

Alpha Uncooled Microbolometer Camera



User's Guide
Version 1.40
412-0003-10

TABLE OF CONTENTS

1	INTRODUCTION.....	5
2	ALPHA SPECIFICATIONS.....	5
3	UNPACKING YOUR ALPHA CAMERA.....	6
4	OPTIONAL FEATURES AND ACCESSORIES.....	6
5	BASIC OPERATION.....	7
6	ELECTRICAL INTERFACE.....	8
6.1	POWER INPUT.....	8
6.2	VIDEO OUTPUT.....	8
6.3	AUXILIARY I/O CONNECTOR.....	8
7	REMOTE CAMERA CONTROL.....	9
7.1	INSTALLATION OF ALPHA CONTROL PANEL SOFTWARE.....	9
7.2	CONNECTING THE ALPHA TO A COMPUTER.....	10
7.3	PALM PILOT OPERATION.....	10
7.4	OPERATION OF THE ALPHA CONTROL PANEL (GRAPHICAL USER INTERFACE) ON A PC.....	10
7.5	CONTROL PANEL FEATURES.....	11
7.5.1	<i>NUC</i>	11
7.5.2	<i>Video Display</i>	11
7.5.3	<i>Digital Output</i>	14
7.5.4	<i>Diagnostics</i>	14
8	ALPHA SYSTEMS INTEGRATION AND INTERFACING.....	14
8.1	CAMERA POWER DISSIPATION.....	15
8.2	AUXILIARY I/O CONNECTOR.....	15
8.3	VIDEO OUTPUT.....	15
8.4	POWER INPUT.....	16
8.5	REAL-TIME DIGITAL DATA OUTPUT.....	16
8.6	DATA SYNCHRONIZATION.....	16
8.7	DIGITAL DATA FORMAT.....	16
8.8	TELEMETRY DATA.....	16
8.9	FPA DATA.....	17
8.10	SERIAL COMMUNICATIONS.....	17
9	ELECTRICAL INTERFACE.....	23
9.1	CAMERA POWER CONNECTOR.....	23
9.2	CAMERA VIDEO CONNECTOR.....	23
9.3	AUXILIARY I/O CONNECTOR.....	24
10	OPTO-MECHANICAL INTERFACE.....	24



APPENDIX A ALPHA DIGITAL INTERFACE (ADI)..... 28
APPENDIX B INTELLIGENT ACCESSORY SHOE (HOT SHOE)..... 35

 **Cautions and Warnings:**

- Do not image very high intensity radiation sources, such as the sun, carbon dioxide lasers, arc welders, etc.
- The camera is not sealed, so avoid dust and moisture exposure, and replace lens cap when not in use.
- Do not exceed 30 volts DC input power, or reverse the polarity of input power.
- Do not apply DC input power to both the DC input and the Auxiliary I/O connector simultaneously.
- The battery pack accessory is uncharged. Charge for 6 hours prior to use.
- This is a precision optical instrument, and should be protected from shock and vibration. Keep the camera stored in the manufacturer's shipping container.
- This camera contains static-sensitive electronics and should be handled appropriately.
- Do not open the camera body, as doing so will void the warranty.
- Do not insert any objects inside the lens housing, as the calibration flag and/or lens can be damaged.
- If you have questions that are not covered in this manual, or need service, contact Customer Support at 805-964-9797 for additional information (prior to returning cameras).

1 INTRODUCTION

ALPHA is a long-wavelength (7.5 – 13.5 microns) uncooled microbolometer camera designed for applications that demand absolute minimum size, weight, and power consumption. A germanium single-element, 11mm focal length lens (40° x 30° field of view) is provided with ALPHA (unless otherwise specified). The camera may be operated by remote control through a serial command interface. ALPHA provides analog RS-170A or CCIR as a factory configured option, and real-time 12-bit corrected digital video. Images generated by the camera are displayed at 30 frames per second (25 FPS in CCIR). Lens options are available.

This manual is organized in increasing levels of detail to provide information for all levels of user. The first level is for the user who wants to use the analog video output only and leaves the camera in its factory default settings. The next level is intended for the system integrator who wants to control the camera functions through the Graphical User Interface (GUI) or with commands sent through the RS-232 interface. The last level is for the OEM user who desires control of the camera functions in addition to the raw digital image data.

2 ALPHA SPECIFICATIONS

- 160 (H) x 128 (V) uncooled microbolometer sensor array, 51 x 51 micron pixels
- Optical Fill Factor: 65%
- 40° horizontal FOV, 11 mm focal length lens, f/1.6 aperture
- Thermoelectric sensor stabilization
- Input power range: 5.0–30 VDC
- Power Consumption: 1.5 Watts RMS nominal at room temperature (2.5 W RMS nominal at temperature limits) [1]
- Operating Temperature Range: 0° C to 55° C conduction, 0° C to 49° C still air
- Humidity: 95% non-condensing
- Dimensions: 1.7" H x 1.7" W x 4.3" L (including 40° lens)
- Weight: < 200 grams
- Analog video outputs: RS-170A (CCIR optional)
- Digital video output: Proprietary real-time, 12-Bit, pixel replaced, normalized, nibble serialized
- Remote interface: Proprietary serial command interface

[1] For peak power, add power in Watts equal to 0.5 Amps multiplied by the input supply voltage when shutter closes. This extra power is consumed for a 0.5 second duration.

Note: These specifications are subject to change without notice.

3 UNPACKING YOUR ALPHA CAMERA

For end user customers (not OEM customers), the following items come standard in your Alpha Camera package:

1. 110/220V AC/DC converter with Cable
2. RCA Video Cable
3. Lens Cap
4. Tripod Adapter
5. Serial Cable: Camera to PC Serial Port
6. Software (PC)
7. Carrying/Transport case
8. User's Guide
9. Packing List/Contract Terms Sheet

If there is any discrepancy between the above list and the contents of your camera package, please contact Indigo Systems Customer Support immediately.

4 OPTIONAL FEATURES AND ACCESSORIES


- CCIR video format factory configured
- 11° V x 15° H Lens [2]
- 20° V x 25° H lens [2]
- Alpha Digital Interface (ADI) Unit
- Alpha ThermoCordeR™ interface (Hot-shoe)
- Battery Pack (Note: battery is sent uncharged. Charge for 6 hours prior to use.)
- Self-Contained Button Panel (Palm Pilot) with cable and adapter

[2] Lenses must be ordered with the camera and are not interchangeable.

5 BASIC OPERATION

Note: If you are using the Alpha Digital Interface (ADI) with your Alpha camera, please see the ADI Manual Appendix A for setup instructions.

1. Attach the tripod adapter plate to the bottom of your Alpha™ camera using the hardware provided if you intend to mount the camera on a tripod.
2. Remove the lens cap, and be sure to replace when the camera is not in use to prevent lens contamination by dust and other materials.
3. Connect the **VIDEO OUT** port on the back of your camera to an unterminated monitor input using the RCA-RCA cable provided. The Alpha will not work with a terminated monitor. See Figure 1 below.
4. Connect the power supply provided to the **DC POWER** input connector on the back of the camera.

 *Note: The voltage range is 5.0-30 VDC. The center pin of the power input connector is positive. If you apply a voltage exceeding 30 volts, or you reverse the polarity of the input power to your Alpha™ camera, you will cause damage requiring factory service.*

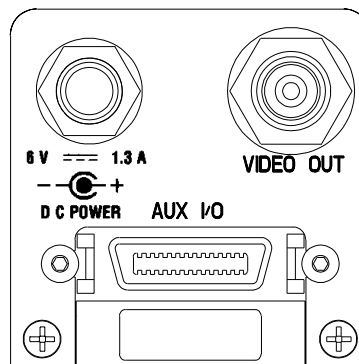


Figure 1. Alpha Back Panel

5. The camera will produce a startup screen immediately upon application of power.
6. The camera will take ~15 seconds to produce an image after power up, as the sensor achieves temperature stability (at which point the startup screen will disappear). The start time is a function of ambient temperature, and increases for temperatures above or below 25 C.
7. The camera will automatically perform a 1-point correction at periodic intervals or whenever the camera case temperature changes by 0.5 degrees C. During this time the image will be frozen for less than 1 second. This feature can be disabled via the command interface. A one-point correction can be initiated at any time through the command interface.

8. The AGC (Automatic Gain Control) is always enabled, and will adjust the image brightness and contrast automatically.

6 ELECTRICAL INTERFACE

The Alpha camera is provided with standard connectors for video output and power input, but all camera inputs and outputs are additionally routed through the AUX I/O connector. However, care should be taken to use one or the other connector for power input to the camera, not both simultaneously. Damage to the camera can result if DC power is applied through both connectors.

6.1 Power Input

The Alpha camera is provided with a “power mouse” transformer that converts 110 VAC or 220 VAC to 6 VDC for the input power. If you prefer to provide your own power supply for the camera (a battery pack, for example), please follow the guidelines in Section 9.1.

6.2 Video Output

The video output of the Alpha camera is factory configured for either RS-170A or CCIR video formats. The camera video output connector is a standard RCA type jack. The center pin is the video output and the sleeve is the video return. The video output of the Alpha camera is factory configured for either RS-170A or CCIR video formats. The load should be unterminated (high impedance input).

