Apogee
INSTRUMENTS INC
11760 Atwood Road, Suite # 4
Auburn, CA 95603
Voice: (530) 888-0500
Fax: (530) 888-0540
Web: http://www.ccd.com

CCD CAMERA OPERATING INSTRUCTIONS

All functions of your Apogee camera are controlled by software via the host computer. To connect ISA-bus cameras, see the instructions in the document, *"Installing the PC ISA-Bus Interface Card."* For PCI-Bus cameras, see the document, "Installing the APOGEE PCI-Bus Interface Card". For parallel port cameras, see the document, *"Parallel Port Camera Instructions."* Since there are no external switches or controls for the camera, **ALWAYS TURN OFF THE COMPUTER BEFORE CONNECTING OR DISCONNECTING THE CAMERA**. It is recommended that you read your software manual to learn more about the camera functions described below.

TURNING ON THE THERMOELECTRIC COOLER

In normal operation, it is intended that the thermoelectric cooler be turned on and allowed to reach as cool a temperature as possible. The typical AP7 and AP8 cooler can reach between 50 and 55 degrees C. below ambient temperature; thus, if used at 25° C, a target temperature of –25° to –30° should be set in the software (see your software manual for instructions on setting the temperature). Other Apogee cameras can obtain a maximum of about 30 to 35 degrees C. below ambient. When the cooler has reached its lowest possible temperature, the software will back it off by 2 degrees and regulate there. To prevent thermal shock to the CCD, the software ramps the temperature up and down very slowly. Allow 10 to 15 minutes for the cooler to reach its maximum temperature.

TAKING EXPOSURES

Shutter times for Apogee cameras can be as short as 0.02 second and as long as 10,400 seconds, with increments of 0.01 second. KX85 cameras can take exposures as short as 0.002 second and as long as 1,040 seconds, with increments of 0.001 second. Other KX series cameras can take advantage of 0.001-second increments by setting "test=12" in the camera INI file (see the document entitled, *"Initialization Files"*). This has three drawbacks: 1) The maximum exposure time becomes 1,040 seconds; 2) some camera-control software cannot anticipate millisecond resolution and the user must be aware that the exposures taken by the camera in this mode will actually be 10 times shorter than programmed; and 3) the shortest possible exposures are still 0.02 second (actual), due to limitations of the electromechanical shutter.

Because CCD's are so sensitive to light, when shooting in typical room lighting conditions with a camera lens, it may be difficult to take a short enough exposure without saturating the pixels; in bright daylight, this may be impossible. Use a small aperture setting and short exposure time (less than a tenth of a second) in normal room lighting with a camera lens.

IMAGE CALIBRATION FRAMES

In most of the software packages that control Apogee cameras there are four types of exposures that can be taken: bias frames, dark frames, light frames, and flat frames. Bias, dark, and flat frames are used to calibrate light frames. Image calibration is the process of removing or diminishing optical artifacts (shadows from vignetting or dust on optical surfaces, such as the camera window or lens elements) and thermal artifacts (dark current) from CCD images through image arithmetic.

The bias frame is a zero-length exposure taken without opening the shutter. Its purpose is to show the electronic offset, which is in every image taken with the camera. The bias offset can be subtracted from an image, but since it exists within a dark frame, the offset calibration can be considered an integral part of the dark correction step.

The dark frame shows the amount of thermal signal contributed to each image by the CCD itself. CCD's are operated at cold temperatures to avoid as much thermal contribution as possible. For proper calibration, the dark frame (see "dark frame" in your software manual or online help) should be taken with the shutter closed, but with the same exposure time and thermoelectric cooler temperature as the light frame. No shutter is completely light tight where CCD's are involved, so it is recommended that the optical system be covered during dark exposures. Subtracting a dark frame removes most of the thermal contribution, leaving only a small amount of thermal noise in the image. As a general rule, the colder the sensor, the lower the resultant thermal noise will be. A single dark frame can be used to calibrate many light frames, if the exposure lengths and cooler temperatures are identical. Combining several dark frames (see "combine images" in your software manual or online help) to produce a master dark frame is considered by many to be a better method of dark subtraction than using a single dark frame.

The **light frame** is a shuttered exposure, and there are two types of light frames: normal imaging frames and the so-called flat-field (or flat) frame. The flat frame is a calibration frame and it is used to reveal artifacts in the optical path. Vignetting and dust particles (on the camera window, lens, and filters) will be revealed in a flat frame, as well as the effects of pixel-to-pixel variability of the CCD in its response to light.

The flat frame is taken by exposing the camera and its optical system to a uniform light source. This can be an evenly illuminated white card placed in front of a camera lens, or it may be a large screen held in front of a telescope tube. Astronomers sometimes use the twilight sky as a light source for flat frames, hence the name "twilight flats." The Hubble Space Telescope has been known to use uniform areas of the earth's oceans for flat frames (occasionally corrupted by intruding ships). The flat frame should be dark-subtracted and normalized (usually done automatically by the software) and then divided into each normal light image (see "flat frame" or "calibration" in your software manual). A flat frame need not be of the same exposure length as normal image frames, but the pixel values in the flat frames should be about halfway to saturation in order to ensure a good signal-to-noise ratio for the flat frame. If the pixel values are too low or too high in the flat frame, the flat field calibration will not improve the quality of the image, and, in some cases, may make the image worse. Like dark frames, a single flat frame can be reused to calibrate many images, as long as the optical artifacts (dust particles, vignetting, etc.) stay the same. A number of individual flat frames may also be combined to create a master flat frame for calibration. The primary requirement of a flat frame is that it should be taken through the optical system exactly the same way as the light frames. If the camera is rotated about the optical axis between images, or if filters are moved or replaced, a new flat frame (or master flat frame) should be created to calibrate each corresponding light frame. When color filter sets are used, a separate flat (or master flat) should be created using each filter to calibrate its respective images.

Image calibration is a tedious process that requires careful understanding, patience, and lots of practice. The user can be the judge as to whether or not any of the above calibrations are necessary for his or her application. If the signal-to-noise ratio is high enough, a raw image might be acceptable. Often, bias and dark correction are the only steps necessary. If vignetting or dust donuts (the out-of-focus result of a dust spec in the optical path) are noticeable in the image, a flat field calibration might be desirable. In applications such as astronomical photometry, where CCD images are used to count photons, it is mandatory that all electronic, thermal and light-path artifacts be removed as cleanly as possible. In many applications, however, photon counting is not important.

