The Genesis CCD Camera

By Rick Smith

An Advanced CCD Camera for Astronomical Imaging

Manual by William D. Carroll © July 2000

Table of Contents

The Genesis CCD Astronomical Camera

The **Genesis CCD** camera is a version of a device that is the concept of the French AUDE Team (Association of the Electronic Detector Users). Their concept is to provide the amateur astronomer with a highly technical observation device, and a truly affordable system that is cost effective. It is an open and evolutionary approach to promote the CCD technology as extensively as possible. We, in the United States and Canada, had the dilemma of acquiring the parts to use this marvelous apparatus ourselves. It is from this original version that modifications were made to the design, to further enhance the features and use of the device. In the future, through the community of amateur users and the sharing of their ideas, the camera will evolve further. We are giving something back to the association that has helped us to have a glimpse of God's universe.

Our Mission

Our way of thinking is much the same as the AUDE team. This should, and will be open to the public to evolve further, with more enhancements, made possible by the community sharing of information from knowledgeable users of astronomy equipment.

AUDE Association

Throughout this web site we will use references to the French Aude web site. Originally the Genesis web site was dedicated to the translated English pages of the Aude French web site. Although that task took hundreds of hours to do, we feel it is time to open this site to the **Genesis CCD** camera and its development. The French team now has their site translated into English. The software written for operating and testing the camera is available from their web site.

A Summary of Genesis Performance:

- Uses Kodak CCD, KAF-0401/-1602/ series 9µm micron square pixels sensors.
- Sensitive active surface of the CCD sensor measures 6.91 X 4.6 mm for a KAF-0401 sensor and 13.8 X 9.2 mm for a KAF-1602 sensor. Sensors are available with blue plus technology.
- Digitization is done at 15 bits.
- Reading time of a complete KAF-0401 image is 15 seconds at binning 1 X 1, and 5 seconds at binning 2 X 2.
- Reading noises lower than 20 electrons.
- Most reading modes are supported by the **Genesis CCD** camera. They are, full image, binning, windowing, half-frame, drift-scanning.
- Camera can be connected to practically all types of PC computers running MS Windows software. This would include desktop machines as well as notebook computers via the printer port.
- The Genesis' many modes of operation are controlled from a variety of software packages some of them free!
- Complete camera unit is compact case, measuring 80 X 80-mm square (3.15 inches) with a height of 95.25-mm (3.75 inches). Its overall weight is 654 grams or 1.44 pounds, complete with shutter and optical tube.
- Cooling system that utilizes a peltier module, heat sink with fan cooling is used to lower the CCD module temperature by 35°C in contrast to ambient temperature.
- Image acquisitions of several minutes are possible with the system.

Contact Information

At Genesis we are committed to producing a quality device that provides users with an imaging system that is cost effective and provides value to you the end user. We welcome all comments, and look forward to hearing from you.

Special Thanks:

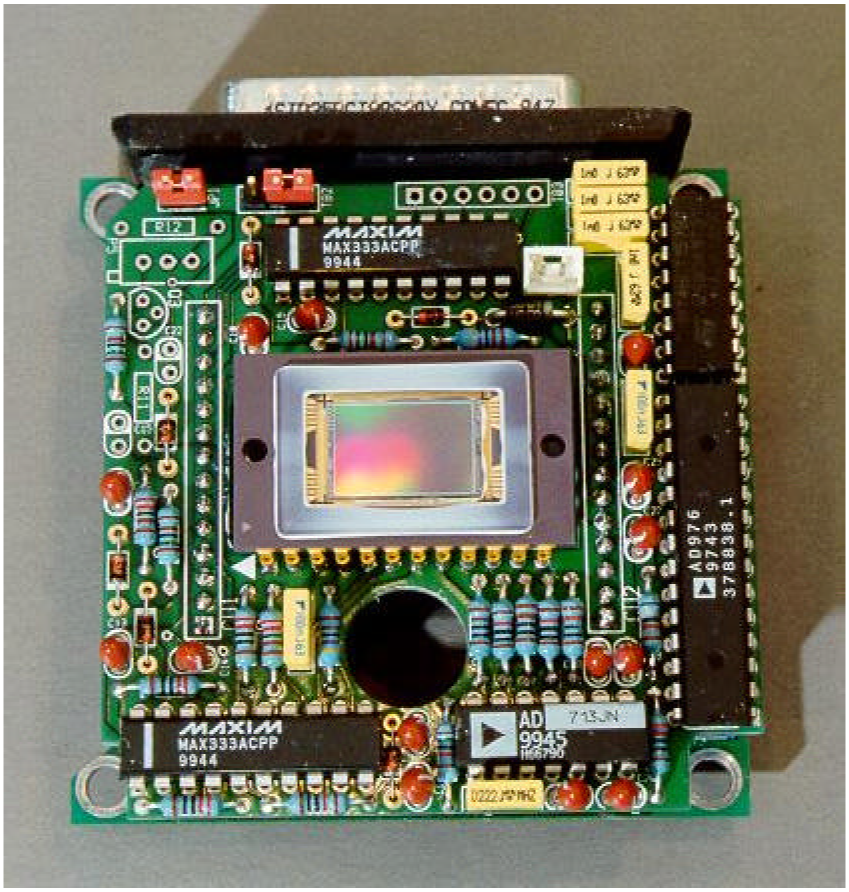
Thanks to Kenn Lynch for his professionalism in the testing and documentation of the prototype phase of the Genesis project. With his help and suggestions, many more improvements have been implemented into the final instrument offered on this web site. He has been a great asset to this project.