Note: For best camera performance, do not connect the video return to either the power return or the digital return when using the Aux I/O connector.

6.3 Auxiliary I/O Connector

The camera Auxiliary I/O connector (shown in Figure 2 with a mating cable) contains input power, video output, serial communications, digital data and data synchronization outputs. A number of digital grounds are included as return paths for each digital input/output. The digital grounds should be connected together at the receiver, however, for best noise performance, the digital grounds should be isolated from the input power return (IOPWRRTN) and video return. See Section 8.2 for the Alpha camera Auxiliary I/O connector pinout. Some users may wish to use this connector exclusively, since every camera function and input/output is routed through it, eliminating the need for multiple connectors.

 *Note: Do not apply power to the DC input connector and the Auxiliary I/O connector simultaneously.*



Figure 2. Alpha Camera with Auxiliary I/O Cable

7 REMOTE CAMERA CONTROL

Note: The camera will always go to the default settings when powered up, thus any changes to the camera settings are lost when the camera is power-cycled.

The Alpha is designed to be controllable through an RS-232 serial interface. A PC-based application is provided that enables the user to change parameters of the camera through a graphical user interface called the Alpha Control Panel. This application can be run on any Windows 95, 98 or NT-based computer. Additionally, a remote button panel accessory based on the Palm Pilot is available as an option. The Palm Pilot comes with the Alpha Control Panel software installed, and enables the user to easily control the camera in field applications.

More advanced users can send ASCII commands to the camera from a terminal emulator program such as HyperTerminal, or write their own software to transmit ASCII commands. Currently the Alpha camera is not designed to transmit data out of the serial command port.

The procedure for controlling the camera with a PC is as follows:

1. Install Alpha PC Control Panel software on the host computer.
2. Connect the cable between the PC serial port and the camera.
3. Run the Alpha software and control the camera.

7.1 Installation of Alpha Control Panel Software

The following procedure should be followed for installing the Alpha Control Panel Software.

- Insert the CD marked *Alpha Control Panel Install Disk* into your CD-ROM drive, and run the .exe program. You can do this by browsing to the CD-ROM using Windows Explorer, or on your Windows start menu, select “Run” and then either type in “D:\setup.exe”, or use the browse button to select and execute this file.

- The installation program will present instructions for installing the application to your hard drive. By default, the setup wizard will install the application in the directory **C:\ProgramFiles\Alpha**, and the shortcut to the application will go into the program group **Indigo**.

7.2 Connecting the Alpha to a Computer

Attach the serial data cable that is included with your Alpha camera to the Aux I/O connector on the back of the camera, as shown in Figure 3. Attach the other end (the one with the 9 pin connector) to an unused serial port on the back of your computer. These ports are usually labeled COM1 and COM2. Serial communication to the camera is accomplished using a RS-232 command protocol. The receive channel on the Alpha camera will accept normal RS-232 signal levels. The com port setting should be 9600 Baud, no parity, 8 data bits and 1 stop bit.

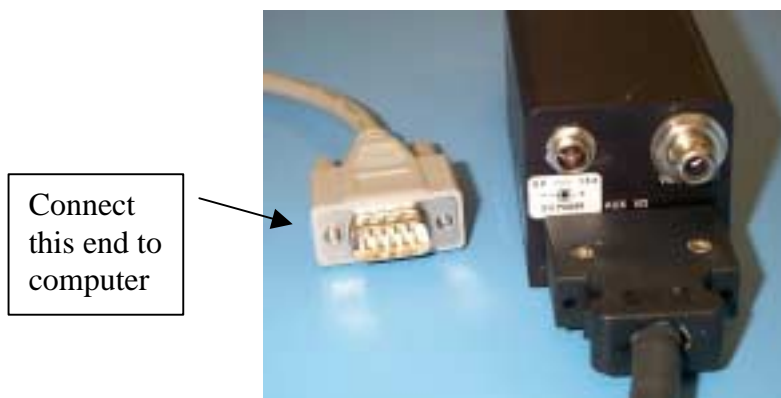


Figure 3. Alpha Camera with Serial Cable Attached

7.3 Palm Pilot Operation

The Palm Pilot accessory is a small palmtop computer, which can be used as a button panel interface for applications that require a camera controller of minimal weight and size. To use the Palm Pilot for camera control, you must connect it to your Alpha camera using the cable and adapter included with the Palm Pilot. The Palm Pilot comes with a Quick Start card. Follow the instructions contained on that card to install the batteries and bring up the “desktop” screen of the Pilot. Under the Start menu, go to Programs, and then select Alpha Control Panel. The Control Panel is then operated in the same way as through the PC-based control panel, except that the buttons are activated with a stylus that is included with the Palm Pilot. Follow the instructions in the following sections to control your Alpha camera.

7.4 Operation of the Alpha Control Panel (Graphical User Interface) on a PC

After you have installed your Alpha Control Panel software, start the software by double-clicking on the Alpha icon. The following window (shown in Figure 4) will appear on your screen, prompting you to select a COM port for the Alpha. In this particular case, COM2 is the only port available, as the others are in use (that is why they appear “grayed out”). To select the port, click on the “radio button” and then hit return, or press OK.

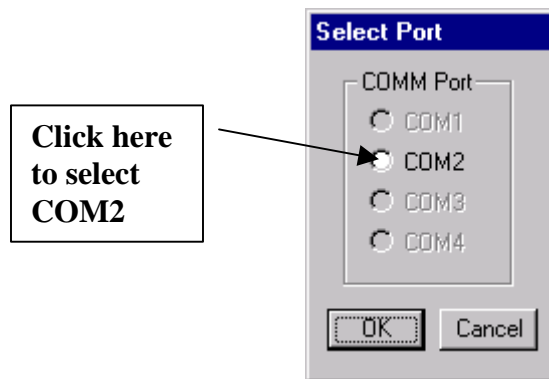


Figure 4. Com Window

You should see the Control Panel window appear. The control panel has two menu options and three tabs. The menus are File and Options. The File menu contains one item, Exit, which exits you from the Control Panel application. This can also be accomplished with the command Ctrl+X. The Options menu contains the Com Port command, which brings up the Com port selection screen (Ctrl+C also does this), and an *About* command, which tells you the version of the Control Panel software you are running (Ctrl+A).

7.5 Control Panel Features

7.5.1 NUC

The **NUC** display box is on the right side of the control panel, shown in Figures 5 and 6. It contains two controls for the NUC, or Non-Uniformity Correction, which is required to correct for differences between detector elements in a microbolometer array. The **FFC** (Flat-Field Correction) button manually initiates a flat-field correction (also known as a 1-point correction). When the user presses this button, a small calibration flag moves into position over the lens and presents a field of uniform temperature to the detector elements. The camera then calculates offset coefficients for each detector on the assumption that each pixel is being illuminated with exactly the same amount of IR energy by the flag. This flat-field correction will also take place automatically whenever the camera temperature changes by 0.5 degrees C, or every two minutes. When the FFC correction is taking place, the video image is frozen on the monitor for less than 1 second. The **Auto FFC** checkbox allows the camera to automatically perform a flat-field correction when the button is selected. In situations where the video image cannot be allowed to freeze for even a fraction of a second, deselecting the Auto FFC button can disable this feature. The box is checked by default (upon power up).

7.5.2 Video Display

The **Video Display** box controls the analog video output from the camera. There are two options for the brightness and contrast control type. The default option is a histogram automatic gain control (AGC), indicated by the word "**Histogram**" in the pull-down menu in the upper right

corner of the video display box. This window is shown in Figure 5. There is a slider in the upper left part of the Video Display box that controls the gain for the AGC. It is adjustable from 0 to 255. The value is displayed in the **AGC** gain entry box below the slider, and can also be manually entered. The top pull-down menu in the upper right part of the Video Display box also has a “**Manual**” option. This option allows the user to manually set the brightness and contrast of the video display. This is very useful if these values need to be fixed at specific levels in order to bring out a specific feature in the scene being imaged. The window shown in Figure 6 shows the changes in the window when the manual setting is chosen. There are now two sliders in the Video Display box, one that controls brightness and the other that controls contrast, along with dialogue boxes below each slider that enable the user to input specific values. The values shown are the defaults: Brightness = 2048, Contrast = 128. The two parameters are adjustable from 0 to 4095 and 0-255 respectively.

The video display box has two additional pull-down menus. The first menu has the two possible polarity settings, white-hot and black-hot video. The factory default setting is **White-Hot**, i.e. hot objects appear whiter than cold objects. The other menu in the video display box enables the user to control whether the image is **Normal** (right side up), **Inverted** (upside-down), **Reverted** (column order flipped, like a mirror image) or both **Inverted** and **Reverted**. These choices are available for situations where the camera must be mounted upside down or a special inverting or reverting optic is used. The factory default setting is **Normal**, which means that the image on a monitor is oriented normally with respect to the camera body.

The **Freeze** checkbox freezes the video image on the screen when checked. Deselecting the box returns the camera to normal streaming video output. The **Freeze** is unchecked by default. The **Enabled** checkbox enables the video output, and this box is checked by default when the camera is powered up. Deselecting the box disables the analog video, thus conserving power for applications where power consumption is critical and only the digital video output is used.