FOCUSING THE CAMERA

Whether the camera is attached to a telescope or a camera lens, focusing and centering can be the most frustrating and time-consuming part of the imaging experience. There is no way to look through the camera and optical system, so focusing is done by taking an image, inspecting it for sharpness, adjusting the focus, taking another image and repeating this process until the sharpest image is produced. Focusing routines in the software are of great help here. These are similar in usage from program to program, but you may require help from the software manual in order to access them (see "focus mode" or "focus" in your software manual or online help). The camera is not automatically focused in any case.

The software focus routine is designed to take a sequence of exposures unattended while the user makes adjustments to the focusing mechanism of the lens or other optical instrument and inspects each new image for sharpest focus. To save time in this step, a subframed image is recommended. Use the region of interest (ROI) tool to mark off a small section of the image (in some cases, this is as simple as using the mouse to drag a box around the region) that contains a point of light or edge of some kind. When this ROI is sent to the camera, only that part of the image will be updated during focus exposures. Reading off a small portion of the chip increases the frame rate, allowing the user to focus the camera more quickly. For maximum frame rate using subframes, increase the values of the hflush and vflush parameters in the camera INI file (see the document, *"Initialization Files"*). Some focus routines are simple, requiring the user to judge best focus by the apparent image sharpness. Other routines are more sophisticated and display a graphical image of the peak pixel values to aid in determining the best focus.

SHUTTING DOWN

At the end of an imaging session, it is important to warm the CCD slowly. Use the temperature control settings in the software to return the CCD to ambient temperature (preferable) or turn off the cooler. Then wait about 10 minutes before powering down the computer and camera. The heat sink fans draw heat away from the CCD. Simply turning off power to the camera while the TEC is turned on would allow heat to flow in the direction of the camera and warm it rapidly, causing thermal shock to the CCD. It is best to allow the camera power to remain on so that the heat sink fans can continue dissipating heat after the cooler has been turned off in the software. The CCD will have a longer life if the user makes a habit of keeping temperature changes slow and regulated.

When the CCD cooler temperature reaches ambient, the computer may be powered off. If an ISA-bus or PCI-Bus camera is to be detached from the computer after use, always remove the cable from the camera head first, and then remove the cable from the computer. When reattaching the camera, reverse the order and plug the cable into the interface card first. In this way, you will reduce the risk of electrostatic shock damage to the camera, since the grounded computer will dissipate any charge from the cable before it comes in contact with the camera head. Parallel-port cameras may be plugged into and unplugged from the computer while the computer is running. In fact, if the computer is running, it is recommended that you power up the camera (fans running) before plugging it into the computer's parallel port. For safest operation, however, it is best to plug in the camera and unplug the camera while the computer is off.

CARE AND HANDLING OF THE CAMERA

Handle your Apogee camera with care, as you would any delicate instrument. The aluminum camera body can be cleaned with a soft cloth and glass cleaner. Never spray liquids directly on the camera; apply cleaning solution to the cloth, then wipe the camera body with the dampened cloth.

Over time the camera's optical window will collect dust and other particles. Clean the window by applying lens cleaner and gently wiping it away with a soft, lint-free cloth or lens tissue; avoid heavy rubbing, which may scratch the coating.

Dust will also collect on the cooling fans located on the back of the camera head. From time to time, it may be necessary to clear away the dust with a small brush. The fans disperse heat as it radiates away from the heat sink. Should the airflow become blocked, the thermoelectric cooler may run a few degrees warmer than normal and the camera body could overheat, causing damage to some of the more sensitive components.

The camera components are sensitive to mechanical, electric, and thermal shock. Follow these guidelines for safe operation of the camera:

1. **Never connect or disconnect an ISA-bus or PCI-Bus camera while the computer is running.**
2. Always ground yourself to dissipate electrostatic charge before handling the camera and its controller card.
3. As much as possible, avoid contact with any of the electrical components of the camera system, especially connector pins and the controller board edge connectors (or fingers).
4. Always tighten down the cable connector screws, both at the computer and at the camera head.
5. If the camera is to be connected to a moving device, such as a mounting stage or telescope, be sure to secure the cable with cable ties and allow enough slack so that the cable connector is not stressed during movement.
6. Always allow the sensor to cool down and warm up slowly.
7. **AP7, AP8, and SPH series camera owners:** Do not expose these back-illuminated CCD chips to direct sunlight (i.e., removing the lid assembly or leaving the shutter open while out of doors). UV charging can result, causing a gradient in light frames. This effect may last for several weeks.
8. Lightning can damage the camera components, even if it is not a direct strike. Always disconnect the camera and remove it from grounded equipment (such as a telescope) whenever there is thunderstorm activity in the area.

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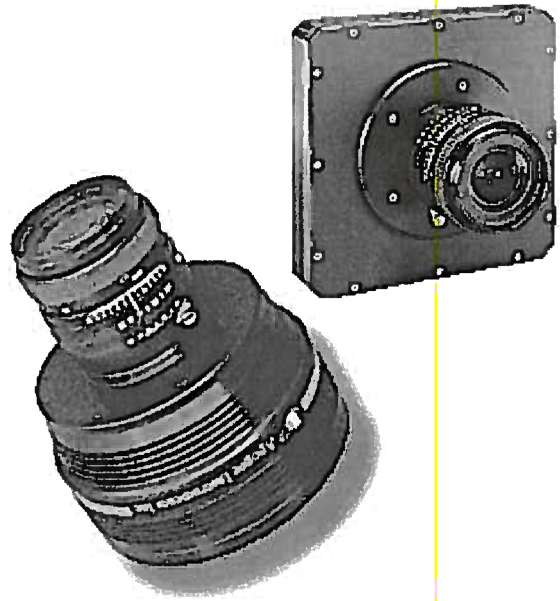

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TEST DATA SHEET

Model:	KX32ME	**Date:**	5/26/2003	**Sensor:**	KAF-3200ME-1
Bits:	14	**Firmware Rev.:**	P14E	**Size**	2148X1472X6.8u
CAM s/n:	A3250	**Cable Length:**	15'	**Cooling:**	STD
PC s/n:	A3250a	**Base Address:**	PCI	**Window:**	STD

