

Copyright Notice

This manual and the software described in it were developed and are copyrighted by Santa Barbara Instrument Group (SBIG). Neither the manual or the software may be copied in whole or in part except as follows:

- 1) You may make backup copies of the software for your own use provided that they bear SBIG's copyright notice.

CCDBLINK

Blink Comparator Utility for the ST-4

CCDBLINK Manual
Version 1.0
Printed January 1991
Converted to PDF November 1998

Table of Contents

Introduction	1
Running the Program.....	2
Image I/O Menu	4
The Display Menu and Graphics Mode.....	5
Align Menu	9
PC Menu	10
Appendix A - Image File Format	11

CCDBLINK - Blink Comparator Utility for the ST-4

INTRODUCTION

The CCDBLINK program is one in a series of programs from Santa Barbara Instrument Group to enhance the operation of the Model ST-4 Star Tracker and

Getting Started

This section describes what you need to do to get the CCDBLINK software up and running on your PC, including installing the software. If you've spent any time with the CCD program included with the ST-4 you'll feel right at home and can briefly scan this and the following section.

Making a Backup Copy

First you should make a backup copy of your CCDBLINK diskette and put the original away in a safe place. The program is not copy protected so you can use the DOS "DISKCOPY" command or your favorite utility. This doesn't mean the software isn't copyrighted though, which it is. Please don't give copies of the software away. Making a backup copy is especially important if you intend to run the CCDBLINK program from a floppy diskette.

Installing on a Hard Disk

If you have a hard disk on your system and wish to install the software on it we suggest you install it in the directory containing your CCD program. In this way the two programs can share access to the graphics driver programs (CGA.BGI, EGAVGA.BGI, etc.), and you will only need to copy the two files "CCDBLINK.EXE" and "CCDBLINK.CFG". If you wish you may install the CCDBLINK program in its own directory, but in this case you will also need to copy the graphics drivers as well.

Imaging Camera. The program allows you to load two image files, align them with sub-pixel accuracy, then blink the display between the two images: Fixed objects remain steady whereas objects which have moved or have changed in brightness will blink. The CCDBLINK program uses image files previously captured and saved with the CCD software that came with your ST-4 and does not contain the routines necessary for interfacing directly to the ST-4. For that you will continue to use the CCD program.



RUNNING THE PROGRAM

Running the CCDBLINK program is just a simple matter of making the directory containing the CCDBLINK program be the current working directory and running the program by typing "CCDBLINK " followed by hitting the "Enter" key. If you're running from a floppy diskette and are swapping diskettes to get access to system files or data files, you will need to insure that the program diskette is installed in the disk drive when you quit the program. The program remembers the user's settings in the CCDBLINK.CFG file which gets updated when you exit the program.

Note:

There are several sample images of comet Austin on the CCDBLINK disk that can be used to demonstrate the operation of the CCDBLINK utility. These are raw images and will have to be aligned as described below.

Elements of the User Interface

The CCDBLINK program interacts with the user through a friendly and efficient user interface containing pull-down menus and dialog boxes, and operates in two distinct modes: Text mode and Graphics mode. The Text mode is activated when the program is first run and contains the pull-down menus, dialog boxes, and other items requiring an interactive role with the user. The Graphics mode is used for displaying images and analyzing them with cross-hairs, etc. This section describes the elements which together make up the user interface.

Menu Bar and Menu Commands

At the top of the screen (in text mode) is the menu bar showing the different menu titles or commands (**Image I/O**, **Align**, etc.). At any time only one menu in the menu bar is highlighted, and the highlighting can be moved from menu to menu using the left and right arrow keys. Once a menu title is highlighted, hitting the "Enter" key causes one of two things to happen: Either a pull-down menu is revealed with several sub-commands (as is the case with the **Image I/O** command) or a dialog box is shown (as is the case with the **Display** command). Either of these

can be exited or canceled by hitting the "Esc" key. How each of these items interacts with the user is described in individual sections below.

Note:

Commands can also be invoked from the menu bar by hitting the first letter of the intended command. For example, hitting the "I" key invokes the **Image I/O** command, revealing its pull-down menu.

Pull-Down Menus

Pull-down menus show several commands arranged vertically, with one command highlighted. The highlighting can be moved from command to command using the Up and Down Arrow keys (or the Tab and Shift-Tab key combinations). Once a command is highlighted it can be invoked by hitting the "Enter" key. Invoking commands can cause a dialog to be displayed or can cause some immediate action, depending on the individual command.