Kenn's first light with a **Genesis CCD** using a KAF-1602 CCD sensor. Binning at 1X1 on a C90 (1000 mm) telescope at 15 feet, 0.1 second exposure, and pre-cooled about 20 minutes. Using Pisco (standard mode) imaging software. T-adapter ring supplied in the Genesis kits is used for interfacing the camera to the C90 OTA

Click on the image for a full frame view

Introduction

The Genesis project began in the fall of 1999. At this time, the Audine CCD camera from France was available for the amateur astronomers, to build an imaging device that would be the next generation of the "Cookbook legend" of CCD imaging systems. The current cost of commercial CCD cameras makes it unlikely that most amateurs would be able to benefit from this technology to explore and advance in this field. For the most part, students or users with a limited budget would find it difficult to own equipment and capture the finest details of deep space for study. There is a great sense of personal accomplishment when one is able to digitally gather deep space phenomenon, and then take that data to process a final image. Additionally, it has been found that individuals who construct their own imaging devices have a better understanding of their working parameters, along with the techniques of operation to get the greatest benefits of digital imaging. Our goal is to help bridge the gap between veteran users of this technology and builders of the future in the hopes that they will share their wealth of experience and expertise to capture the interest and development of all interested.



Upper board of Genesis CCD camera shown with a Kodak KAF-1602E imaging sensor

At this time, all information on building, and the software for operation of this device is freely given. The Genesis project is now your project as well. The object of the Genesis project is to provide users with a system that is dependable, and at low cost to allow for future enhancements as they materialize through the community sharing of information. We have been encouraged by the interest in this project as it developed. In spite of its simple design, the Genesis camera has the performance of a product in the mid to upper middle cost range, but with package pricing in the very low range of currently available systems! To achieve this, the task related to assembly is done by the end user. Every effort has been made to make this an enjoyable experience that will give years of user satisfaction.

The **Genesis CCD** camera is a rectangular box that measurers 80 X 80 mm square (3.15 inches) with a height of 95.25 mm (3.75 inches). Its overall weight is 654 grams or 1.44 pounds, complete with shutter and optical tube. The Kodak CCD sensors that are currently adaptable to the current circuitry are numerous and therefore will adapt to many different telescope systems. The pixel size of all the current sensors is 9 microns square, with a total surface area determined by which sensor is used. This pixel size is a good choice for the most common aperture telescopes found on the market today. This makes it possible to support most image modes. This would include full image, binning, windowing, half-frame and drift scanning.

The **Genesis CCD** camera also supports a shutter device. It is built into the camera body internally and is supported by the operating software. There are two shutter size choices available that are usable and the size selected depends upon the sensor in use. This makes it possible to use the camera in a broad spectrum of imaging choices when capturing brighter objects, as well as capturing flat (dark) frames for image possessing.

The **Genesis CCD** camera is controlled by a PC parallel port. It is connected using a twisted pair flat ribbon cable with a maximum length of 22 feet 11 inches. We have heard of longer lengths of cable but cannot guarantee their dependability. In addition, the possibility of network connection for greater distances is available.

The acquisition software controls the camera from the PC. As of this time we only know of 5 software packages that will control the unit. With the proliferation of this design more operating software will become available in the future.

- **PISCO** Functions under Windows 95/98 and soon under Windows NT. It is a simple but very powerful program for acquisition.

- **IRIS** For Windows 95/98 is used to process images and also some other functions that make it possible to operate the camera.

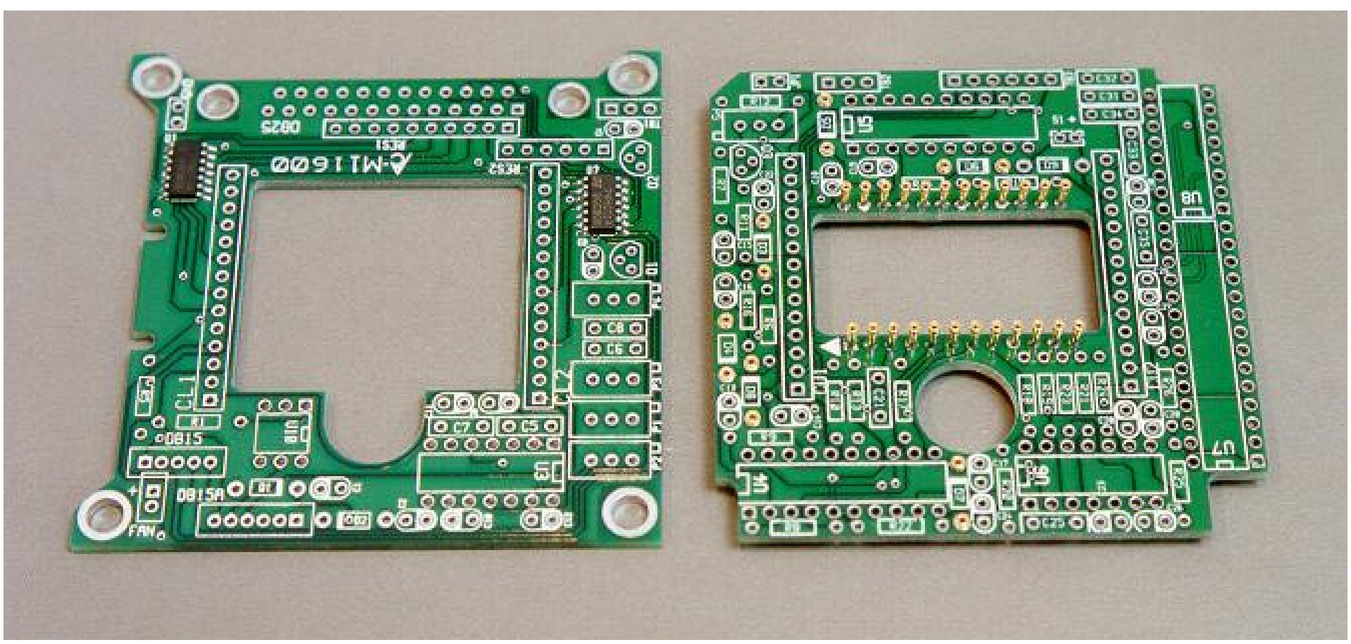
- **PRiSM** An excellent inexpensive, GUI based, image processing and scope control package completely compatible with the Genesis. The scripting and analysis tools are very promising and simple to use! We currently have the Help files translated into English for those that are interested.