TEST DATA

System Noise

GAIN:	5.4
SDEV	1.7
n(e-)	9.2

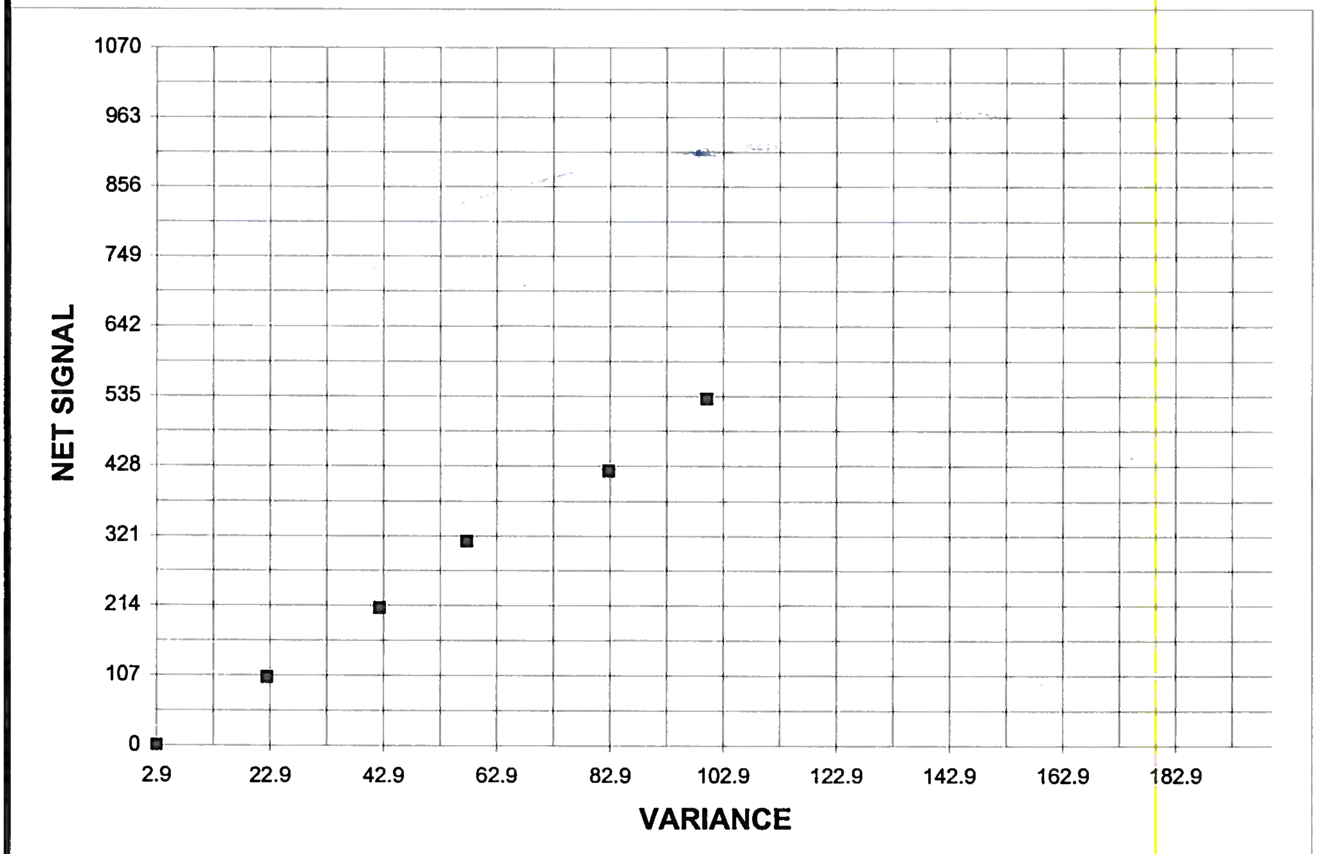
Bias Level Setting: 326

Power On Cooling n/a

Maximum Digitized Well Capacity: 87k

GAIN 5.4 e-/ADU   16,100 levels

	Zero	Scale
Temp Calibration:	165	2.1



DARK COUNT

Temperature	-12
Net Count	.09 e/p/s

Notes: 4H0242 4379

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Apogee
INSTRUMENTS INC

Initialization Files
Tech Note 015

Introduction

The initialization (INI) file contains vital information for the operation of Apogee Instruments cameras and it should be placed in the main program directory of whichever software you installed for camera control. The contents of the INI file will vary depending on the sensor used and other operational factors. A sample INI file is listed in its entirety at the end of this document for reference.

Installation of the INI file

The camera INI files on the accompanying diskette have been named for the type of camera (e.g., AP1.INI is for an AP1 camera, regardless of whether it is UV-coated or the new KAF-0400 "E" sensor). Choose the file that matches your camera and copy it into your camera-control software directory. In the case of the *Image-Pro Plus* camera driver from CRI, the camera INI file must be renamed APCCD.INI and placed in the C:\IPWin3 directory. Other applications allow the user to select the INI file they need to use, independent of the file name or location.

NOTE: If you have properly connected the camera to your computer but it cannot be found by the control software, the most common reason is a conflict with the base address. See the description of the base= parameter later in this document.

Using the INI file

The parameters in the INI files on the Apogee diskette are for standard systems. As such, they will operate any standard camera without the need for making any changes. However, there are a few important parameters that you should check and modify accordingly, depending on which options you have selected for your camera system, before using the INI file:

ecp=OFF (Parallel Port Cameras Only) This parameter should be set to off if your computer BIOS has an option of "bi-directional" or "PS/2" for the parallel port (e.g.,LPT1). If your computer BIOS does not have either of those options but instead has "ECP" or "ECP/EPP", select one of these modes and set "ecp=ON" in your camera INI file.

base = 290 Apogee cameras use a base address but not an IRQ. For cameras that use an ISA-bus controller card, the base address for the camera is set by a jumper on the card. The INI file base= parameter value must match the setting on the card. If the card's default setting of 290 conflicts with other devices on the computer, the jumper may be moved to one of the other settings (390, 310, etc.), in which case, the base address value in the INI file must be changed to match the address of the card. Parallel-port cameras use the base address of the parallel port. If the computer's parallel port is not 378, the INI file must be changed to match the parallel port's base address.

trigger = OFF By default, this parameter is set to OFF. If you are synchronizing your shutter with an external pulse, you should set trigger=ON. Currently, only *PMIS* and *MaxIm DL CCD* support this function.

cable = SHORT The two valid parameter values are "SHORT" and "LONG". Standard camera systems may include a 10-foot, 15-foot or 25-foot cable. These are all considered "short" in the camera INI file. Custom length cables up to about 200 feet may be ordered. For 16-bit cameras, cable longer than 115 feet is considered "long." For AP10 systems, over 35 feet is "long." In KX and 14-bit AP systems, above 25 feet is considered long. In these systems, you may have to modify the test= and mode= parameters. See the detailed description of the cable= parameter later in this document for instructions on choosing the appropriate cable= parameter value.

cal = 165.000000 Not critical for camera initialization, but still important for proper operation of the camera, this parameter can vary from system to system. The default is 165. The value for cal= should match the "zero" value in the "Temp Calibration" section of the test data sheet you received with your camera. The range for temp calibration is typically between 145 and 165.