Note:

Commands in menus can also be invoked directly once the pull-down menu is visible (without moving the highlighting) by hitting the key corresponding to the highlighted capital letter shown in the command.

Dialogs

Dialogs are outlined boxes drawn in the center region of the screen for interacting with the user and typically contain several parameters which can be changed by moving to the desired line and changing the setting. You move the flashing cursor up and down through the dialog parameters using the Up and Down Arrow keys (or the Tab and Shift-Tab key combinations).

Note:

In the dialogs, the descriptive text to the left of each parameter contains a single highlighted character. This character indicates that you can move the flashing cursor directly to that parameter by pressing the "Alt" key in conjunction with the highlighted character

The method used to change a parameter's setting depends on the type of the parameter, of which there are two: ones where you select a single choice from a list of choices and ones where you type in some number or text. For the first type, you select the desired setting by using the Left and

Right Arrow keys. In the second case you simply type in the desired setting. You can use the "Backspace" key to edit the text or use the "Del" key to completely erase all the text entered in the parameter. When you are done setting the parameters in the dialog, you can proceed on to execute the command by hitting the "Enter" key or abort the command by hitting the "Esc" key.

Status Box

Towards the bottom of the Text mode display is the Status box which is used by the program to convey passive information to the user such as the introductory information presented when the program is first run. You will want to check the status box periodically for this information.

Data Buffer Information Box

Just below the Status box is the Data Buffer information box which indicates whether any image data is currently held in memory, and whether that information has been saved on disk or not. The CCDBLINK program has two image buffers. The first image loaded (using commands from the **Image I/O** command) goes into the Reference Image buffer and the second image goes into the Source Image buffer.

Graphics Display Mode

The program switches to Graphics mode when images need to be displayed or analyzed, such as after executing the **Display** command. You can switch back to Text mode from Graphics mode by hitting the "Esc" key.

IMAGE I/O MENU

The **Image I/O** menu contains commands which are used to retrieve and store images from/to disk. Central to the use of the **Image I/O** menu is the File Path, File Filter, and the Directory Dialog which are explained in detail below.

The File Path (which can be set using the **Path/Filter** command in the **Image I/O** menu) tells the CCDBLINK software where to look for files to display and where to save files. This should be set to the directory where you save your image data files, and can be changed easily if you have created multiple directories for your images. If, for example, your image files have been saved in the DATA directory which resides at the root level of your C: hard disk, you would set the File Path to "C:\DATA". Although they serve similar purposes, you should not confuse the File Path with DOS's Path command. The File Path is only used by the CCDBLINK software, and must be set using the **Path/Filter** command in the **Image I/O** menu.

Note:

If you specify a blank File Path (to use the current DOS working directory), the program will substitute the equivalent File Path ".\".

The File Filter allows you to exclude certain files from showing in the Directory Dialog by specifying a "match string". Only files matching the File Filter will be shown in the Directory Dialog. You can use the DOS wild card characters "*" and "?" in the File Filter, and specifying a File Filter other than the all-showing "*.*" will cause some files not to appear. For example setting the File Filter to "*.ST4" will cause only files with the extension ".ST4" to appear in the directory dialog.

The Directory Dialog is shown whenever you need to choose a file on the disk for loading. Rather than having you type in the name of the file, the program displays all the files (that match the File Filter) in the current File Path. You can then use the four arrow keys to select the desired file. For directories which contain more than 40 files, the PgUp and PgDn keys allow you to page through the files 40 at a time. The files are sorted into alphabetical order, and you can move the selection cursor to the first file starting with any letter by hitting that letter on the keyboard. Additionally, the directory dialog shows the current path and filter at the top of the box containing the files, the current page and number of pages of files and the amount of free space on the disk at

the bottom of the box, and as the cursor is moved from file to file, the file's name, size and creation date are shown in a box below the files.

Load Images Command

The **Load Images** command is used to retrieve pairs of ST-4 image files from the disk. Once the File Path and File Filter have been set as desired, invoking the **Load Images** command reveals the Directory Dialog. There you select the first image file to load (the Reference Image) and hit the "Enter" key. The directory dialog will momentarily disappear then reappear so that you may select the second image file to load (the Source Image). The difference between the Reference Image and the Source Image is that the Source Image can be translated and rotated in order to align it with the Reference Image, and because of this, changes to the Source Image are can be saved using the **Save Aligned Image** command described below. In the process of using the **Load Images** command, the Status box will display a message saying it is loading each file, and then another when that file has been completely loaded. If any errors occur, the program will warn you. Images must always be loaded in pairs when using the CCDBLINK utility.