- **AUD'ACE** For Windows 95/98. The powerful script language written into AUD'ACE makes it possible to program sequences of commands to perform specific tasks of an individual users preferences. An example would be to control the interface on one PC and then the parts of the program controlling the camera can be installed on another PC. One of the parameters of AUD'ACE would allow to control the drive of a telescope. This software package uses the concept of the client/server interface so that the various dialogs can operate on the TCP/IP protocol. This will allow the use of a host computer while the remote computer interfaces with the camera at a distance of more than 165 feet. Another extension of AUD'ACE makes it possible to control the camera, telescope or other peripherals via. Internet link. Using the software in this manner makes it possible to operate the total astronomical system from another part of the world! (*At this time only a French version is available*)

- **QMips32 for DOS** (32 bit mode). This package was used by the Audine team for developing new digital acquisition techniques.

Currently, PISCO, IRIS, and AUD'ACE can be downloaded from the Internet for free. PRISIM must be purchased for individual users with key codes for each PC it is installed on. This will include multiple PCs on the same copy purchased by the original owner. QMips32 is also a program that requires purchase to use. In time many other software packages will be added, as the interface is written into currently offered packages for the operation of the camera.

The **Genesis CCD** camera consists of two printed circuit boards. The lower board interfaces the camera to PC using a DB 25 pin waterproof connector. A DB type waterproof power connector is used to supply all power requirements, as well as external commands for operation of color filter wheels, peltier temperature control, etc. This card has circuitry for the distribution of power for operation of the camera. The upper card is comprised of the CCD sensor, circuitry for generating the clock cycles, amplification circuits, and the analog-to-digital conversion circuits.



All camera kits purchased from Genesis CCD are provided with serial numbered identification labels.

Why Build

CCD cameras are available as commercial products for amateur astronomers. It will, therefore, be necessary to explore the reasons to build such a camera. For a better perception let's research the commercial units.

High grade, top quality imaging cameras are capable of extremely quick operation due to the use of powerful computer interfaces. Cameras of this caliber have circuits designed with very low noise as well as CCD sensors with more than 4 million pixels. The detectors might be back illuminated or also have a high spectral response in the blue range.

This type of device is used by the most demanding amateur or professional that would be willing to pay $8,000 dollars or more for a device. The midrange of equipment that is very popular has pricing in the range of $1,500 to $4,500 dollars. These devices also use the KAF-0401 CCD sensors. These apparatuses have infinite possibilities and are very effective if used properly.

Then, at the low end of products we find devices that cost $1,000 to $1,500 dollars. These cameras are used for auto guiding and imaging or just auto-guiding. To arrive at the low pricing, these units usually have very small active area CCD sensors installed in them.

This being the case, it takes far more effort to target and image objects, than to acquire images without having anguish and discouragement. Indeed it is very difficult to point and guide a telescope if the CCD has only a few arc minutes of total pixel area. Then again, the telescopes built in guiding system may not be capable of handling the pointing accuracy without special additional equipment.

Even though the Genesis is a simple design, it rivals the performance of commercial products in the medium price range, but at the same time costs what imaging units at the low end do, or less. To arrive at this figure, you the builder, absorb the assembly costs.

Most of the components are fairly easy to obtain through most electronic resellers at a moderate cost. Moreover, with the complete documentation on this web site and news groups related to this camera, you are self-assured to have an operational high performance camera.
The advantage to building your own camera is that you have personal knowledge of the assembly, and techniques of testing the device. If something is wrong, you will not hesitate to open the unit and probe for the problem. This cannot be said for commercial units.

If a problem arises, the probability of sending back the device to the manufacturer is guaranteed. From the commencement of shipping the camera, to receiving the unit back many weeks to months may transpire. Then, issues of warranty may become additional problems in the service of the device. In all this time, you do not have the instrument to use as it was intended for.

The beauty of the Genesis design is, that it is the builder who can adapt the system to the users desired needs.

At the same time, responsibility of constructing the camera also falls on the builder (the pages of this web site). We cannot guarantee 100% success to you, even if the Genesis looks relatively simple to construct. This is the major difference between the Genesis camera and a commercial unit.

To the novice, that difference alone might justify the difference in price of a Genesis unit, to a finished warranted commercial package.
Many factors are used to arrive at the price of a commercially delivered package. You are purchasing the research and development, the expertise and reputation of that company. Running a corporation requires much in overall operating costs, and in advertisement. Then, they also support you, the customer with technical support and warranty repair, most of the time free of charge.

When all these factors are taken into account, it becomes clear that the established price schedule of these companies is quite competitive. Then it becomes quite evident that the Genesis is not in this price range because you do not have to absorb these additional costs.

For most, building a **Genesis CCD** camera will be done for the subsequent reasons: they are not wealthy, they are versatile with hand tools and electronic equipment, they are fascinated with challenges, they are educators. To students of a class or members of a club the **Genesis CCD** camera will make it possible to study all aspects of obtaining an electronic digital image. These will include: electronics, optoelectronics, data processing, mechanics, refrigeration engineering technology, image processing and observation techniques. Last but not least, are the hobbyists with a wide range of talents and skills, enjoying the majesty of the celestial universe with their own imaging apparatus.

