin 9:	External Trigger.

The pin-out of the utility connector is

Pin 1:	Data Output Bit 3
Pin 2:	Data Output Bit 2
Pin 3:	Data Output Bit 1
Pin 4:	Data Output Bit 0
Pin 5:	Vertical Sync
Pin 6:	Field Status
Pin 7:	Analog Output A
Pin 8:	Analog Output B
Pin 9:	+5 V
Pin 10:	Ground
Pin 11:	Open Drain Output
Pin 12:	Data Input Bit 0
Pin 13:	Data Input Bit 1
Pin 14:	Data Input Bit 2
Pin 15:	Data Input Bit 3.

Questions and Answers

Q: Why do I see a cross-hatched interference pattern in the captured image?

A: You are probably trying to capture images from a color (NTSC or PAL) camera. The LG-3 is designed to capture images from an RS-170 (or CCIR) video source. RS-170 (CCIR) is grayscale video. Color video has color information modulated on the grayscale portion of the video signal. This color information causes the distortion pattern in the captured image.

Q: I am trying to do a color capture in Image. I have an RGB camera connected to the LG-3 with the four source cable, but I seem to be having difficulty getting the LG-3 to sync to the camera. What could be causing this?

A: You need to have the 'Separate Sync' box selected in the 'Video Control' dialog box. This dialog box is found under the 'Special' menu. Separate sync tells the LG-3 to look for sync information on the sync signal of the four source cable.

Q: When I try to capture a sequence of frames at video rate with Scion's modified version of Image, the software tells me that the sequence is actually captured at a slower rate. Why can't I capture in real-time?

A: If your Macintosh is busy with some background task when you try to acquire a sequence of frames, it may not be able to capture real-time. Situations that may slow sequence acquisition include network activity such as AppleShare. Try turning off such background tasks while you are capturing sequences.

Q: How can I capture grayscale images from an RGB camera?

A: There are two methods for capturing grayscale images from an RGB camera. The first is to simply capture from the green signal (source 2 in the 'Video Control' dialog box). The green signal contains the majority of the grayscale information of a color image. The second method is use Image's 'Capture Color' command. After the three color slices are captured, choose the 'RGB to 8 bit Color' command with the existing palette option selected. If you were currently working with a grayscale look-up table, then the resulting image will be the correct grayscale image.

Optional Cables

The LG-3 comes with a Cab-SS-LG3 single source cable suitable for connecting to a grayscale video camera. A number of additional cables are available for connecting to other sorts of cameras and devices:

Cab-RGB-LG3 – This cable, terminated in four BNC connectors, can be used to connect the LG-3 to four separate grayscale video sources. It may also be used to connect to RGB video sources with separate connections for red, green, blue, and sync.

Cab-SVHS-Adp – This adapts any BNC terminated cable to an SVHS connector.

Cab-SST-LG3 – This cable is similar to the supplied single source cable but, in addition, has a BNC connector for the LG-3's external trigger input.

Cab-Int-LG3 – This cable connects the LG-3 to the integration input of the Dage CCD-72 camera.

Cab-Cohu-Adp – This adapts the Dage integration cable for Cohu 491X cameras.

Optional cables are available direct from Scion. We can also manufacture custom cables for use with video sources with non-standard connectors.

Software Support

AxoVideo

AxoVideo is a program for video microscopy that automates both the acquisition and processing of time-lapse images. Acquisition methods include averaging, specifying regions-of-interest (ROI), "zones" that quantify average intensities of ROI's, and a line scan "composite-time image" for fast changing intensities. Dual-image acquisition operations are available with foreground/background control for subtraction, merging and ratioing of images. There are many filtering convolutions, as well as pseudo-coloring, directional measurements and annotations. Macro recording is built-in. AxoVideo includes hardware device support for frame grabbers, such as the Scion LG-3, stage controllers, shutter controllers and a filter wheel. AxoVideo runs on the Apple Macintosh II and Quadra computers.

Axon Instruments, Inc.
1101 Chess Dr.
Foster City, CA 94404
(415) 571-9400.