Save Aligned Image Command

The **Save Aligned Image** command allows you to save the Source image in memory onto the disk as a standard ST-4 image file, the format of which is described in Appendix A. After setting the File Path if necessary, invoking the **Save Aligned Image** command will present you with a dialog where you can specify the file's desired name. At this point you can hit the "Enter" key and the file will be saved, or you can hit the "Esc" key and the whole process canceled. While the file is being saved, the Status box will show a message to that effect, and then when the save has been completed another message is shown. Should any errors occur, the program will warn you.

THE DISPLAY MENU AND GRAPHICS MODE

The **Display** command/menu is used to switch the program from Text mode (with the menu bar, menus, etc.) to Graphics mode where the image is displayed. Invoking the **Display** command brings up a dialog with several parameters discussed below.

Image:

Using this item, you can display either of the images individually (*Reference* or *Source* settings) or blink between the two images (*Blink* setting). When using the *Reference* or *Source* settings, crosshairs can be used to examine the images and markers can be placed on the images for use in aligning the images.

Auto contrast:

Setting this item to *Yes* causes the software to pick values for the *Background* and *Range* parameters based upon the image data. You will usually want to use Auto contrast when first viewing an image, and then later you can redisplay the image, specifying the contrast parameters to fine tune the display.

Reference Background:

When the *Auto contrast* item above is set to *No*, the Reference image is displayed with all pixel values below the Background level as off or black. Raising this item cuts off more dim pixel values, and lowering it shows more low intensity pixels.

Reference Range:

When the *Auto contrast* item above is set to *No*, this item controls the Reference image's contrast. Pixels between the Background level and the Background level plus the Range are displayed using the intensity capabilities of your display adapter and monitor. Pixel values above the Background + Range level are saturated on the display. Increasing this item decreases the image's contrast and vice versa.

Source Background:

This item is identical to the **Reference Background** item above except that it applies to the Source image.

Source Range:

This item is identical to the **Reference Range** item above except that it applies to the Source image.

Smoothing:

Setting this item to *Yes* causes the displayed image to be smoothed or lowpass filtered. The smoothing doesn't actually affect the image data; it is accomplished by averaging displayed pixel intensities with their neighbors.

Negative image:

Setting this item to *Yes* causes the image to be displayed as a negative, with brighter pixels being black and dimmer pixels being white.

Blink Delay:

When the **Image** item above is set to *Blink*, this parameter controls the delay between blinking the images. Zero is used for manual blinking (the images blink every time the Space key is hit), and 1 through 99 correspond to successively longer delays (slower blink rates). This parameter can also be adjusted while the Blink images are being displayed by using the left and right arrow keys on the keypad to decrease/increase the **Blink Delay** respectively.

Note:

The **Display** command does not modify the image data in the process of displaying it. Any changes to the image's contrast, smoothing, etc. are only for display purposes.

After the items in the Display dialog have been set, hitting the "Enter" key causes the program to switch to Graphics mode and display the image(s). The format of the display is different depending on the setting of the **Image** item above:

Reference or Source setting:

The appropriate image is shown to the right of the screen with any image note at the top of the image and a menu below the image.

Blink setting:

The Reference image is momentarily shown in the center of the screen, then it is replaced by the Source image. Finally, the images will Blink unless the **Blink Delay** item was set to Zero.

You can exit from the **Display** command back to text mode by hitting the "Esc" key. Additionally, if the **Image** item from the Display dialog was set to *Reference* or *Source*, you can invoke the Crosshairs mode or the Markers modes discussed in the next sections.

Crosshairs Mode

The Crosshairs mode is entered by hitting the "X" key from the Analysis display mode mode. This shows a crosshair superimposed upon the image, a series of parameters to the left of the image, and a new **X-Hair** menu at the bottom of the display, the commands of which are described below. Finally, you can exit the Crosshairs mode by hitting the "Esc" key.

Backgnd:

By positioning the cursor and hitting the "B" key, the software uses the data under the cursor as representative of the background level for magnitude calculations. For accurate measurements of magnitudes you should set the Background in a region of the image void of stars or nebulosity.

Star:

By positioning the cursor and hitting the "S" key, the software uses the pixel position under the cursor as the reference position for Separation measurements. For example to measure the separation between two stars you would position the cursor over one of the stars, hit the "S" key, then reposition the cursor over the second star.

Toggle size:

By hitting the "T" key the software cycles the box size used in measuring the Smoothed Pixel value and the Magnitudes from 3 x 3 pixels through 11 x 11 pixels.