A Summary of Genesis Performance:

- A Kodak CCD, KAF-0401 with a 768 X 512 of 9 micron square pixels.
- Sensitive surface of the CCD sensor measures 6.9 X 4.6 mm (32 mm^2).
- Digitization is done at 15 bits.
- Reading time of a complete image is 15 seconds at binning 1 X 1, and 5 seconds at binning 2 X 2.
- Reading noises lower than 20 electrons.
- Most reading modes are supported by the **Genesis CCD** camera. They are, full image, binning, windowing, half-frame, drift-scanning.
- Camera can be connected to practically all types of PC computers running MS Windows software. This would include desktop machines as well as notebook computers via the printer port.
- The Genesis' many modes of operation are controlled from a variety of software packages some of them free!
- Complete camera unit is compact, measuring 80 X 80 mm square (3.15 inches) with a height of 95.25 mm (3.75 inches). Its overall weight is 654 grams or 1.44 pounds, complete with shutter and optical tube.
- Cooling system that utilizes a peltier module, heat sink with fan cooling is used to lower the CCD module temperature by 35°C in contrast to ambient temperature.
- Image acquisitions of several minutes are possible with the system.

Considerations

To assemble a **Genesis CCD** camera you must have the following requisites:
A sufficient amount of spare time (4 to 5 evenings) to assemble the complete camera, with testing, if you have on hand all the required components.
The cost of $845.00 US approximately for one complete camera with large Daco shutter. Among all the components the cost of the CCD is the most expensive and this amount will fluctuate depending on the class of sensor chosen.

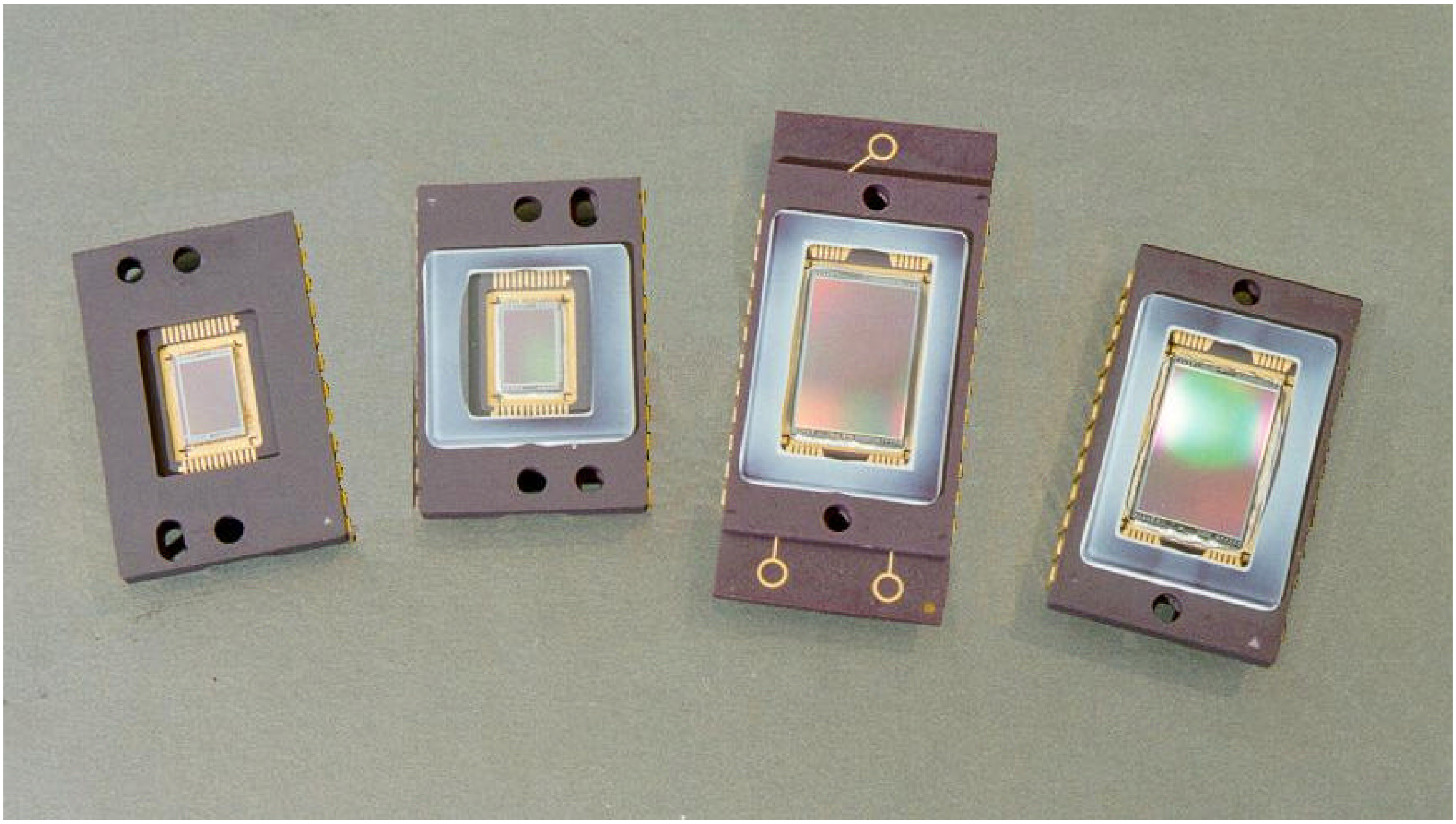
- You must have a bare minimum comprehension of electronics.
- You must know how to decipher the color codes of a resistor.
- You must know how to solder.
- You must know how to manipulate and deduce the values indicated by a Digital Multimeter (DMM).

The required electronic hardware as listed:

- A quality fine tipped soldering iron.
- A Digital Multimeter.
- Quality stable linear power supplies to deliver +/- 15VDC, and 5VDC, and 12VDC.

An oscilloscope is not required, but could prove to be a great asset in the event of a problem.
If you are mechanical, and have equipment at your disposal (lathe and milling machine), you could manufacture a camera housing. Genesis does have complete case assemblies that have been manufactured using CNC machinery for consistent part quality.
In conclusion, you can download, for free, the operational software for the Genesis to operate very effectively. If you happen to be a programmer, precise information on the operation of Genesis is given. Therefore, you can develop your own programs of operation. It is in the spirit of this concept that you would freely share your efforts and realizations.