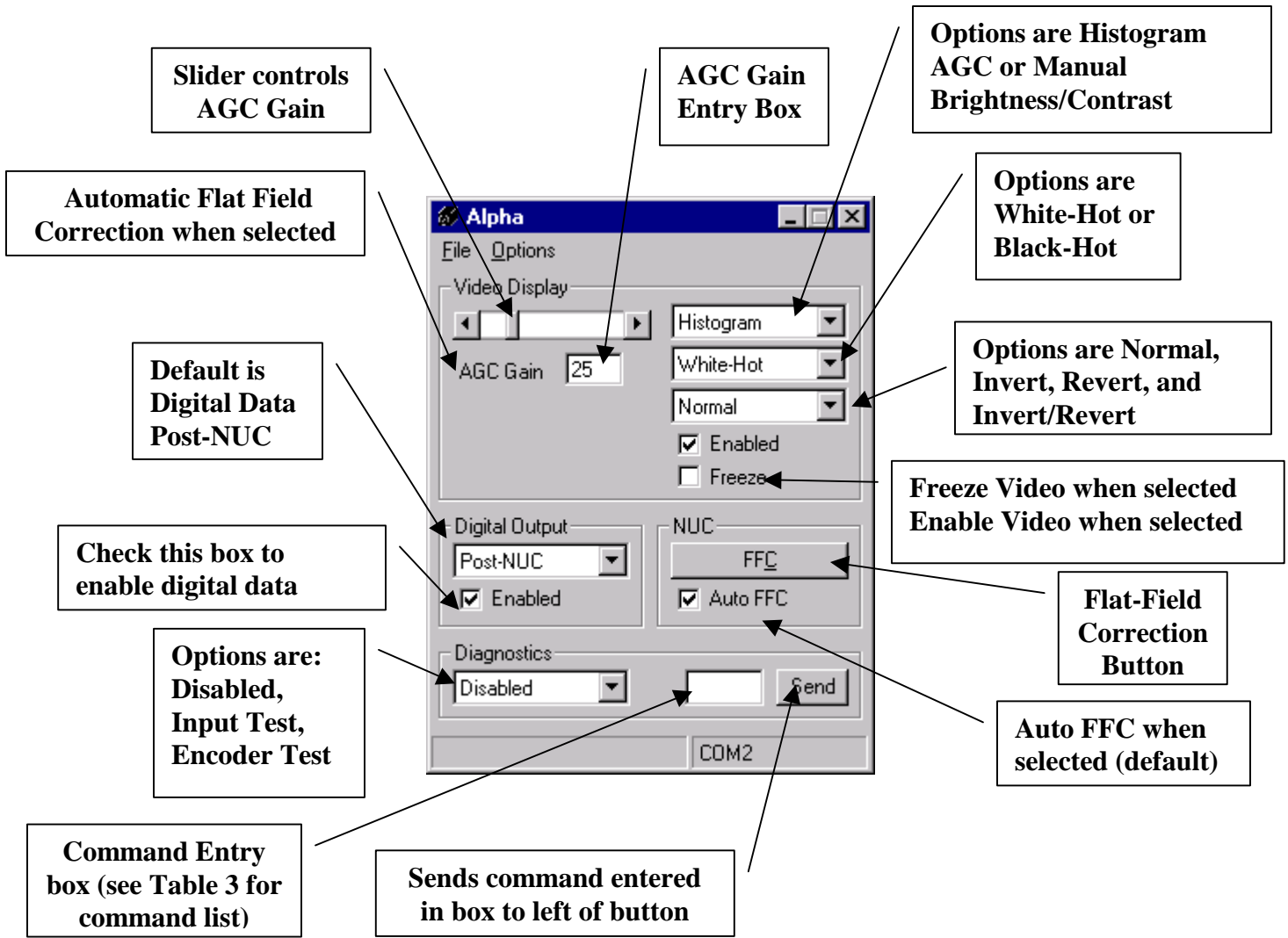


Figure 5. Histogram AGC Control Panel Window

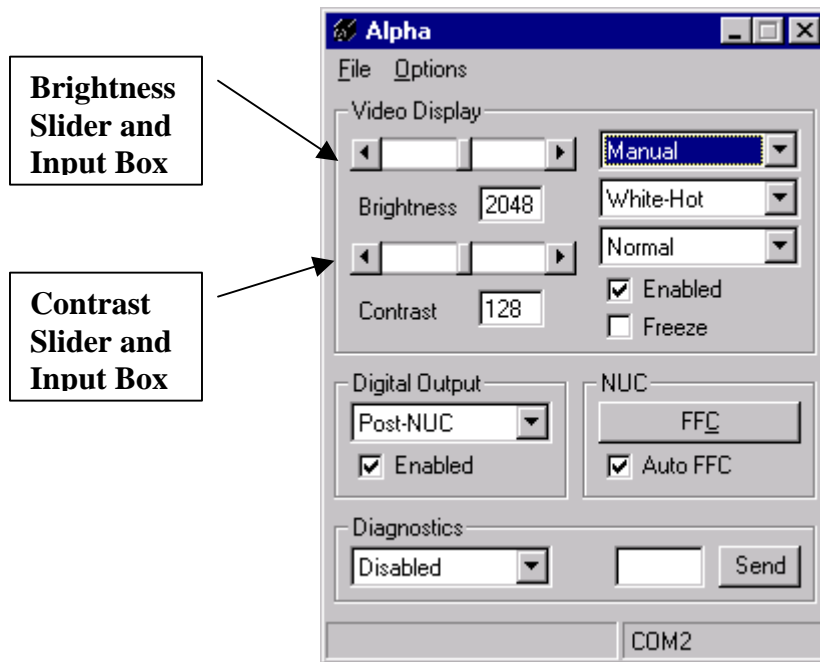


Figure 6. Manual Brightness/Contrast Control Panel Window

7.5.3 Digital Output

The **Digital Output** dialog box has a pull-down menu that controls whether the data has had a Non-Uniformity Correction (NUC) applied to it. The data is available as Post-NUC (corrected) the default setting, or **Pre-NUC** (uncorrected)., The **Pre-NUC** option is for cases where the user wants to apply an external NUC using image-processing software. The **Enabled** checkbox enables or disables the digital data output. It is checked by default (digital output enabled).

7.5.4 Diagnostics

The **Diagnostics** dialog box contains a pull-down menu to make the diagnostic mode **Disabled**, or enable either the Input Test or the Encoder Test. The Input test substitutes a 0-4096 bit data ramp for the FPA output. This is intended for diagnostics at the factory. The Encoder Test creates a test pattern whereby each successive column from left to right is set to gray scale values from 0 to 255. At column 256, the gray scale resets back to 0. This enables the user to adjust the video monitor so that the “black” columns (low number) are just barely black, and the “white” columns (high numbers) have just a trace of gray in them. The **Command Entry** box enables the user to send commands to the camera by typing them into the box, then pressing the **Send** button. The commands are listed in Table 3.

8 ALPHA SYSTEMS INTEGRATION AND INTERFACING

Some users will want to go beyond the scope of the Alpha Control Panel software and write their own applications that will control the camera via the RS-232 interface. This section gives the user the interface information required to communicate with the Alpha camera. This section also describes the electro-mechanical interfaces of the Alpha camera. It includes information

regarding optical, mechanical and connector locations with respect to the camera mounting features. A description of the electrical connections is also provided. Some of the information in this section is a repeat of earlier sections of this manual, but this section goes into more detail for the OEM user.

8.1 Camera Power Dissipation

The power dissipation of the camera is a function of the ambient temperature of the camera (due to the TE cooler/heater). The nominal power dissipation is 1.5 watts average (25° C ambient temperature) and increases to 2.5 watts average at the ambient temperature limits. To calculate the peak power of the camera, add the shutter drive power to the average camera power. The shutter drive power is found by multiplying the input voltage by 0.5 amps. The duration of the shutter drive pulse is 0.5 seconds. The following is an example camera power calculation:


Input voltage = 6 V;
Shutter drive power: $6V \times 0.5A = 3$ watts;
Camera power: $3 + 1.5 = \underline{4.5}$ **watts peak** (at 25 C ambient temperature)

The camera base is the thermal rejection surface and must be held within the ambient temperature limits for proper operation. The temperature limits for the Alpha camera are 0° C to 55° C.

 **Note:** *The maximum ambient temperature when the camera is operated in still air should be derated by 6° C.*

8.2 Auxiliary I/O connector

The camera Auxiliary I/O connector contains input power, video output, serial communications, digital data and data synchronization outputs. A number of digital signal grounds are included as return paths for each digital input/output. The digital signal grounds should be connected together at the receiver, however, for best noise performance, the digital signal grounds should be isolated from the input power return (IOPWRRTN) and video ground (Video Gnd). A separate coaxial cable for the video signal (Video) and video return (Video Gnd) is recommend for best performance. See Table 1 for the Alpha camera Auxiliary I/O connector signal positions. The backshell of the Auxiliary I/O connector is connected to the camera chassis.