Detailed description of the INI file parameters

ecp = OFF

Parallel Port Cameras Only: This parameter should be set to off if your computer BIOS has an option of "bi-directional" or "PS/2" for the parallel port (e.g.,LPT1). If your computer BIOS does not have either of those options but instead has "ECP" or "ECP/EPP", select one of these modes and set "ecp=ON" in the camera INI file.

base = 290

Most critical for camera recognition is the base address. All Apogee cameras (except parallel port cameras; see note below) are configured for a default base address of 290. If this address causes a conflict on your computer, you can change the base address by resetting the jumper on the ISA-bus controller card (see the instruction sheet entitled "Installing the PC ISA-Bus Interface Card"). After making the jumper change on the controller board, be sure to make the "base=" line in the INI file correspond to that address.

NOTE: For parallel-port cameras the INI file default is "base=378", which is typically the base address of the computer's parallel port (usually LPT1). In some cases, the computer's parallel port base address is 278 or 3BC. If so, the INI file base= parameter should be modified to match it. Sometimes a second parallel port (LPT2) is added to the computer. Make note of which port the camera is connected to and set the INI file's base=- parameter accordingly.

mode = 1

The mode value is used to invoke special operating modes in some cameras. Currently "mode=1" is the default setting. For AP7b users with controller firmware S16H and above, mode should be set to 8. Otherwise, the data will have a 32,768-count offset. KX and AP 14-bit cameras (except AP10) use mode to extend cable length (see the "cable=" parameter).

test = 4

In most cameras, the default is test=4. The test value is used to invoke special operating modes in some cameras. These are as follows:

Cable Extension (KX systems only): The KX and 14-bit AP series (except AP10) cameras use this bit to extend the maximum cable length to 200 feet. This parameter and the mode= parameter are used in conjunction with the cable= parameter. Cable length is discussed in detail there.

Timer Resolution (KX systems only): Changes operation of the exposure timer to give 0.001-second resolution. At 0.001-second resolution, the minimum exposure time is 0.002-second (instead of 0.02-second) and the maximum becomes 1040 seconds (instead of 10,400 seconds). The advantage is that exposures can be set for 0.001-second intervals rather than 0.01 second intervals in normal mode. Not all software packages support this mode, although all of them can be "fooled" by entering an exposure value 10 times higher when in this mode (thus, 0.02 in the software becomes actual 0.002).

The table below lists the possible values for test=. The final value is the sum of the options desired. For example, if cable extension AND 0.001 second timer resolution is desired, the final value for test is 4+1+8=13.

Operation	test =
Default	4 (or 0*)
Vdd control inversion	Add 2
Cable Extension (KX cables longer than 25 feet; see "cable=" parameter below)	Add 1
0.001 Timer resolution	Add 8

***All controller cards with Q (e.g., QRX1) firmware, such as those for AM series cameras, should use** test=0.

Flush Frequency matching (AP7 only): For AP7 users with controller firmware S16H and above, the test value can be used to "tune" the flush frequency to eliminate bright lines (rows) when other programs are running in the background during image readout. The default value is 10. The range is 1-15. Lowering the number will result in brighter lines during readout, while raising the number will result in darker lines during readout.

shutter = ON

trigger = OFF

These are used by the application to enable the shutter during exposures and to allow triggered exposures. Shutter is normally left ON. Trigger is normally set to OFF. Trigger should be ON if you are using the trigger port with *PMIS* or *MaxIm DL CCD.*

caching = ON

All cameras are now shipped with cached fifo memory on the controllers, and should have this value set to ON. Older AM and AP series 16-bit controllers did not have caching capability; caching should be turned off for those systems. Memory caching improves throughput, especially on the 14-bit systems. This parameter can be set to OFF with caching controllers, but the download speed will be slower.

cable = SHORT

Sets the expected cable length range for the system (except for parallel-port cameras – they use the c0_repeat= parameter discussed later in this document). An incorrect setting of the cable= parameter will cause corrupted data. A clue that this has happened is the abrupt data changes by some power of 2. The KX systems use cable= in conjunction with the test= and mode= parameters to extend the range. The table below shows the possible cable length ranges and their test=, mode=, and cable= settings. Note that the test values are written as "add 1", to accommodate other uses of the test= parameter (see above); however, the mode= parameter is listed as its final value because there are no other uses of mode for KX and 14-bit AP systems.

System	cable = SHORT	cable = LONG
16-bit AP and SPH Series	1-115 feet	125- 250 feet
14-bit AP10 Cameras	1- 35 feet	65-100 feet
14-bit KX and AP Series (*Firmware K14N and higher)*	1- 25 feet 65 – 75 feet, mode=5 115 – 135 feet, mode=9	26-55 feet, test=(add 1) 85 – 115 feet, test=(add 1) + mode=5 145 – 165 feet, test=(add 1) + mode=9 175 – 200 feet, test=(add 1) mode=13

data_bits = 14

Set for the number of bits in the system. The typical values are 14 or 16. Some software applications ignore these values.

port_bits = 8

The output port now has 8 bits, but some older controllers had 6 bits. This is only used by applications that allow manipulation of the open-collector output port, such as *PMIS.*

tscale = 1.000000

This is a calibration of the timer with respect to the master oscillator on the controller boards. The application software uses this value to adjust the ACTUAL value written to the timer to compensate for faster or slower oscillators. The default value is 1.000000 when used with a 16.257 MHz Oscillator.

gain = OFF

This parameter was created for dual-gain 12-bit camera systems, which are now obsolete. It should be turned on only when using 12-bit (dual-gain) cameras running with *PMIS* or *MaxIm DL CCD* software. When turned on, the software allows you to set the camera for high (32 e-/ADU) and low (15 e-/ADU) gain. Use high gain if you wish to increase your dynamic range under bright light conditions. Use low gain to distinguish subtle details in low-light conditions.

c0_repeat=1

For parallel port cameras only. This is equivalent to the "cable=" parameter. For up to 60 feet of cable, use c0_repeat=1. Beyond that length, increase the value in increments of 1 if data dropouts appear in the images (these may appear as a scattering of hot pixels across the image).