Kodak



Kodak CCD sensors shown from left to right. KAF-0401 without optical window, KAF-0401E, KAF-1600, KAF-1602E

The Technical Choices

Full-frame charged coupled devices (CCD) image sensors are utilized in the most demanding imaging applications because of their dynamic range, low noise floor, high optical fill factor, and availability in large physical formats. Full-frame sensors are the technology of choice in low signal applications where they exhibit the lowest dark current of available image sensor technologies. The low dark current results from operating the photo active area in multi-pinned phase (MPP), or accumulation mode. In this mode, the gate electrodes are held at a voltage that accumulates the silicon surface with majority carriers, and quenches the dark current component because of generation at these surface states. The highest yields result from illuminating the sensor from the electrode (front) side, eliminating the need to thin the sensor substrate.

The disadvantage is a reduction in the response caused by the absorption of photons by the polysilicon gate structure. This is especially apparent at the blue wavelengths between 400 and 500 nanometers (nm). Attempts to remedy this have the undesirable effect of increasing the manufacturing process complexity and/or compromising other sensor performance parameters. The best solution is to replace one or both of the polysilicon gates with a more transparent material. This improves the response while preserving the other benefits of manufacturability and performance.

More Sensitivity Increases Options

Many scientific applications rely on cameras that contain high-performance charged-coupled device CCD sensors. These applications require sensors that provide high signal levels and very low noise. This capability allows users to acquire images more quickly or identify features that would otherwise not be clearly discernible. For example, amateur astronomers use very long exposures with filters, especially in the blue, to achieve the correct balance for a full color image. Increasing a detector's blue sensitivity means astronomers can reduce blue exposure times, an important factor in minimizing motion effects, which can degrade the quality of an image. Alternatively, they can maintain their acquisition time and use the detector's extra sensitivity to identify fainter astronomical objects.

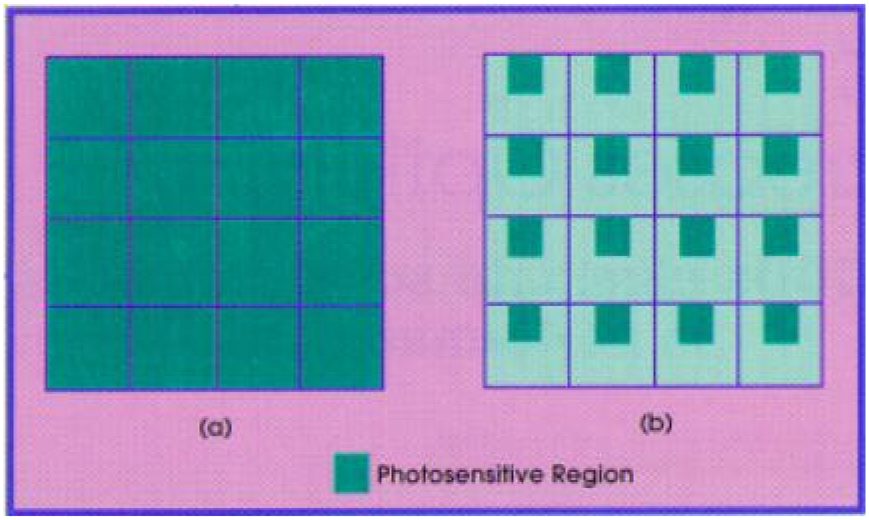


Image sensor trade-offs

Individuals who need to acquire high-resolution images have several options for detectors:

- Full-frame CCDs are photosensitive over 100 percent of their surface area, so an electrode covers the entire area to read out the signal charge ***(Figure a).*** Cameras that use full-frame CCDs also include a mechanical shutter or strobe light to control the exposure. When the shutter is open or the strobe light on, charge accumulates on the pixels. When the shutter is closed or the strobe light off, the charge is read out. The architecture accommodates long exposure times, such as in astronomy. The drawback to this technology is that because 100 percent of the surface area is photosensitive, the electrode must cover each pixel if it is to read out the charge. Typically, the electrode material has been composed of polysilicon, which is only semitransparent in the visible portion of the spectrum. It absorbs and reflects some wavelengths there, thus reducing the sensors overall quantum efficiency.

- Interline-transfer CCDs include an electronic shutter mechanism to control the exposure time. This means that each pixel contains a photosensitive area and a charge transfer and readout area ***(Figure b)***. No electrode covers the photosensitive area, so quantum efficiency does not suffer. The trade-off for these devices is that only a fraction of the pixel area (as little as one fifth) is photosensitive. This may be acceptable for applications that do not require wide dynamic range, but it is a problem for applications that need very long or very short exposures times.

Back-illuminated CCDs are full-framed image sensors, polished from the back to remove most of the bulk silicon substrate. Light is imaged on the backside, but the polysilicon electrode is on the front, so it does not effect quantum efficiency. The trade-off for these devices are cost and noise; they are expensive and require cooling to liquid-nitrogen temperatures to mitigate excess noise. Despite these disadvantages, they are still the best alternative for those applications that demand extremely high performance at any cost.