The crosshair parameters displayed to the left of the image are updated as the crosshair is moved around the image. The Arrow keys move the cursor by 1 or 5 pixels per keypress depending on whether the "NumLock" or "Shift" keys are down.

Note:

You may find it easiest to move the cursor by keeping your left hand on the Shift key and using your right hand to work the keypad. In this way, you control the speed of the cursor by pressing or releasing the Shift key. Also, you can use the i,j,k, and m keys (and their Shifted versions) as a virtual keypad to move the cursor.

Each of the parameters from the Crosshairs mode are described below:

Pixel:

These are the Crosshair's X and Y coordinates, with Pixel 1,1 being in the upper left hand corner of the image.

Value:

This is the pixel value or intensity of the pixel directly under the crosshair and will range from 0 through 255.

Sm-Value:

This is the average pixel value of the box of pixels centered under the crosshair. The box size is controlled with the **Toggle size** command.

Mag.:

This is the magnitude of the object inside the box of pixels centered under the crosshair. The magnitude is calculated by summing the contributions of all the pixels in the box with the background level subtracted. The calculated magnitude also depends on the Exposure time,

the Aperture and the CCD's Response factor which were stored with the image and can be changed using the CCD program.

DifMag:

This is the diffuse magnitude, or magnitude per square arcsecond, of the object inside the box of pixels centered under the crosshair. In addition to the items affecting the magnitude calculation, the diffuse magnitude depends on the Focal length of the telescope used.

Sep.:

This is the separation in arcseconds between the current position of the crosshair and the position marked with the **Star** command.

Angle:

This is the orientation of the line drawn between the current position of the crosshair and the position marked with the **Star** command, measured in degrees clockwise from vertical

Boxsize:

This the size of the box used in making the average pixel, magnitude and diffuse magnitude calculations, and is changed using the **Toggle size** command.

Markers Mode

The Markers mode is entered from the display or graphics mode by hitting the "M" key, and is used for marking the position of pairs of reference points in images for aligning those images.

To align one image to another you must specify two points in each of the images. One image is referred to as the Reference image, and the second image is called the Source image. The process of aligning images actually involves translating and rotating the Source image to align it with the Reference image, which itself does not get modified.

In each of the two images, you must specify the position of two objects (stars). The position of these objects are referred to as the Pivot and Angle Reference points. The alignment of the Source image to the Reference image is done by the computer by translating the Source image until its Pivot point aligns with the Reference image's Pivot point, and then rotating the Source image until the orientation of the line between the Source image's Pivot and Angle Reference

points matches the orientation of the line between the Reference image's Pivot and Angle Reference points. This is shown diagrammatically below.

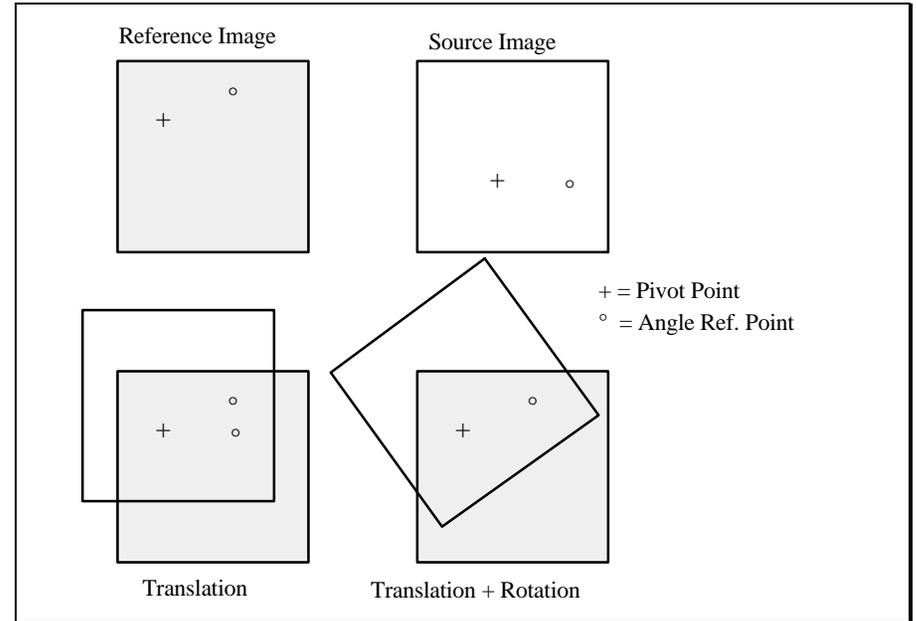


Figure 1 Image Alignment

The Markers mode allows you to mark and record the position of the reference points in the images using the "P" or "A" keys as described below. Pressing one of these keys causes the software to calculate the X and Y centroid of the data under the cursor and retain those coordinates for later use with the **Align** command.