[geometry]
rows = 521
columns = 792
imgcols = 768
imgrows = 512

These parameters are used to set the chip geometry, i.e., the number of rows and columns. The total number of columns (columns=) and rows (rows=) includes a border of non-imaging columns (or "overscan and underscan") and rows around the imaging area, which is defined by imgcols= and imgrows=. The non-imaging regions can be supressed by making use of bic and bir (discussed in the following section). The camera will not initialize if bic+skipc+imgcols is greater than or equal to the value of "columns." Likewise, bir+skipr+imgrows should not equal or exceed the value of "rows." When describing a CCD array (e.g., 1536x1024), the first number is the number of columns (the long side of a non-square CCD).

bic = 12
bir = 6

Bic= sets the imaging offset in columns and can be set to ignore the pre-scan columns. The minimum number allowed is bic=2. Bir= sets the imaging offset in rows and can be set to ignore the pre-scan rows. The minimum number allowed is bir=2. Note that the rows= and columns= values are not constrained by the actual sensor. For instance, an AP1 camera with 768x512 imaging pixels can be fooled into taking a 1024x1024 image, by setting the geometry section to mimic an AP6. The resultant image will show the 768x512 image, with extended bias filling out the remainder of the 1024x1024 array.

The table below lists array sizes for sensors used in Apogee cameras. Remember that the physical array is only a ballpark figure and can be increased in order to accommodate before-imaging and after-imaging offsets.

Camera	Total Pixels (Cols x Rows)	Imaging Pixels (Cols x Rows)	BIC	BIR	SKIPC	SKIPR
AP260, KX260 (KAF-0260)	531 x 521	509 x 511	14	7	7	2
AP1, KX1 (KAF-0401)	792 x 521	768 x 512	12	6	6	2
AP6 (KAF-1000)	1040 x 1034	1024 x 1024	9	7	6	2
KX14 (KAF-1400)	1336 x 1039	1317 x 1030	12	6	8	2
KX85 (ICX085AL)	1335 x 1039	1300 x 1030	26	6	8	2
AP2, KX2 (KAF-1600)	1560 x 1033	1536 x 1024	12	6	6	2
AP4, KX4 (KAF-4200)	2067 x 2058	2048 x 2048	12	6	6	2
AP7/B/P (SITe 502)	532 x 532	512 x 511	12	3	6	2
AP8 (SITe 003)	1043 x 1033	1024 x 1024	12	6	6	2
AP9 (KAF-6303)	3095 x 2057	3072 x 2048	14	6	8	2
AP10 (THX7899M)	2081 x 2058	2048 x 2048	26	6	6	2

hflush = 4
vflush = 4

The hflush= and vflush= values define the binning used for flushing between images and for row and column skipping for subframe operation. The binning used for flushing and subframe can be different than that used for the region-of-interest data. This can be a very useful tool for increasing the speed of subframes for focus mode. The parameter values can be as high as hflush=8 and vflush=63, but generally little speed is gained above values of hflush=8 and vflush=8.

skipc= 6
skipr=2

These parameters throw out the first number of rows and columns specified before displaying a region of interest. Some systems produce non-data artifact rows, typically in rows 1 or 2. Eliminating them helps auto-scaling routines function properly.

Skipc= and skipr= must be greater than 1. Additionally, skipr= must be less than the value for bir=. Since the digitization process always produces 2 bad rows along the upper portion of the image, skipr= can always be set to 2, thus forcing bir= to always be at least 3.

Upon inspection of the images produced by your camera, you may notice dark or bright columns and/or rows at the edges of the frame. Bic=, bir=, skipc=, and skipr= work together to eliminate unwanted pre-imaging and post-imaging columns and rows, but some trial and error may be necessary to eliminate them completely.

A logical sequence for setting these parameters is to set bic=2, bir=3, skipc=2 and skipr=2. Take a subframe and zoom in on the top and left edges of the frame. Set skipc= and skipr= in the INI file to values equal to the number of bad columns and rows seen at the edges of the image. Next, increase bic= and bir= until all the unwanted pre-imaging columns and rows are suppressed in a full-frame image. It may be necessary to increase the total physical columns and rows in order to accommodate higher values of bic=, bir=, skipc=, and skipr=.

[temp]
target=-15
cal=165.000000
scale=2.100000
backoff=2.0

These parameters program the temperature controller used for cooling the CCD. The target= value establishes a default target temperature. Not all applications use this value, but may instead remember the last value entered by the user.

Cal= and scale= factors calibrate the controller. Cal= is a decimal number from 0-255, which corresponds to the digital byte written to the controller producing a temperature of 0 degrees C. Cal= may be between 100 and 165, but the default value is 165. The value used should match the "zero" value in the "Temp Calibration" section of the test data sheet sent with the camera. Scale= determines the weighting of each digital count, as referenced to 0 degrees C. The typical value for scale= is 2.1.

The application software uses backoff= to determine how many degrees to reset the controller if a maximum temp delta flag is detected. For example, if the user programs the CCD for –20 C, but the controller can reach only as low as –15 C, the application will reset the temperature at –13 C if backoff=2. This ensures that the controller will always regulate temperature properly.

[camreg]
gain = 0
opt1 = 0
opt2 = 0

This parameter is only for 12-bit cameras, now obsolete. It sets the default gain (0 for normal, 1 for high) used in the software. The "opt1=0" and "opt2=0" parameters are optional bits used by Apogee for special test purposes. Leave these set to 0.

INI-file Notes for Camera-Control Software

Camera (for Linux) from Clear Sky Institute

The INI files on the accompanying diskette cannot be used directly with *Camera*. However, the contents of the INI file for your camera will be helpful when building the Linux camera driver.