 **Note:** *Do not connect power to both the auxiliary and power input connectors simultaneously.*

8.3 Video Output

The video output of the Alpha camera is factory configured for either RS-170A or CCIR video formats. A high impedance (HI-Z) termination is required at the load.

Note: *For best camera performance, do not connect the video return to either the power return or the digital return.*

8.4 Power Input

The power input to the Alpha camera is nominally 6 volts DC but the camera will operate over a range of 5.0 VDC (minimum) to 30 VDC (maximum). For best performance, the ripple on the power input should be less than 100mV peak-to-peak (DC to 10 MHz).

8.5 Real-Time Digital Data Output

The Alpha camera will output real-time, 12-bit digital data from the Auxiliary I/O connector. The digital data bus output and timing are enabled at camera start-up. The digital data stream includes camera telemetry and FPA data. The FPA data may be represented as either pre-NUC (on command – no NUC processing applied to the data) or post-NUC (default – NUC processing applied to data). The camera digital output can be disabled (via serial command) to reduce power consumption. See Section 7.5.3.

8.6 Data Synchronization

The Alpha camera generates three synchronization signals. The DATA FRAME signal is a synchronization pulse issued once per frame time with duration of one DATACLOCK pulse width. The DATA FRAME signal should be captured using the rising edge of the DATACLOCK. The DATA VALID signal is asserted when valid data is present on the digital output and is synchronous with the rising edge of DATACLOCK. The falling edge of DATA CLOCK is used to latch the data. The DATACLOCK frequency is determined by the video configuration of the camera. The DATACLOCK frequency is 12.27 MHz in RS-170A video configuration and 14.75 MHz in CCIR mode. Figure 7 shows the relationship between the data and the synchronization signals.

8.7 Digital Data Format

The digital data output from the camera consists of 4-bit wide nibbles generated at the DATA CLOCK rate. Each nibble of data should be latched using the falling edge of the DATA CLOCK. Four nibbles are needed to reconstruct each 12-bit word. The first nibble (A) contains the least significant bits, the second nibble (B) contains the middle bits and the third nibble (C) contains the most significant bits of the reconstructed word. The fourth nibble (D) is always held low. The digital data is output in groups of 8 words (4 nibbles per word) and a reference word. The first 20 groups (0 to 19) represent the camera telemetry data. The remaining groups represent the FPA pixel and group reference data. Figure 8 depicts the data output format and timing

8.8 Telemetry Data

The Alpha camera outputs telemetry information each frame period. The telemetry information is used to support factory calibration processes. The telemetry information consists of various camera operational parameters and occupies the first 20 groups (output words 0 to 159) in the digital data stream and replaces the pixel data from the first physical row of the array. A detailed description of the telemetry data format is found in Table 2.

Note: The reference data has no relationship to the telemetry data.

8.9 FPA Data

The Alpha camera also outputs FPA pixel value and group reference data. The data is output in groups that include a reference and 8 pixels. In pre-NUC output mode, the group reference data can be subtracted from the 8 pixels that follow to improve the common-mode noise performance. The first group of pixel data is found in the group number 20 (output word number 160). The first group of pixel data represents the first 8 pixels from the second row of the physical array (pixel coordinates row 1, columns 0 through 7). The data for pixels in the first physical row (row 0) is not available. Subsequent groups of data are in a raster type pattern (i.e. group # 21 contains pixels from row 1, columns 8 through 15; group # 22 contains pixels from row 1, columns 16 through 23). The total number of rows in the output is a function of the video format. For RS-170 video format, the number of rows is 119 while the number of rows for CCIR video format is 127.

Note: the group reference data output precedes the DATA VALID signal as shown in Figure 8.

8.10 Serial Communications

Serial communication to the camera is accomplished using a RS-232 command protocol. The receive channel will accept normal RS-232 signal levels. The transmit channel is currently non-functional. See Table 3 for a list of commands.

Pin #	Signal Name	Description
1	Video	RS-170A or CCIR video output
2	Tx[3V]	RS-232 transmit, 3 volt levels
3	Rx[3V]	RS-232 receive, 3 volt levels
4	-	Unused
5	-	Unused
6	Data Frame	Frame synchronization output, 3 volt level
7	Data Valid	Data valid output, 3 volt level
8	Data Clock	Pixel clock output, 3 volt level
9	Data0	Real-time digital data output, bit 0
10	Data1	Real-time digital data output, bit 1
11	Data2	Real-time digital data output, bit 2
12	Data3	Real-time digital data output, bit 3
13	IOPWR	Camera input power, 5 volt nominal
14	Video Gnd	RS-170A or CCIR video return
15	Dgnd	Ground, return for Tx
16	Dgnd	Ground, return for Rx
17	Dgnd	Ground, return for SyncFrame
18	Dgnd	Ground, return for SyncClock
19	Dgnd	Ground, return for Data Frame
20	Dgnd	Ground, return for Data Valid
21	Dgnd	Ground, return for Data Clock
22	Dgnd	Ground, return for Data output bit 0
23	Dgnd	Ground, return for Data output bit 1
24	Dgnd	Ground, return for Data output bit 2
25	Dgnd	Ground, return for Data output bit 3
26	IOPWRRTN	Camera power return

Table 1. Auxiliary I/O Connector

Parameter	Word Location	Nibble A				Nibble B				Nibble C				Nibble D			
		0	1	2	3	0	1	2	3	0	1	2	4	0	1	2	3
FPA temperature	0	0	1	2	3	4	5	6	7	8	9	10	11	L	L	L	L
	1	12	13	X	X	X	X	X	X	X	X	X	X	L	L	L	L
Chassis Temperature	2	0	1	2	3	4	5	6	7	8	9	10	11	L	L	L	L
	3	12	13	X	X	X	X	X	X	X	X	X	X	L	L	L	L
Chassis temp low threshold	4	0	1	2	3	4	5	6	7	8	9	10	11	L	L	L	L
	5	12	13	X	X	X	X	X	X	X	X	X	X	L	L	L	L
Chassis temp high threshold	6	0	1	2	3	4	5	6	7	8	9	10	11	L	L	L	L
	7	12	13	X	X	X	X	X	X	X	X	X	X	L	L	L	L
Table switch data threshold	8	0	1	2	3	4	5	6	7	8	9	10	11	L	L	L	L
	9	X	X	X	X	X	X	X	X	X	X	X	X	L	L	L	L
Population below data threshold	10	0	1	2	3	4	5	6	7	8	9	10	11	L	L	L	L
	11	12	13	14	15	X	X	X	X	X	X	X	X	L	L	L	L
Population above data threshold	12	0	1	2	3	4	5	6	7	8	9	10	11	L	L	L	L
	13	12	13	14	15	X	X	X	X	X	X	X	X	L	L	L	L
Active calibration table	14	0	1	2	3	4	5	6	7	X	X	X	X	L	L	L	L
	15	X	X	X	X	X	X	X	X	X	X	X	X	L	L	L	L
Reserved	16 - 159	H	H	H	H	H	H	H	H	H	H	H	H	L	L	L	L

Table 2. Telemetry data description

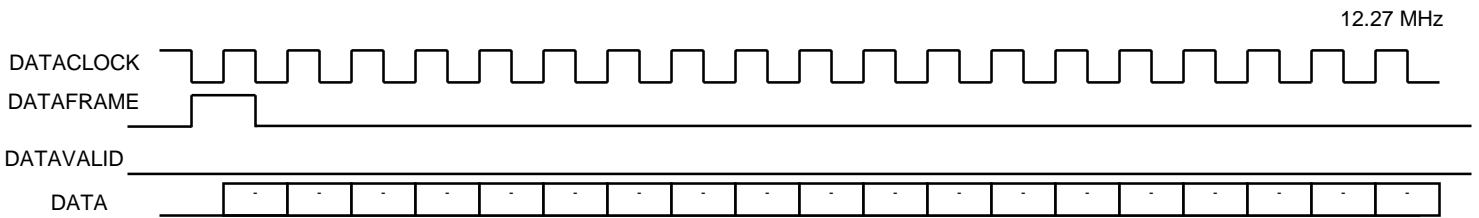
Name	Description	Cmd	Argument	Default	Reply
VIDEO_DISPLAY	Enables or disables the video output	d	0=disable, 1=enable	1	> if ok, ? Otherwise
VIDEO_DISPLAY_POLARITY	Sets the video display polarity	p	0=white hot, 1=black hot	0	> if ok, ? Otherwise
VIDEO_DISPLAY_ORIENTATION	Sets the video display polarity	x	0=normal, 1=invert, 2=revert, 3=invert+revert	0	> if ok, ? Otherwise
FREEZE_FRAME	Freezes the video display	g	0=normal, 1=freeze frame	0	> if ok, ? Otherwise
DIGITAL_OUTPUT	Enables or disables the digital output	o	0=disable, 1=enable	0	> if ok, ? Otherwise
DIGITAL_OUTPUT_TAP	Sets the digital output tap point	w	0=pre-nuc, 1=post-nuc	0	> if ok, ? Otherwise
AGC	Selects the automatic gain corrector mode	a	0=Linear LUT, 1=Linear AGC, 2=Histogram AGC	2	> if ok, ? Otherwise
CONTROL_BITS	Sets the state of various control bits	e	Bit Map: 0=safe mode disable, 1=table switch disable, 2=TEC disable, 3=Auto FFC disable, 4-7=N/A	0	> if ok, ? Otherwise
HISTOGRAM_CLIP_VALUE	Sets the histogram AGC clipping value	h	A byte >= 2 for the new clipping value	25	> if ok, ? Otherwise
HISTOGRAM_LIMITER_VALUE	Sets the histogram AGC gain limiter value	l	A byte >= 1 for the new limiter value	5	> if ok, ? Otherwise
FLAT_FIELD_CORRECT	Performs a flat field correction	f	None	NA	>
CAMERA_RESET	Performs a soft camera reset	r	None	NA	>! (! indicates hard or soft reset)
ZERO_OFFSET	Clears the flat field correction memory	z	None	NA	>
BRIGHTNESS	Sets the linear LUT brightness value	b	Two bytes for the new brightness value: LSB, MSB using the least significant 12 bits.	2048	>
CONTRAST	Sets the linear LUT contrast value	c	A byte for the new contrast value	128	>