"P":

Use this to mark the position of the Pivot point in either the Reference or Source image.

"A":

Use this to mark the position of the Angle Reference point in either the Reference or Source image.

Alignment of the two images can then be performed as discussed under the **Align** menu.

ALIGN MENU

The **Align** command is used to align images to one another, and is aided by the Markers mode of the **Display** command described above. If you haven't read that section, you should do so because it describes the nomenclature used in the **Align** command .

When the **Align** command is invoked a dialog is shown where you need to specify the X and Y coordinates of the Pivot and Angle Reference points in the Source and Reference images. Procedurally the way you align a pair of images is as follows:

1. Load the Reference and Source images using the **Load Images** command in the **Image I/O** menu. Remember, the first image loaded is the Reference image and the second is the Source image.
1. Display the Reference image and mark the position of the Pivot and Angle Reference points using the "P" and "A" keys in the Markers mode of the **Display** command.
2. Display the Source image, and mark the position of the corresponding Pivot and Angle Reference points using the "P" and "A" keys in the Markers mode of the **Display** command.
3. Invoke the **Align** command to align the Source image to the Reference image.
4. Save the aligned Source image with the **Save Aligned Image** command from the **Image I/O** menu, using a different name (so you don't destroy the original, unaligned, copy of the Source image).

PC MENU

The **PC** command/menu is used to fine tune the operation of the CCDBLINK program to the capabilities of your PC. The parameters in the PC Setup dialog are discussed below:

Graphics card:

Set this item to *Auto* to have the software choose the best possible display mode for your particular PC, or set it to the type of display adapter you have installed in your system. Users with VGA can use all modes except Hercules, users with EGA can use EGA and CGA.

Note:

VGA user may like the MCGA display better which has lower spatial resolution but greater grey-scale resolution.

Color display:

Usually you should set this item to *Yes* if you have a color monitor attached to your system, although you should experiment with the setting to see its effects.

APPENDIX A - IMAGE FILE FORMAT

This appendix describes the image file format used by the CCD and CCDBLINK programs for saving image files, and is included for users who wish to write their own image processing or translation routines.

The image files contain the 8-bit pixel data for the 192 horizontal by 165 vertical pixel images as well as the telescope calibration factors and file annotation.

As shown below in Figure A1, the first 31680 bytes (192 x 165) of the file are the pixel data, in left to right, top to bottom order: The first byte corresponds to the left-most pixel in the top line, the 2nd byte corresponds to the 2nd pixel in the top line, the 193rd byte corresponds to the left-most pixel on the 2nd line, etc. The data should be interpreted as unsigned bytes (values from 0 through 255).

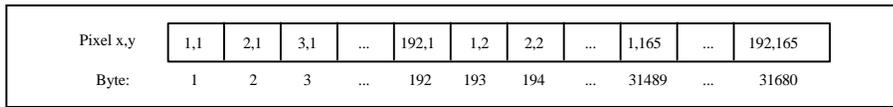


Figure A1 Image Data Bytes in the Image File

After the 31680 bytes of image data, the telescope parameters are stored in a "166th" line of 192 bytes, making the total file size be 31872 bytes. The data on this 166th line is written in text using ASCII characters. ASCII was chosen so that it could be easily interpreted using most programming languages. As shown below in Figure A2, the first byte of the 166th line is a lowercase 'v' character (118 in decimal, which signifies the total length of ASCII data on the 166th line). Bytes 2 through 79 (78 bytes total) are the file's annotation or note. The annotation is left justified and padded with spaces on the right to fill out the 78 character field width. The next 10 bytes (80 through 89) are the exposure or integration time in $\frac{1}{100}$ ths of a second. This field and the next three fields are right justified, padded with spaces as required on the left to fill out the 10 character field widths. The next 10 bytes (90 through 99) are the focal length in inches. Bytes 100 through 109 are the aperture area in square inches, and finally bytes 110 through 119 are the image calibration factor. The remaining bytes (120 through 192) on the 166th line are reserved for future use.

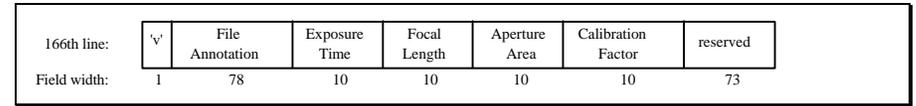


Figure A2 166th Line Containing Image Parameters