CCDSoft from Software Bisque

CCDSoft versions prior to 4.00.021 used a DLL that did not make use of some of the INI file parameters discussed here. In those versions, the INI file had to be called APCCD.INI and it had to be located in the *CCDSoft* directory. In 4.00.021 and higher versions, the INI file can have any valid filename and its location can be in any directory on your computer. However, when upgrading to version 4.00.021 from prior versions, you must click the "Settings..." button in the camera setup window and select the INI file you wish to use. You should also refresh your INI file by deleting the APCCD.INI file in your CCDSoft directory and recopying the INI file for your camera from the accompanying diskette. If you are using an older copy of *CCDSoft*, it is recommended that you upgrade to version 4.00.021 or higher. Software Bisque offers free upgrades on their web site. You can download the current version of *CCDSoft* by visiting **http://www.bisque.com** and navigating to the "Downloads" section.

Image-Pro Plus™ capture driver from CRI

The camera initialization file should be renamed to APCCD.INI and placed in the *IPP* directory prior to installation of the capture driver from CRI. The installation program will abort of it doesn't find the APCCD.INI file in the *IPP* directory. Also, the data_bits parameter value may need to be increased if the range of the image pixel values is lower than expected.

KestrelSpec from Catalina Scientific

KestrelSpec comes with its own INI file for Apogee CCD cameras. Some of the required INI file parameters for *KestrelSpec* do not exist in the INI files provided by Apogee Instruments. Therefore, do not replace the *KestrelSpec* INI file with an Apogee INI file.

MaxIm DL CCD from Diffraction Limited

MaxIm DL CCD remembers the location of the INI file after initializing the camera the first time. Thereafter, clicking the "Restart" button in the Setup tab of the camera-control window will establish a link to the camera.

PMIS from GKR Computer Consulting

There are 3 common error messages in *PMIS* camera control, related to CCD format, image size, and sometimes, the INI file. It is helpful to know which of these is caused by an incorrect INI file, and which is caused by program settings.

% CLI – Error, Camera interface error, bad load. This message is usually due to a mismatch in the INI file geometry parameters. The sum of imgcols+bic+skipc must be at least 1 less than columns=; likewise, the sum of imgrows+bir+skipr must be at least 1 less than the value of rows=. Additionally, the value of skipr= must be 1 less than the value of bir=. If any of these rules is broken, a "bad load" message will occur.

%CLI – Error, CCD format incorrectly defined. This is not the result of a faulty INI file. Go to the "Acquisition Area…" window in the "Camera" menu. Click "Full Camera" and then click "OK" and open a new image window.

% CLI – Error, Image size or offset illegal or inconsistent, image size and CCD format incompatible. This is not the result of a faulty INI file. Close the current image window and open a new one before attempting to take an exposure.

Besides the camera INI file, the PMIS.INI file (located in the *PMIS* directory) has camera parameter entries. Generally, the PMIS.INI file takes precedence when entries exist in both INI files. For instance, the target temperature parameter in the camera INI file will be ignored if a target temperature parameter exists in the PMIS.INI file.

The following is a sample INI file in its entirety:

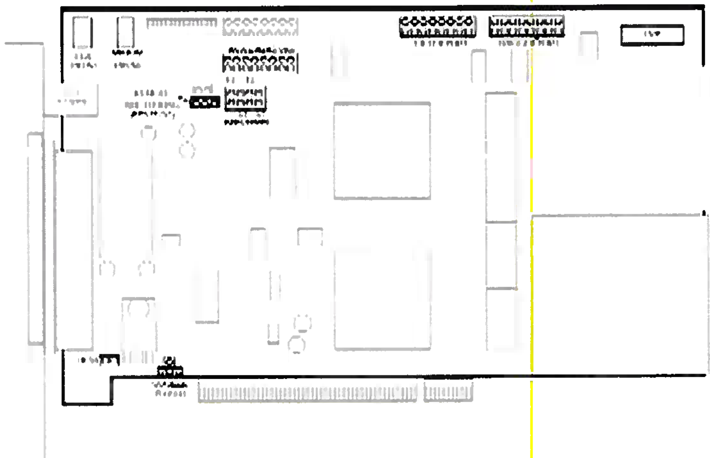
```
[system]
ecp=OFF
base=290
mode=1
test=4
shutter=ON
```

```
trigger=OFF
caching=ON
cable=SHORT
data_bits=14
port_bits=8
tscale=1.000000
gain=OFF
c0_repeat=1

[geometry]
rows=521
columns=792
imgcols=768
imgrows=512
bic=12
bir=6
hflush=4
vflush=4
skipc=6
skipr=2

[temp]
target=-10.0
cal=165.000000
scale=2.100000
backoff=2.0

[camreg]
gain=0
opt1=0
opt2=0
```

See Back Page

Installing the Apogee PCI-Bus Interface Card

Apogee
INSTRUMENTS INC



203
205 Tech Support
11760 Atwood Road, Suite # 4
Auburn, CA 95603
Voice: (530) 888-0500
Fax: (530) 888-0540
Web: http://www.ccd.com

Your Apogee Instruments CCD camera comes with an interface card (controller board) to be installed inside your PC. This card is supported within the Windows family of operating systems, including Windows 98, Windows ME, Windows NT 4.0, and Windows 2000.

To ensure proper and safe installation of the interface card, follow the instructions below:

Preparation

The electronics of the CCD camera head and the PC interface card are extremely sensitive to electrostatic charge. To avoid damage to the camera components, be careful not to handle them while carrying electrostatic charge. Leave the interface card in its anti-static bag until you have the computer open. You will need a Phillips screwdriver and a pair of scissors. Have these and the interface card within reach of the computer when you are ready to install the interface card.

Step 1

Turn off your computer and open its case.

Step 2

Look for an open PCI bus slot on your computer's motherboard. Use the Phillips screwdriver to remove the back-panel dust-cover plate adjacent to the PCI slot where you will install the interface card. If you have an AP10 camera or are using the trigger port option, remove as many dust-cover plates as necessary to accommodate the extra ports.