Image Analyst

Image Analyst is a menu-driven image processing and analysis package that runs on the Macintosh II family of computers. This intuitive interface allows you to quickly apply the latest image processing algorithms without the complexities of traditional programming. It is designed to process both live video and stored image files, and to extract quantitative data. Image Analyst comes with an extensive set of interactive image examination tools, image processing routines, and powerful image analysis options. Image processing capabilities include user-configurable linear and non-linear filters, intensity scaling, pseudo color, and mathematical morphology. Image analysis options include pixel counting, connectivity analysis, grayscale analysis, edge detection, Hough transforms, normalized correlation, dimensional measurements, and statistics. Collections of image processing and analysis operations on multiple regions of interest can be saved and executed as user-defined sequences.

Automatix, Inc.
755 Middlesex Turnpike
Billerica, MA 01821
(508) 667-7900

IPLab Spectrum-LG-3

IPLab Spectrum-LG-3 software provides scientific imaging, visualization, analysis, image acquisition and laboratory automation in a single package. This version of IPLab controls all features of Scion's LG-3 frame grabber. Users can do real time image sequence acquisition and frame averaging, and control external devices through the digital I/O and analog outputs on the board, all coordinated with image capture. Applications include microscopy, low-light imaging, bio-medicine, and others. Signal Analytics provides specific solutions based on this board for low-cost fluorescence imaging applications, including ion ratio imaging and fluorescence in situ hybridization. With IPLab you can: automatically analyze particles; perform FFTs, image enhancement, densitometry and

morphometry; acquire, deconvolve, and display 3-D serial sections; control lab equipment such as motorized stages and filter wheels. You can also use IPLab as a development environment for new algorithms by adding your own code written in C or Pascal. Custom software development is also available from Signal Analytics.

Signal Analytics Corporation
440 Maple Ave. East
Suite 201
Vienna, VA 22180
(703) 281-3277

NIH Image

NIH Image is a public domain image processing and analysis program for the Macintosh. It can acquire, display, edit, enhance, analyze, print, and animate images. It reads and writes TIFF, PICT, PICS, and MacPaint files, providing compatibility with many other applications, including programs for scanning, processing, editing, publishing, and analyzing images. It supports many standard image processing functions, including contrast enhancement, density profiling, smoothing, sharpening, edge detection, median filtering, and spatial convolution with user defined kernels up to 63x63. NIH Image also incorporates a Pascal-like macro programming language, providing the ability to automate complex, and frequently repetitive, processing tasks.

National Technical Information Service
5382 Port Royal Rd.
Springfield, VA 22161
(703) 487-4650

Ultimage

Ultimage is a powerful image processing and analysis tool that takes full advantage of the graphic capabilities and user interface of the Macintosh II. It offers a complete library of image processing functions that can be used for a large variety of applications. The program can process images acquired from scanners, cameras, microscopes, and other acquisition systems. Several images of different formats can be displayed and manipulated simultaneously, using either the 256 gray levels or the color capabilities of the Macintosh. The main features of Ultimage include image enhancement, thresholding, zooming, contour detection, histogram manipulation, palette modification, 3D display, and arithmetic and logic operations. A set of advanced functions is also available for scientific and professional image processing such as morphology analysis, pattern recognition and classification, frequency domain analysis, and linear and non-linear filtering.

GTFS, Inc. (West Coast)
2455 Bennet Valley Rd. #100C
Santa Rosa, CA 95404
(707) 579-1733

Engineering Technology Center (East Coast)
240 Oral School Rd. Suite 105
Mystic, CT 06355
(800) 959-3011

Concept VI

Concept VI is a package of libraries compatible with the LabVIEW graphical programming and instrumentation software from National Instruments. Each library includes various groups of functions ranging from image display utilities and fundamental image processing to advanced quantitative analysis. These libraries include time-lapsed and triggered image acquisition, automatic image indexation, filing and archiving, basic densitometry analysis, automated image processing, object identification and measurement, feature-based labeling, data collection, and statistical and frequency domain analysis.

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(707) 579-1733

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(800) 959-3011

Video VI

The Video VI package supports video data acquisition and image manipulation in the LabVIEW environment for the Macintosh. LabVIEW is the graphic and object oriented instrumentation software from National Instruments. The Video VI package is a cost effective alternative for building systems that require image acquisition, analysis, and documentation in process control environments. There are currently over 20 VI's (Virtual Instruments) in the Video VI package. These include VI's for capturing images with the Scion LG-3, reading and writing TIFF files, displaying images, moving and scaling images, and thresholding.