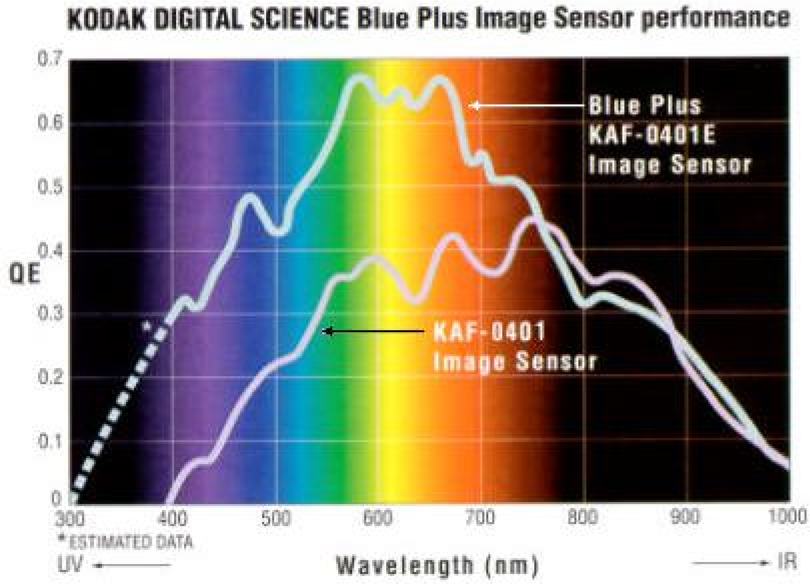


Figure A

For users who need a less expensive, but highly sensitive sensor, a new full-frame CCD provides an alternative. Blue Plus image sensors developed by Kodak use a new, transparent gate electrode material and fabrication process to improve their quantum efficiency. This results in much higher signals in the blue and green portions of the spectrum, boosting overall responsiveness with no increase in noise. While quantum efficiency above about 800 nm remains the same, visible spectrum response improves (see photo above, Fig A). For example, at 400 nm, the quantum efficiency improves from 2 to 30 percent. From 550 to 700 nm, it increases from 40 to 65 percent. In fact, the spectral response surpasses that of an interline-transfer CCD. In addition, the technology opens up the spectral region from 300 to 400 nm, where standard full-frame image sensors have very low quantum efficiency. One application that would immediately benefit from this technology is UV-VIS spectroscopy, which was previously possible only with back-illuminated CCDs. The astronomy application outlined in the opening paragraphs is another example.

The Impact of Pixel Size

The quantum efficiencies (photon-to-electron conversion ratio) of most CCDs are similar, but the size of the photosensitive area makes their performance unequal. Responsivity is a measure of the signal that each pixel can produce and is directly proportional to the pixel area. As the responsivity increases, the same amount of signal can be collected in a shorter period of time or, conversely more signal can be realized during a fixed exposure time. For systems limited by photon shot noise, this means the signal-to-noise (S/N) ratio is higher.
Another benefit of increased responsivity is that less illumination is needed to achieve a desired S/N level. Or, with low-level illumination, the image will have a higher S/N ratio and appear less grainy.

Pixel area also affects the dynamic range of the camera system. Each pixel is like a well that stores up charge during its exposure period before it is read out. The larger the pixel area, the larger the charge capacity, and the higher the signal level. A pixel is saturated when further increases in illumination do not create a corresponding increase in signal voltage. Larger pixel areas help improve dynamic range because they hold more charge, so brighter objects do not saturate the pixel. In fact, the technical definition of dynamic range is the ratio of saturation voltage to the total noise of the CCD. Because camera system noise is generally independent of pixel area, increasing the pixel size gives a higher S/N ratio.
Dynamic range is sometimes characterized by the number of gray levels in a camera system. That which is a measure of how much contrast an image can display. An 8-bit digital system can produce 256 gray levels, Whereas a 10-bit system can provide 1024 gray levels.

The CCD sensor by far will be the single most expensive component used in the **Genesis CCD** camera. Therefore being the main investment a reasonable balance concerning performance and price must be contemplated. For the Genesis a Kodak KAF-0401 or KAF-0401E are the entry sensors currently available.

- KAF-0401 features:
- 393K pixel area CCD
- 768H X 512V (9µm) pixels
- 6.91 mm H X 4.6 mm V Photosensitive area
- 2-Phase Register clocking
- 100% fill factor
- High output sensitivity (10µV/e-)
- Low dark current (<10pA/cm²@25°C)
-

The size of pixels on the sensor are equivalent to the size of particles on 35mm photographic film. Although it makes it possible to do high-resolution deep space imagery, it will not be effectively suitable to take part in survey-type programs (comets, novae, and supernovas). In theory, it would still be possible, to do by creating a mosaic of images to cover the entire object being acquired. In relative comparison, the area of surface of 35mm photographic film would be 27 times larger than the imaging surface of the KAF-0401.

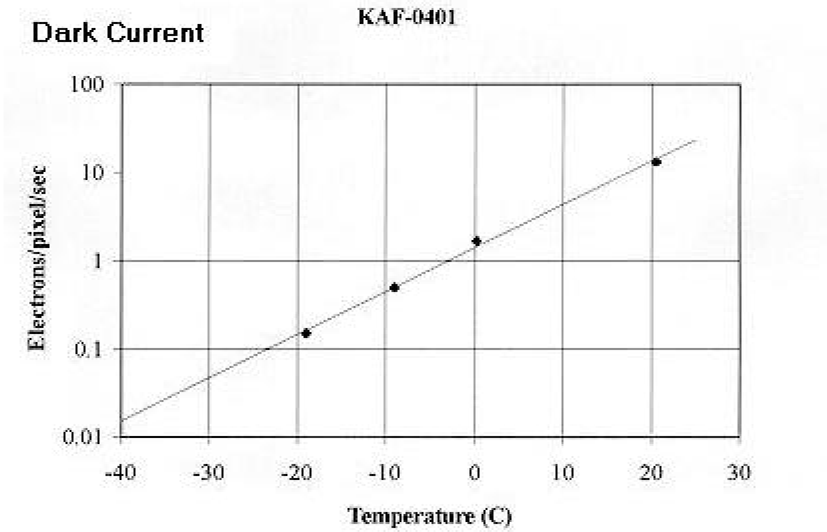


Figure B

Kodak also manufactures a sensor with anti-blooming technology. When the pixels capacity is reached, excess electrons will leak into the adjacent pixels within the same column. This is called blooming. With this sensor it makes it possible to image brighter objects without saturating the detector. The pitfalls with this sensor are that it has a 30% deterioration of its sensitivity to obtain this feature. It is recommended that the sensor used in the Genesis does not use this technology to optimize total sensitivity of the detector.