Step 3

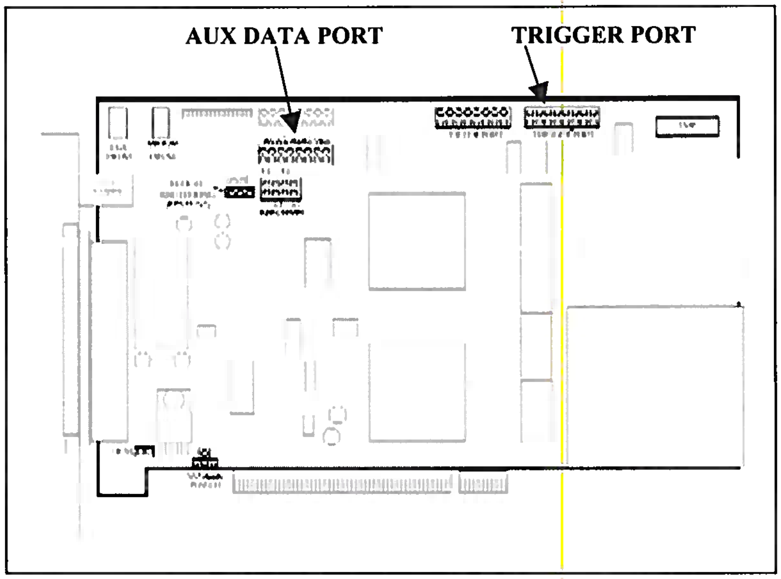
Touch the metal frame of the computer to dissipate any electrostatic charge you may be carrying, then use a pair of scissors to cut open the plastic bag containing the interface card. Remove the interface card from the bag, grasping it by the mounting bracket and card edges. DO NOT touch the edge-connector fingers of the card, and avoid, as much as possible, contact with any of the components.

AP10 Camera Owners:

The AP10 cameras have two control cables: the large 37-pin cable that plugs into the controller card, and a smaller 15-pin cable for auxiliary data that plugs into the AUX DATA ribbon cable's DB15-plate. The 15-pin data cable uses the auxiliary data port on the controller card (see illustration). Attach the ribbon cable marked "AUX DATA" to the controller card before proceeding to Step 4. To install the AUX DATA cable:

a) Insert the 16-pin header connector on the controller port header marked "AUX DATA PORT." **Make sure that the red stripe on the ribbon cable is on the side of the connector marked '1' on the controller board (this is the left side of the connector as shown in the illustration).**

b) After installing the controller board (see Step 4), install the DB15-plate end of the cable in an available card slot opening.



Using the optional Trigger Port:

If you are using the optional Trigger Port, install the Trigger Port ribbon cable before proceeding to Step 4. It is installed in the same way as the AUX DATA ribbon cable, but refer also to the instruction sheet entitled, *"Trigger/Port Instructions."*

Step 4

Align the edge connector fingers with the PCI slot receptors and press the interface card firmly into the PCI slot. When it is fully seated, use the screw from the dust-cover plate to secure the interface card.

Step 5

Replace the computer case but do not tighten it down with screws yet. Should there be a configuration problem, you may need to access the card and change a jumper setting.

Plugging in the Camera

If you are installing the optional Remote Boost Unit, refer to the document entitled *"Remote Boost Unit Instructions."* Otherwise, proceed with these instructions.

With the computer turned off, plug the male end of the 37-pin cable into the connector on the interface card. Next, plug the other end of the cable into the male connector on the CCD camera head. AP10 camera owners: repeat these steps with the 15-pin data cable. **Be sure to tighten down the cable connector shell screws, both at the computer end and at the camera head. The camera can be damaged if the cable(s) should become unplugged during use.**

Whenever you are connecting the camera to the computer, always plug the cable(s) into the computer first, to dissipate any electrostatic charge that might otherwise damage the camera head electronics. Likewise, when disconnecting the camera from the computer, always remove the cable(s) from the camera first, and then unplug the cable(s) from the back of the computer. **Never connect or disconnect the camera cable(s) while the computer is turned on!**

After connecting and securing the cable(s), the computer may be powered up.

Software Installation

For most operating systems, your Apogee PCI controller card is treated as a Plug-n-Play device. The operating system will automatically detect the card and install the driver in the proper location. The procedure that follows is taken from the Windows Millennium (ME) installation. Windows 98 and Windows 2000 will follow a similar process.

Prior to installation, please make a note of the driver file location. Depending on your particular configuration, these may be located on floppy disk, CD-ROM, or you may copy the driver files to a location on your hard disk drive.

Step 1

After booting the machine for the first time, the operating system should detect the new PCI adapter. A message will be displayed that new hardware has been found in the system. The new hardware detected should state that a "PCI Bridge" device was located. Continue to add the new hardware into the system.

Step 2

The operating system displays a dialog indicating that "Windows found the following new hardware: PCI Bridge". Select the option to "Specify the location of the driver" and press the "Next" button.

Step 3

The operating system will now present a dialog box asking where the driver files are located for installation. Select the option to "Specify a location (Browse)". Browse the file dialog to locate the directory where the ApPCI.inf is located. Note that this file, plus the ApPCI.sys file, should reside in the same directory for installation, since the ApPCI.inf will perform the actual file installation on the system.

Step 4

Once the location is specified, Windows will confirm the location. A dialog box will appear stating "Windows driver file search for the device: Apogee PCI Hardware". The file location from the previous step will be displayed. If this information is correct, press the "Next" button to complete the installation procedure.

Step 5

Assuming the file path for the location of the ApPCI.inf file is correct, the ApPCI.inf file will perform the actual system installation of the ApPCI.sys file. Once this operation is finished, a dialog box will appear that "Windows has finished installing the new hardware device." Click the "Finish" button to end the installation.

User's Note

Please note that many current operating systems such as Windows ME and Windows 2000 support power management capabilities. The Apogee PCI controller card does not support power management, since power is being supplied to the camera electronics and cooler directly from the system's bus. Therefore, some operating systems may display a message indicating that the system cannot enter a low power state due to the Apogee PCI hardware. This is expected behavior.

Also note that there is another Apogee driver called ApogeeIO.sys. This driver is not required for the Apogee PCI controller card, unless the PCI card is being used under Windows NT 4.0. Similarly, if the PCI card is being used under the Windows NT 4.0 operating system, the ApPCI.sys (and ApPCI.inf) files are not used or installed.