Table 3. Command Interface Description

Name	Description	Cmd	Argument	Default	Reply
MANUAL_CAL_TABLE_CMD	Selects the active cal table when in manual table mode	t	An byte value from 0 to 31 inclusive indicating the table beginning at 0 (zero) for table 0 proceeding through subsequent ASCII codes for the desired table: 0 (zero)=table 0, 1=table 1, 2=table 2..., 9=table 9, ':'=table 10, ';'=table 11, '?'=table 15..., 'O'=table 31	0	> if ok, ? Otherwise
USE_MANUAL_CAL_TABLE_CMD	Selects calibration table selection mode	m	0=auto cal table switching, 1=manual cal table selection	0	> if ok, ? Otherwise
COLUMN_OFFSET_NULL	Enable and disable column offset nuc	n	0=disable, 1=enable	0	> if ok, ? Otherwise
TEST_MODE	Sets built in test modes	l	0=normal operation, 1=input test, 2=encoder test	0	> if ok, ? Otherwise
SYNC_MODE	Sets the camera synchronization mode	k	0=internal, 1=master, 2=slave	0	> if ok, ? Otherwise
QUERY	Query the state of any command	?	The command letter to query	NA	Current camera state
CAL_TABLE	Returns the active cal table	?q	None	NA	Active calibration table regardless of mode

NOTES:
 The camera transmits a '!' when powered up to indicate a reset.
 The camera incorporates a fixed 0.5 second receive timeout.

Table 3. (cont.) Command Interface Description



DATAFRAME should be latched with the rising edge of DATAFRAME

Figure 7. Data Synchronization Timing (RS-170A video configuration)

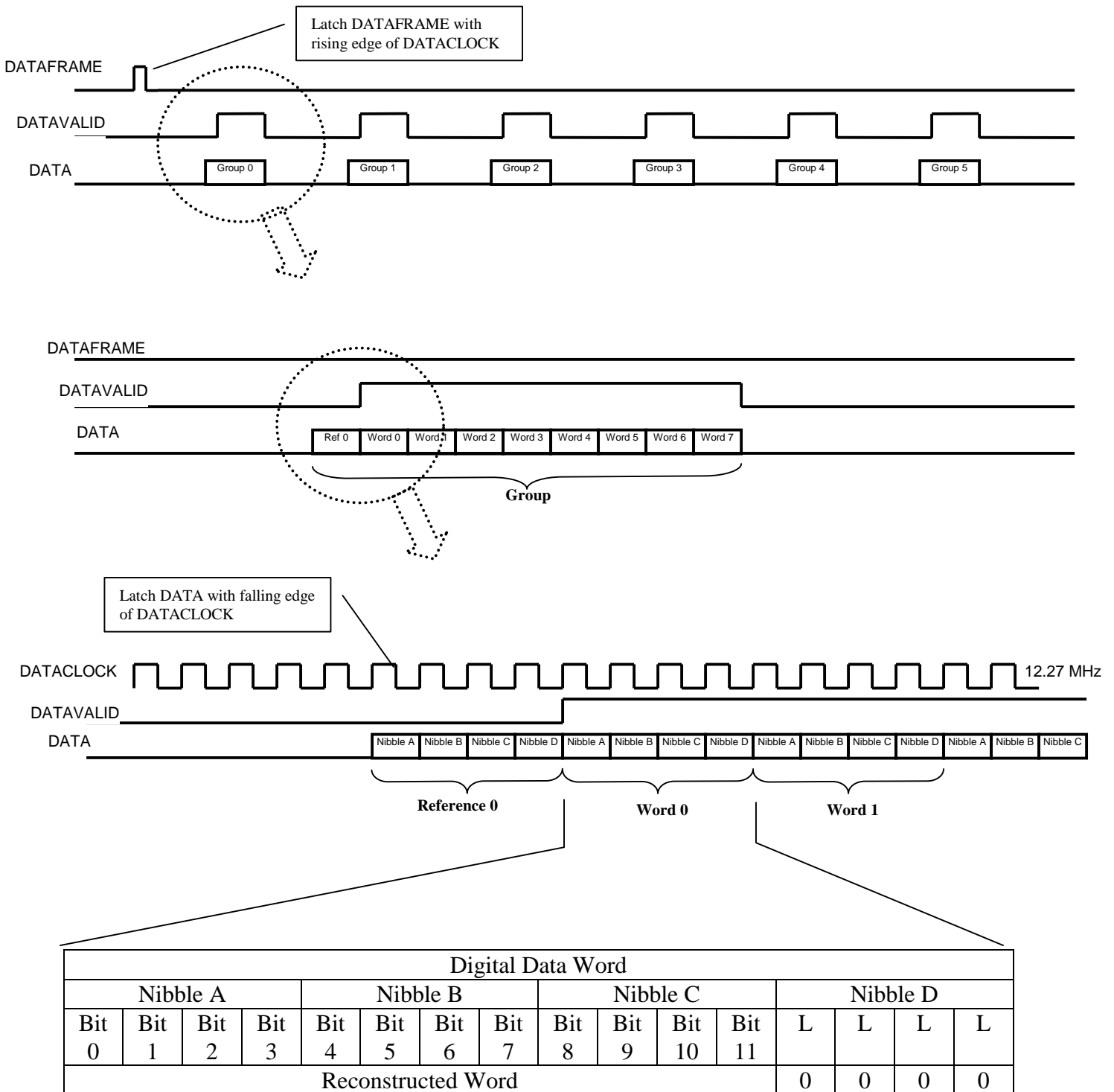


Figure 8. Digital Data Output Format & Timing (RS-170A video configuration)

9 ELECTRICAL INTERFACE

9.1 Camera Power Connector

The camera power input connector is a 2.1mm (center pin diameter) coaxial power jack. The center pin is the positive supply voltage while the sleeve is the return. The camera power jack and plug part numbers are given below. The power input to the Alpha camera is nominally 6 VDC but the camera will operate over a range of 5.0 VDC (minimum) to 30 VDC (maximum). For best performance, the ripple on the power input should be less than 100 mV peak-to-peak (DC to 10 MHz). The power input connector is in parallel with the Auxiliary I/O power input (i.e. power may be supplied from either connector but not both). The camera power connector is isolated from the camera chassis.

⚠ Note: *The IOPWRRTN line on the Auxiliary I/O connector will be opened when a plug is inserted into the camera power jack. Do not apply power to both the auxiliary and power input connectors simultaneously.*

Camera Power Jack:	Switchcraft part number PC722A
Mating Power Plug:	Switchcraft part number S-760K



Figure 9. Alpha Cameras with Power Jack

9.2 Camera Video Connector

The camera video output connector is a standard RCA type jack. The center pin is the video output and the sleeve is the video return. The video output of the Alpha camera is factory configured for either RS-170A or CCIR video formats. A high impedance (HI-Z) termination is required at the load. The camera video connector is isolated from the camera chassis.

Note: *For best camera performance, do not connect the video return to either the power return or the digital return.*

9.3 Auxiliary I/O Connector

Some users may wish to connect a circuit board directly to their Alpha camera without any cable, or create their own special cables. The Auxiliary I/O connector and mating part numbers are as follows:

Auxiliary I/O connector:	3M part number 10226-1210VE
Solder cup mate:	3M part number, 10126-3000VE
Board mount mate:	3M part number, 10126-5212VC (See Figure 10)
IDC cable mate:	3M part number, 10126-6000EC

10 OPTO-MECHANICAL INTERFACE

The location of the optical axis for the Alpha camera is in the geometric center of the camera when viewing the lens entrance aperture. Figures 10, 11 and 12 gives the specific dimensions of the optical axis with respect to the camera base and side for the three lens options. The camera base has three #4-40 tapped holes for mounting to a thermal rejection surface. Precision alignment is accomplished using two 0.063 inch diameter pins inserted into a mating hole and slot in the camera base. Figures 10, 11 and 12 also give the detailed dimensions and locations of the tapped holes and alignment features, as well as the locations of the camera power input connector, video output connector and Auxiliary I/O connector with respect to the camera base and side.