The Kodak sensors use MPP technology so that the dark current is as indiscernible as possible. A 1000-second image at 25°C is necessary to get saturation because of thermal signal. In theory, this would indicate that the KAF-0401 sensor would be suitable to use for astronomical exposures of 2 to 3 minutes without adverse effects. In practice, this performance is not obtained, because there are pixels with a thermal signal higher than the average value. After imaging for a very short period of time at ambient temperature, an image would reveal brilliant points due to hot pixels. The most intense of these will remain after cooling the detector to -10°C with an exposure time of 2 to 3 minutes.

These pixels are always located in the same place in the acquired image. Removing them is easily done by pre-processing the saved images. However, these pixels become quite numerous if the CCD is operated at 25°C, and the exposure time is greater than one minute. Under these conditions, processing the image reaches the threshold of the limits of subtracting these defects. Then the maximum exposure time of 1 minute at ambient temperature is the theoretical limit for imaging applications such as planetary or auto guiding. At -10°C the KAF-0401 produces an average dark current of 0.1 electron/pixel/second (Fig B). After 2 minutes, 12 thermal electrons on average. This signal is very weak compared to the sky background on average. The peltier cooling system built into the Genesis will therefore allow cooling the CCD detector to -18°C when ambient temperature is at 20°C.

The construction of the CCD sensor has no specific electrodes for the use of shutter control. For that reason, the use of a mechanical shutter will need to be used in some aspects of astronomy imaging. In the Genesis, this is a built-in option, which is controlled by the operating software.

Cosmetic Classification of Sensors:

The pricing of sensors is relatively expensive if a high-grade sensor is chosen. This is an important decision and we will analyze it. The sensors are available with a class grading system. These tests are done at 25°C.

Class	Point Defects Total	Cluster Defects Total	Column Defects Total
Class 0		0	
Class 1		0	
Class 2	10	4	2

- Point Defect-Dark: A pixel which deviates by more than 6% from neighboring pixels when illuminated to 70% of saturation, or -Bright: A pixel with dark current > 5000 e/pixel/second at 25°C.
- Cluster Defect: A grouping of not more than 5 adjacent point defects.
- Column Defect: A grouping of > 5 contiguous point defects along a single column; or A column containing a pixel with dark current > 12,000 e/pixel/second; or A column that does not meet the minimum vertical CCD charge capacity; or a column which looses more than 250e under 2Ke illumination.
- Neighboring Pixels: The surrounding 128 X 128 pixels or ±64 columns/rows.
- Defect Separation: Columns and cluster defects are separated by no less than two (2) pixels in any direction (excluding single pixel defects).
- Defect Region Exclusions: Defect region excludes the outer two (2) rows and columns at each side/end of sensor.

New users of CCD sensors at times criticize sensors because of 3 or 4 defective pixels are present in an image. If you look at the total amount of active pixels in a KAF-0401 sensor we see in the order of 400,000 pixels. That defect amount calculates to approximately 0.001% of total defects. Defective columns in the center of the active area of a sensor would seem to be unacceptable under any circumstances. This proves not to be the case at all after software processing the defects out of an image. Considering this, a Class 0 sensor would not be a reasonable purchase for cost to performance ratio. Therefore a Class 1 sensor is more than sufficient, however the Class 2 sensor proves to be more than satisfactory for use in an astronomical camera. Whatever class of sensor you choose to use, they will all have approximately the same number of hot pixels.

In conclusion, we recommend implementation of the Class 2 sensor for the Genesis for cost effectiveness and performance.

Kodak Sensors used in Genesis

The following list of Kodak CCD sensors are supported by the **Genesis CCD** camera. The files are downloadable .pdf files and are the most current versions for each sensor listed.

- **KAF-0400L -Rev 0**
- **KAF-0400C - Rev 0**
- **KAF-0401 - Rev C**

KAF-0401LE - Rev B

KAF-0401E - Rev C

- **KAF-1600 -Rev No. 3**
- **KAF-1602 - Rev No 0**

KAF-1602E - Rev B

KAF-1602LE - Rev A

- Indicates sensors no longer manufactured by Kodak.

There is still the possibility of obtaining these sensors form outside sources.

Migration to the Blue Plus Sensors KAF-1600, KAF-0400

Kodak recommended glass cleaning

Cover Glass Cleaning Procedure for Kodak CCD Sensors

Kodak Application Notes

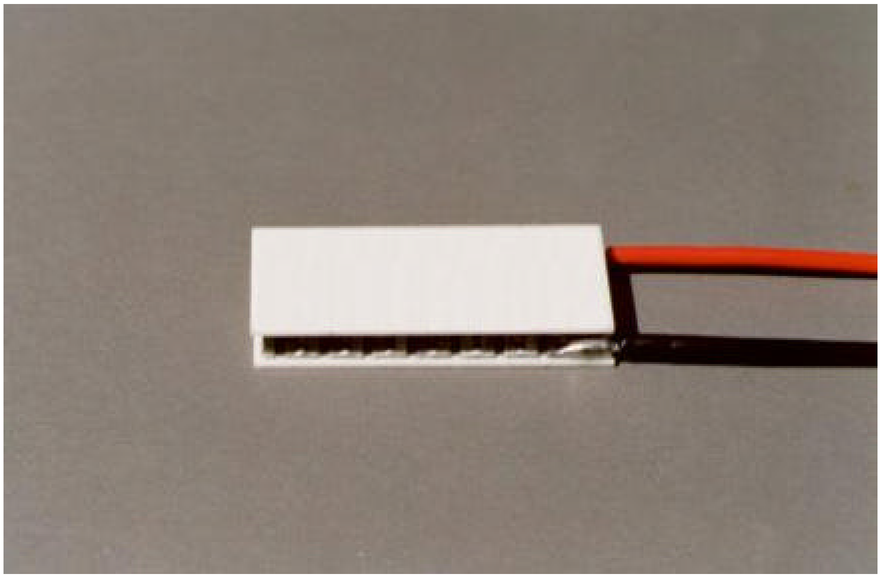
Fundamental Radiometry and Photometry

True Two Phase CCD Image Sensors Employing a Transport Gate

Information on this page is an assortment of resources from printed Kodak literature.