Developer's Note

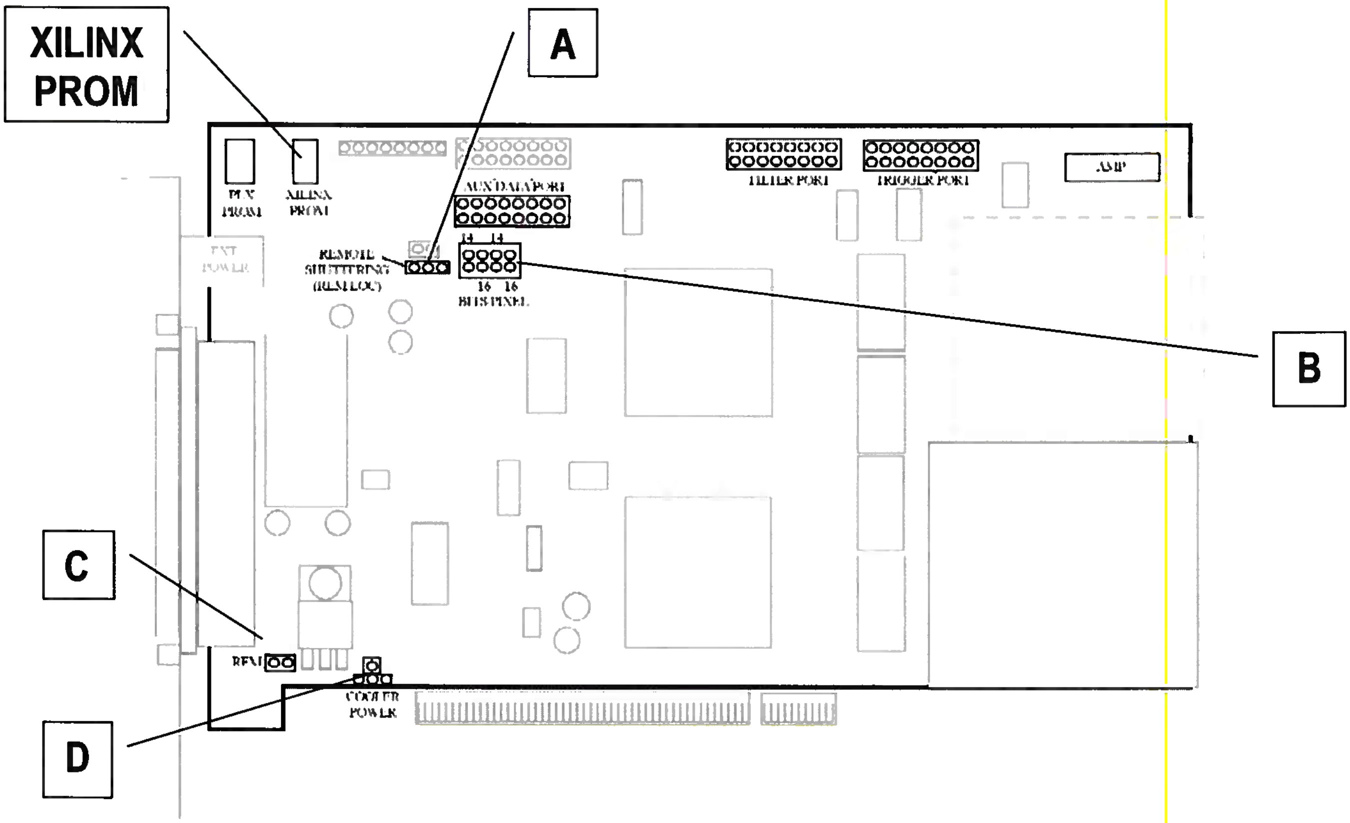
At various stages in the development of your code to control Apogee cameras, the controller card may end up in a state whereby the only means of resetting it is to turn off the computer. If the camera fails to respond during the testing of software, power down the computer and then restart.

The Apogee.DLL file contains the ActiveX/COM interface for application writers. Please see the documentation for the ActiveX/COM API for a reference to the interface.

One card supports all cameras

The Apogee PCI-bus card can be configured for any Apogee camera by changing a few jumpers and the 8-pin firmware **XILINX PROM**. The illustration below shows the location of the **XILINX PROM** and the 4 jumper blocks, which are labeled **A**, **B**, **C** and **D**. Jumper blocks **A**, **C**, and **D** pertain to cooler and shutter operation, and whether or not a remote boost unit is being used. Jumper block **B** is for digitization. **The following illustration is for reference only; the PCI card is preconfigured and need not be changed by the user.**

NOTE: IT IS CRITICAL THAT THE JUMPERS FOR JUMPER BLOCK "D" (COOLER POWER) ARE PROPERLY SET. FAILURE TO SET THESE JUMPERS CORRECTLY COULD LEAD TO PERMANENT DAMAGE OF BOARD ELECTRONICS!



AP1, AP2, AP4, AP6 14-Bit Cameras
The **XILINX PROM** chip is labeled *PK14x* (where *x* denotes the current version) and the two jumpers on block **B** are across the pins marked **14**. If a remote boost unit is not being used, the jumper on block **A** is across the two pins on the **LOC** side, and there is no jumper on block **C**. The jumper on block **D** is across the two pins on the **+12** side.

AP7 and AP8 Cameras
The **XILINX PROM** chip is labeled *PS16x* (where *x* denotes the current version) and the two jumpers on block **B** are across the pins marked **16**. If you are not using a remote boost unit, the jumper on block **A** is across the two pins on the **LOC** side, and there is no jumper on block **C**. The jumper on block **D** is across the two pins on the **+12** side.

AP10 Cameras
The **XILINX PROM** chip is labeled *PT14x* (where *x* denotes the current version) and the two jumpers on block **B** are across the pins marked **16**. If you are not using a remote boost unit, the jumper on block **A** is across the two pins on the **LOC** side, and there is no jumper on block **C**. The jumper on block **D** is across the two pins on the **+12** side.

KX Series Cameras
The **XILINX PROM** chip is labeled *PK14x* (where *x* denotes the current version) or *PKX85x* (where *x* denotes the current version). The two jumpers on block **B** are across the pins marked **14**. If a remote boost unit is not being used, the jumper on block **A** is across the two pins on the **LOC** side, and there is no jumper on block **C**. The jumper on block **D** is across the two pins on the **+5** side.

SPH Series Cameras
The **XILINX PROM** chip is labeled *PH16x* (where *x* denotes the current version) and the two jumpers on block **B** are across the pins marked **16**. If you are not using a remote boost unit, the jumper on block **A** is across the two pins on the **LOC** side, and there is no jumper on block **C**. The jumper on block **D** is across the two pins on the **+12** side.

All Cameras with Remote Boost Unit
The jumper on block **A** is moved to the two pins on the side marked **REM**. The jumper on block **D** is moved to block **C**.