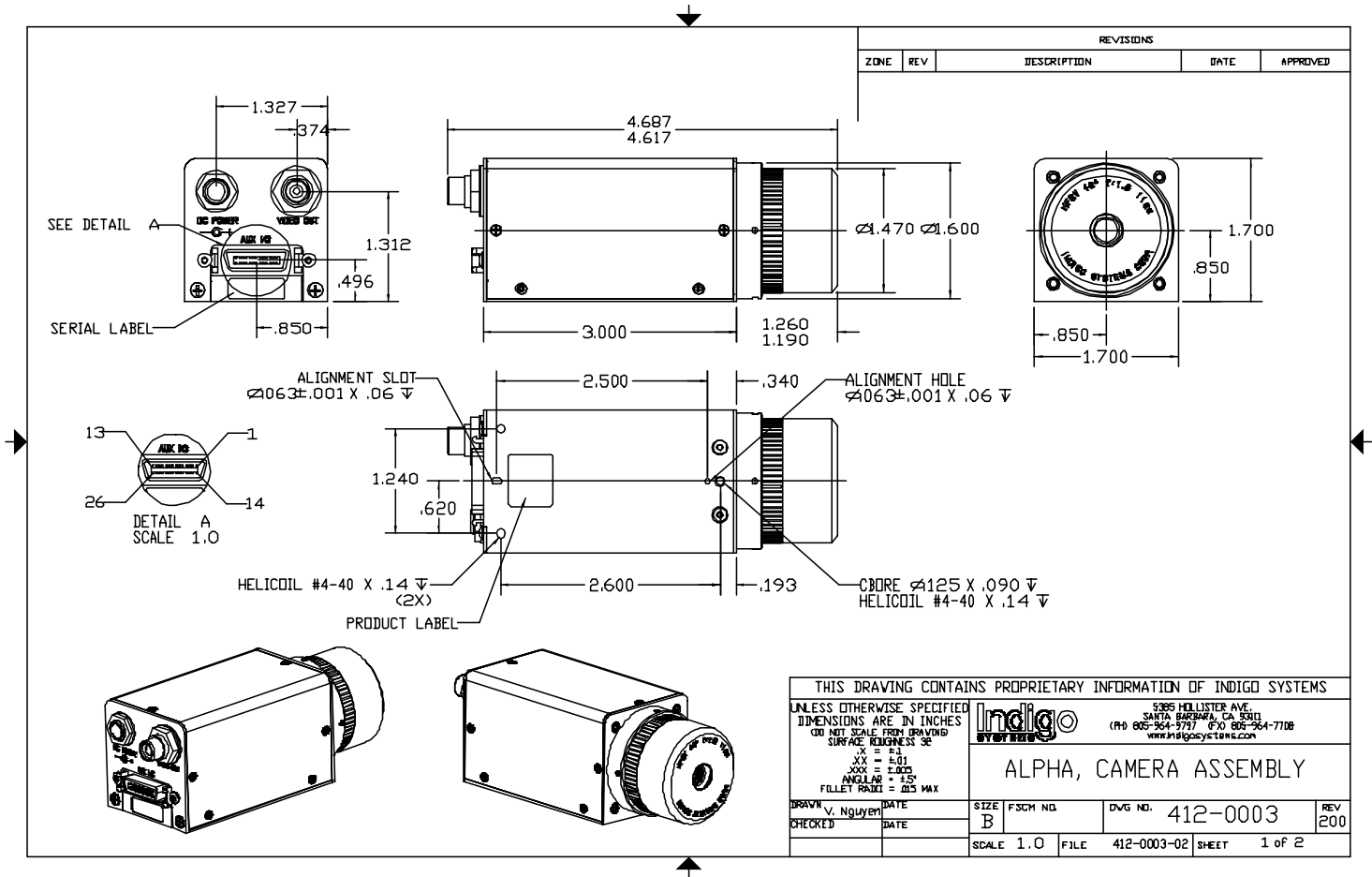


Figure 10. Opto-Mechanical Interface Drawing (40° FOV Lens)

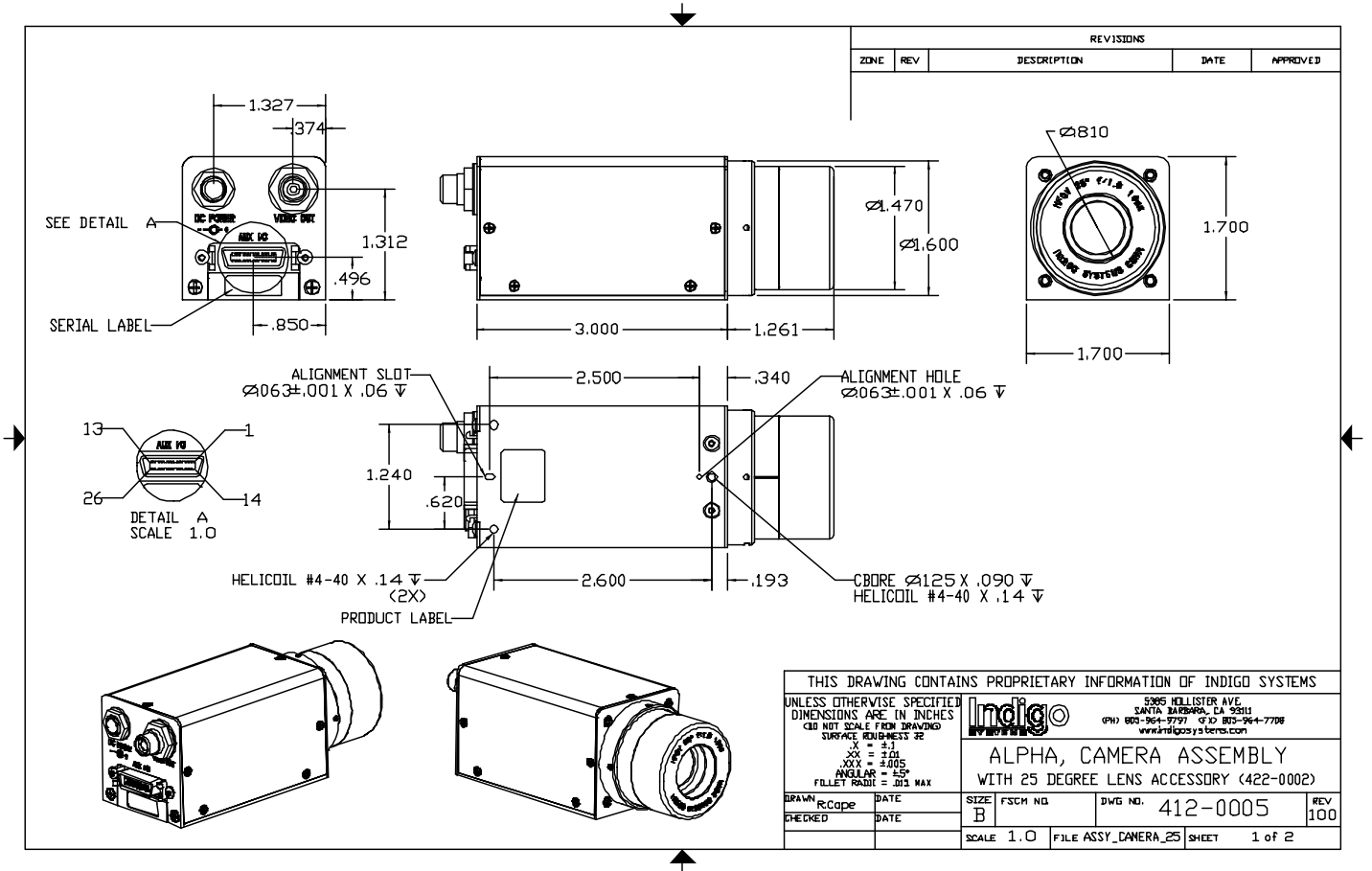



Figure 11. Opto-Mechanical Interface Drawing (25° FOV Lens)

APPENDIX A ALPHA DIGITAL INTERFACE (ADI)

Product Description

This product forms the interface between the Alpha camera and a digital acquisition system. Indigo's Talon digital acquisition system (using a Bit Flow digital frame grabber) is configured to accept the data from the ADI. The ADI transforms the bite- serial, digital data from the camera into word- wide, parallel data conforming to the RS-422 electrical standard. A detailed description of the data format and timing is given below. The ADI provides power to the camera through the Alpha interface cable (shown in Figure A1).

 ***Warning!!! DO NOT apply power to the camera's power input jack when the camera is connected to the ADI as damage to the camera may result!***

The video output from the camera is buffered in the ADI. A choice of video termination impedance is provided. Use LoZ for loads with 75 ohm input impedance and HiZ for high input impedance loads.

Physical Interface and Dimensions

The camera control is accomplished via the RS-232 interface. The interface software is provided with the Alpha camera and the physical interface is a standard 9-pin, sub-miniature D style connector (wired straight through). Overall chassis dimensions of the ADI are 8"W X 2.5"H X 7"D, not including connectors. The standard length of the Interface Cable between the Alpha and the ADI is 10 feet.