GTFS, Inc.
2455 Bennet Valley Rd. #100C
Santa Rosa, CA 95404
(707) 579-1733

Specifications

Imaging

Digitizing Speed: 1/30 (1/25) second
Pixel Depth: 8 bits
Image Resolution: 640 x 480 (768 x 512 or 768 x 576) pixels
Pixel Aspect Ratio: 1 to 1

Capturing

Capture Mode: field or frame
Initial Field: even or odd

Memory

Frame Buffer: 1 to 64 Mb
Input Look-up Tables: 8

Video Inputs

Video Input Level: 1 volt peak to peak
Video Signal Type: RS-170 (CCIR) or similar
Input Sources: 4, AC coupled
Video Gain Factor: 3
Digitizing Range, Bottom: 0 to 4 volts
Digitizing Range, Top: 0 to 4 volts

I/O

Digital Inputs: 4 TTL level
Digital Outputs: 4 TTL level
Analog Outputs: 2, 0 to 5 volts

Connectors

Video Connector: 9 pin D shell
Utility Connector: 15 pin HD D shell

General

Installation: 1 PCI slot (full size)
Operating Conditions : 0 to 70° C
Power: 15 watts maximum

Warranty and Support

Limited Warranty

Scion Corporation ("Scion") warrants this LG-3 against defects in materials and workmanship for a period of one (1) year from the date of original purchase. If you discover a defect, Scion will, at its option, repair, replace, or refund the purchase price of this LG-3 to you, provided you return it during the warranty period, with transportation charges prepaid, to Scion. Each LG-3 returned for warranty service must bear a Return Materials Authorization number, which may be obtained from Scion, on the outside of the shipping box.

This warranty does not apply if the product has been damaged by accident, misuse, or misapplication; if the product has been modified without the written permission of Scion; or if the LG-3 serial number has been removed or defaced.

THE WARRANTY AND REMEDIES SET FORTH ABOVE ARE EXCLUSIVE AND IN LIEU OF ALL OTHERS, WHETHER ORAL OR WRITTEN, EXPRESS OR IMPLIED. SCION SPECIFICALLY DISCLAIMS ANY AND ALL IMPLIED WARRANTIES, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. NO SCION DEALER, AGENT, OR EMPLOYEE IS AUTHORIZED TO MAKE ANY MODIFICATION, EXTENSION, OR ADDITION TO THIS WARRANTY.

Scion is not responsible for special, incidental, or consequential damages resulting from any breach of warranty, or under any other legal theory, including but not limited to lost profits, downtime, goodwill, and damage to or replacement of equipment and property.

Some states do not allow the exclusion or limitation of incidental or consequential damages or exclusions of implied warranties, so the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights, and you may also have other rights that vary from state to state.

Money-Back Guarantee

You may return your LG-3 to Scion Corporation, within 30 days of the date of invoice, for a full refund of the purchase price. All returns must be in as new condition and be returned with all supplied accessories in the original shipping box. All returns must bear a Return Materials Authorization number, which may be obtained from Scion, on the outside of the shipping box.

If payment has already been made at the time you return your LG-3, a cash refund will be made within 30 days of Scion's receipt of the LG-3. If payment has not been made at the time Scion receives your LG-3, a credit memo will be issued against the outstanding invoice within 15 days of Scion's receipt of the LG-3.

Service Information

Should you determine that your LG-3 requires service, it should be returned directly to Scion Corporation for repair. Before returning your LG-3, call Scion for a Return Materials Authorization number. This number should be printed on the outside of the

shipping carton. Carefully pack the LG-3 in its original shipping materials and include a short note describing the problem. You are responsible for all shipping costs to Scion and for insuring the returned unit. Scion will commit its best efforts to repairing your unit within 5 days of receipt of the unit at our factory.

If your LG-3 is under warranty, it will be repaired or replaced at no charge. Scion will pay for shipping your LG-3 back to you by ground transportation. You may, at your cost, request faster transportation. If your LG-3 is not under warranty, there will be a minimum repair charge of \$150. If the repair cost is greater than \$150, you will be called to approve the necessary work. You must provide, in advance, appropriate payment information (e.g., approved purchase order, credit card number) for non-warranty repair work.