Connecting the ADI

Figure A1 shows the typical configuration of the ADI. Figures A2 and A3 show the front and rear panels, respectively.

 ***Note: Use only the supplied power supply for ADI power. Do not make any connections to the Alpha camera power or video jacks when using the ADI.***

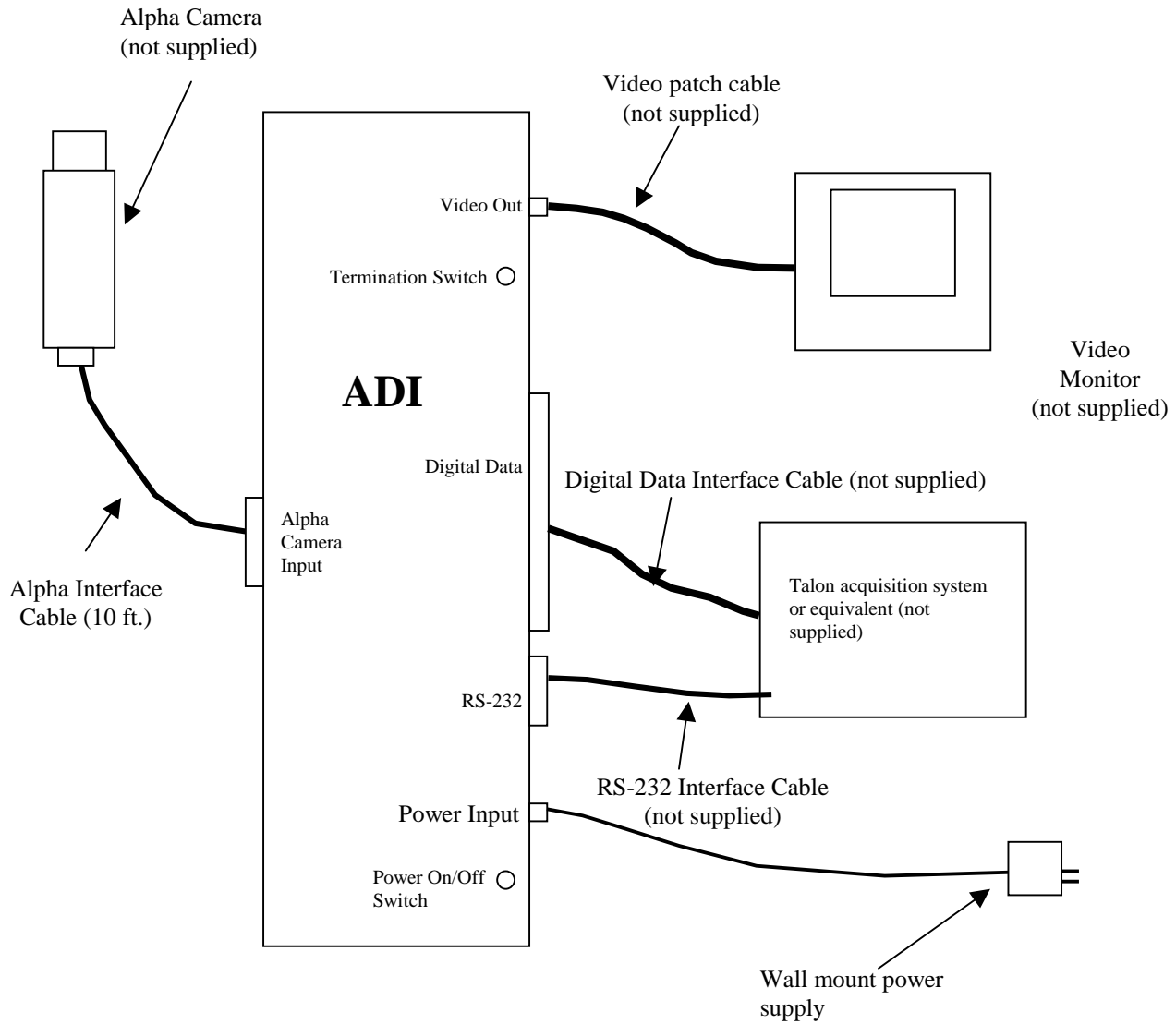


Figure A1. ADI Connections



Figure A2. ADI Front Panel

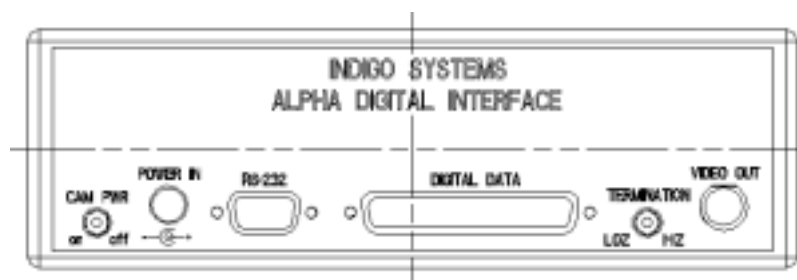


Figure A3. ADI Rear Panel

Digital Data

The Alpha camera, when connected to the Alpha Digital Interface (ADI) accessory, will output real-time, 12-bit digital data to a digital frame grabber. The digital data bus output and timing are enabled at camera start-up. The digital data stream includes camera telemetry, group reference and pixel data. The pixel data may be represented as either pre-NUC (on command – neither NUC processing nor pixel replacement applied to the data) or post-NUC (default – NUC processing and pixel replacement applied to data). The digital data output from the ADI consists of 12-bit wide words generated at the DATA CLOCK rate. Each data word should be latched using the rising edge of the DATA CLOCK. The DATAFRAME pulse is one DATACLOCK period wide and represents the beginning of the image frame. The DATAVALID signal is asserted during valid group data. The first 20 groups (0 to 19) represent the camera telemetry data. The remaining groups represent the FPA pixel and group reference data. Figure A5 depicts the data output format and timing. The digital data and synchronization signals are transmitted in a differential format complying with RS-422 standards. For each output there are two complementary signals, a (+) indicating positive polarity and (-) indicating negative (inverted) polarity. A RS-422 compatible receiver with a 100 ohm termination (between the (+) and (-) signals) is recommended.

Telemetry Data

The ADI outputs telemetry information each frame period. The telemetry information is used to support factory calibration processes. The telemetry information consists of various camera operational parameters and occupies the first 20 groups (output words 0 to 159) in the digital data stream and replaces the pixel data from the first physical row of the array. A detailed description of the telemetry data format is found in Table A1.

Note: The reference data has no relationship to the telemetry data.

Pixel Data

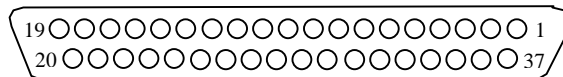
The ADI also outputs FPA pixel value and group reference data. The data is output in groups that include a reference and 8 pixels. In pre-NUC output mode, the group reference data should be subtracted from the 8 pixels that follow to improve the common-mode noise performance. In post-NUC mode, the reference subtraction is accomplished in the camera, therefore, the reference data should be ignored. The first group of pixel data is found in group number 20 (output word number 160). The first group of pixel data represents the first 8 pixels from the second row of the physical array (pixel coordinates row 1, columns 0 through 7). The data for pixels in the first physical row (row 0) is not available. Subsequent groups of data are in a raster type pattern (i.e. group # 21 contains pixels from row 1, columns 8 through 15; group # 22 contains pixels from row 1, columns 16 through 23). The total number of rows in the output is a function of the video format. For RS-170 video format, the number of rows is 119 while the number of rows for CCIR video format is 127.

Serial Communications

Serial communication to the camera is accomplished using a RS-232 command protocol. Please refer to Section 8.10 in this manual for more information.

Parameter	Word Location	Group Location	Bit Location													
			0	1	2	3	4	5	6	7	8	9	10	11		
FPA temperature	0	0	0	1	2	3	4	5	6	7	8	9	10	11		
	1		12	13	L	L	L	L	L	L	L	L	L	L	L	
Chassis Temperature	2		0	1	2	3	4	5	6	7	8	9	10	11		
	3		12	13	L	L	L	L	L	L	L	L	L	L	L	
Chassis temp low threshold	4		0	1	2	3	4	5	6	7	8	9	10	11		
	5		12	13	L	L	L	L	L	L	L	L	L	L	L	
Chassis temp high threshold	6		0	1	2	3	4	5	6	7	8	9	10	11		
	7		12	13	L	L	L	L	L	L	L	L	L	L	L	
Table switch data threshold	8		1	0	1	2	3	4	5	6	7	8	9	10	11	
	9			L	L	L	L	L	L	L	L	L	L	L	L	L
Population below data threshold	10			0	1	2	3	4	5	6	7	8	9	10	11	
				12	13	1	1	L	L	L	L	L	L	L	L	L
	11			4	5											
				0	1	2	3	4	5	6	7	8	9	10	11	
Population above data threshold	12			0	1	2	3	4	5	6	7	8	9	10	11	
		12		13	1	1	L	L	L	L	L	L	L	L	L	
	13	4		5												
		0		1	2	3	4	5	6	7	L	L	L	L	L	
Active calibration table	14	L		L	L	L	L	L	L	L	L	L	L	L	L	
	15	L		L	L	L	L	L	L	L	L	L	L	L	L	
Reserved	16 - 159	2 - 19		H	H	H	H	H	H	H	H	H	H	H	H	

Table A1. Telemetry data description



Mating connector: AMP 747916-2

Figure A4. Digital Output Connector, 37 pin D-sub, female (face view)

Signal Name	Pin Number		Signal Name
Ground	1	20	No Connect
No Connect	2	21	Data 0 (+)
Data 0 (-)	3	22	Data 1 (+)
Data 1 (-)	4	23	Data 2 (+)
Data 2 (-)	5	24	Data 3 (+)
Data 3 (-)	6	25	Data 4 (+)
Data 4 (-)	7	26	Data 5 (+)
Data 5 (-)	8	27	Data 6 (+)
Data 6 (-)	9	28	Data 7 (+)
Data 7 (-)	10	29	Data 8 (+)
Data 8 (-)	11	30	Data 9 (+)
Data 9 (-)	12	31	Data 10 (+)
Data 10 (-)	13	32	Data 11 (+)
Data 11 (-)	14	33	Ground
No Connect	15	34	Ground
No Connect	16	35	Frame (+)
Frame (-)	17	36	Data Valid (+)
Data Valid (-)	18	37	Data Clock (+)
Data Clock (-)	19		

Table A2. ADI Digital Output pin assignments

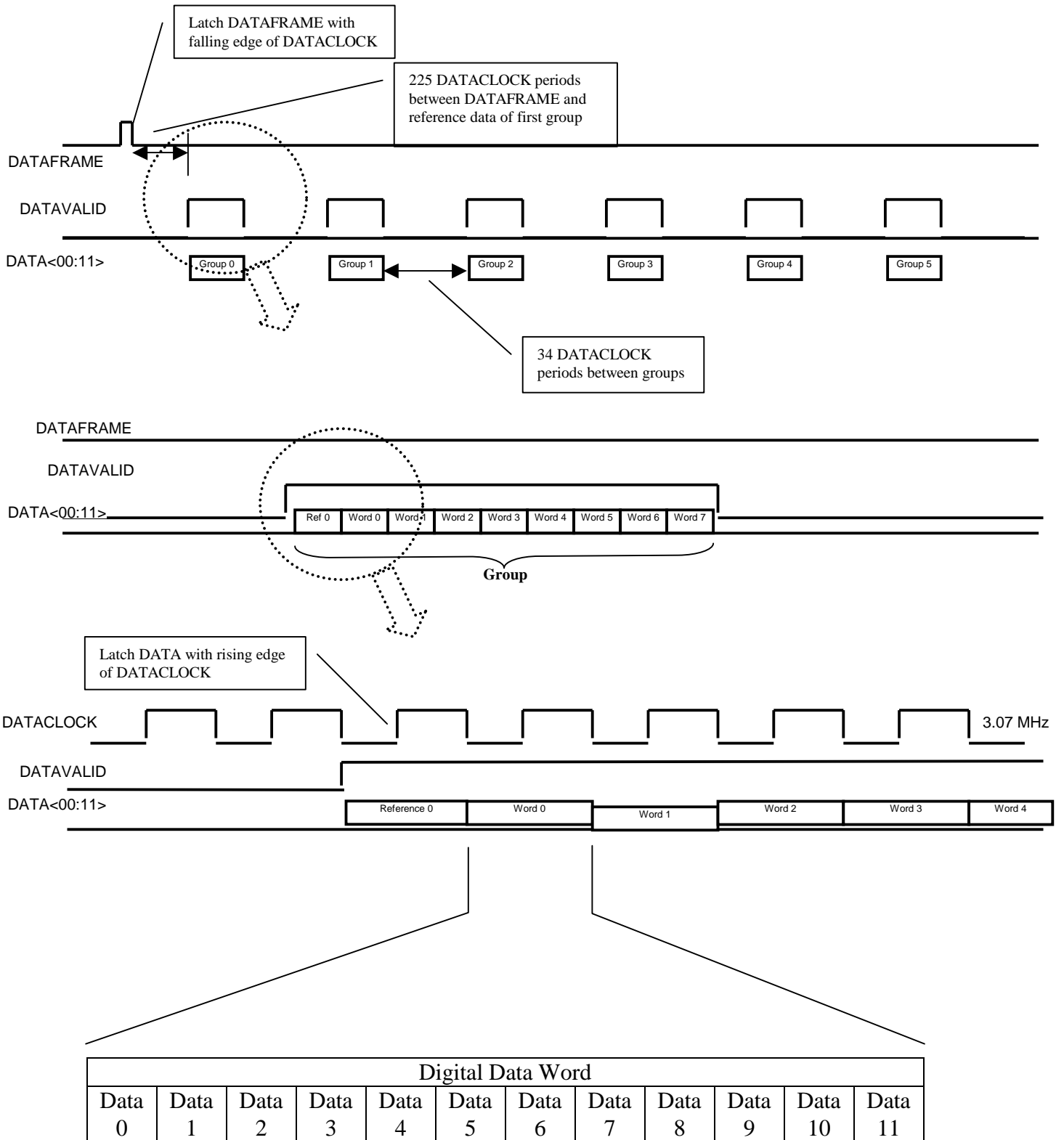


Figure A5. Digital Data Output Format & Timing (RS-170A video configuration)

APPENDIX B INTELLIGENT ACCESSORY SHOE (HOT SHOE)



Figure B1. Alpha Integrated with Sony Camcorder

ThermoCordeR™ is an enhancement that transforms Indigo's Alpha infrared camera into a complete, handheld thermal imaging and recording system as shown in Figure B1.

ThermoCordeR™ integrates Alpha with a Sony camcorder via the Intelligent Accessory Shoe (Hot Shoe) interface. This interface enables Alpha's video signal to be input into the Sony camcorder for viewing on the LCD display or viewfinder (Figure B2). It also allows the camcorder battery to power the Alpha.



Figure B2. Alpha™ Image Displayed on LCD

Installation

Mount the Hot Shoe to the bottom of the Alpha using the three supplied 4-40 x 2.00 Black Oxide socket head cap screws. Make sure the Alpha's AUX I/O connector fully mates with the Hot Shoe. To connect the Hot Shoe to the camcorder, first verify the white arrow on the bottom of the Hot Shoe foot is pointing toward the rear of the assembly. If it is not, simply rotate the entire foot so that it is positioned properly. Next, slide the Hot Shoe foot into the camcorder accessory mount and place the locking ring in the LOCK position. The video signal from the Alpha is

transferred to the camcorder by plugging the Hot Shoe video cable into the auxiliary Audio/Video (yellow) input located on the side of the camcorder.

⚠ Warning!!! DO NOT apply power to the camera's power input jack when the camera is connected to the Hot Shoe, as damage to the camera may result!

Operation

To turn on ThermoCordeR™, switch the camcorder power selector switch to VCR. All standard features and furnished accessories of the Sony camcorder are available with ThermoCordeR™. Recording of the video output from the camera is available on both mini-DV (digital video) tape and Memory Stick (digital still image) formats. The Hot Shoe adapter is designed to be compatible with any Sony camcorder featuring the Sony Intelligent Shoe. The baseline Sony camcorder model offered by Indigo is the DCR-TRV10. ThermoCordeR™ requires an Alpha camera and Indigo's Hot Shoe adapter.

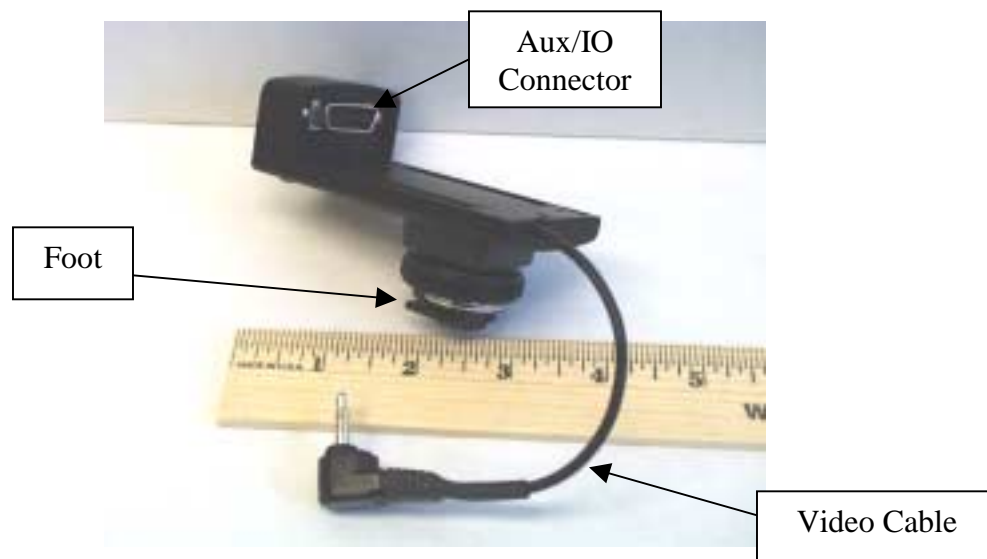


Figure B3. Hot Shoe Interface