Thermoelectric Cooler

To understand the capabilities of a thermoelectric cooling module, it is necessary to understand what TEC module specifications represent and their implications. The four standard specifications for a module are:



Peltier module used in the Genesis CCD camera.

- The heat pumping capacity or Qmax in watts
- The maximum achievable difference in temperature, between the hot and cold sides, of the module known as the Delta Tmax or DTmax, usually represented in degrees Celsius
- The maximum (optimal) input current in amps or Imax
- The maximum input voltage or Vmax when the current input is optimal (Imax).

As a practical matter, it is only possible to reach either heat pumping capacity in watts or to obtain the maximum temperature differential in degrees. In other words, the DTmax is the maximum temperature difference between the hot and cold side of the module when optimal power is applied and there is no heat load (Q=0). As a thermal load Q is added, the difference in temperature between the two surfaces will decrease until the heat pumping capacity, or Qmax value, is achieved and there is no net cooling (DT=0).

Since our application requires net cooling of an object with a thermal mass, the actual heat pumped or Q will be less than Qmax and the actual difference in temperature will be less than the DTmax.

As current flows through a material, heat is generated. Thermoelectric material is no different. There is a point where the heat generated internally offsets the TEC ability to pump heat. Each TEC has a limit on how much heat that it can pump. This limit is referred to as Qmax The current associated with Qmax is referred to as Imax. The corresponding voltage across the coolers is referred to as Vmax. If a TEC is completely insulated and isolated from the environment and running at Imax, it will produce its maximum temperature difference, dTmax. At this point it will also be pumping no heat whatsoever. As heat is applied to the cold side of the TEC, the temperature differential is suppressed. Effectively, one trades temperature differential for heat pumping. As such, if the temperature differential is 0, the corresponding heat load is Qmax.

Thermoelectric coolers operate directly from DC power, and suitable power sources can range from batteries, to simple unregulated "brute force" DC power supplies or linear power supplies. Additionally, extremely sophisticated closed-loop temperature control systems are used for effective device control.

TECs generate virtually no electrical or acoustical noise, and can be used in conjunction with sensitive electronic components. A TEC is a low-impedance semiconductor device that presents a resistive load to its power source. Due to the nature of the Bismuth Telluride material, modules exhibit a positive resistance temperature coefficient of approximately 0.5 percent per degree C based on average module temperature. For many non-critical applications, a lightly filtered, conventional battery charger may provide adequate power for a TE cooler, provided that the AC ripple is not excessive. Simple temperature control may be obtained through the use of a standard thermostat, or by means of a variable-output DC power supply used to adjust the input power level to the TE device.
In applications where the thermal load is reasonably constant, a manually adjustable DC power supply often will provide temperature control on the order of +/- 1°C over a period of several hours or more. Where precise temperature control is required, a closed-loop (feedback) system generally is used, whereby the input current level or duty cycle of the thermoelectric device is automatically controlled. With such a system, temperature control to +/- 0.1°C may be readily achieved and much tighter control is not unusual.

Tec's have extremely high reliability, as a result of their solid state design and are virtually maintenance free. Although reliability is application dependent, the typical life of a TEC is greater than 200,000 hours.

Power Supply ripple filtering normally is of less importance for thermoelectric devices, than for typical electronic applications. Thermoelectric module performance will degrade only about two percent with an AC ripple of 10 percent, and at 20 percent ripple, the maximum temperature differential is reduced by less than five percent.

Although we recommend limiting power supply ripple to a maximum of 10 percent, some applications may tolerate a higher value. The use of a regulated linear power supply will have the greatest possible benefit of low ripple, typically 2 percent, with the additional features of voltage and current adjustment. Achieving a large temperature differential is the typical goal, and a ripple component of less than two percent may be necessary to maximize module performance. In situations where very low level signals must be detected and/or measured, even though the TE module itself is electrically quiet, the presence of an AC ripple signal within the module and wire leads may be unsatisfactory.

In our application a TEC (Melcor CP 1.0-63-08L) is used. It measures 15 X 30 X 4 mm with a Imax of 2.5, Qmax of 10.6, Vmax of 7.62 and DT max of 67°. In looking at the power leads attached to the device, the hot side of the unit is the side that the leads are soldered to. Care must also be observed to the polarity of the leads as well. Great care must be used in handling the device.

Tec's outer faces are made of thin ceramic plates. If the module is dropped or mishandled, it can chip or crack the ceramic or damage the bismuth telluride blocks. The module is constructed with the blocks running in series throughout the whole apparatus. If one block is damaged, it will render the TEC useless.

The handling of the wire leads also needs careful attention. If bent sharply close to their attached point, they could break away from the module. Re-attaching them to the module, if they detach is next to impossible to do.

The Cold Finger

The cold finger is made of aluminum (thermal conductivity of 120W/m/K) that is sufficient to guarantee adequate thermal conductivity. The use of other materials of greater conductivity, copper, silver, for instance offset by their cost, weight or both make them undesirable.
The thermal heat transfer collected by the cold finger is affected by many parameters internally in the camera:

- CCD heat dissipation.
- Thermal heat transfer of nylon hardware.
- Heat radiated off the electronic components.
- Convection of heat transferred by the camera case.

The use of stainless steel, or steel hardware for attaching the cold finger to the heat sink, is not appropriate. It will add typically 10°C to the cold finger via thermal transfer.

Nylon has a thermal conductivity of 0.2 W/m/K and therefore makes it a suitable material to use. The cold finger is not anodized black to aid in the minimized thermal exchanges. If the exposed surfaces are polished it will also aid in the efficiency of cooling by the loss of thermal transfer to air surrounding it.

If possible, we suggest using insulation on the cold finger, to achieve approximately -4°C reduction in operating temperature. This will be made possible by the air tight design of the Genesis camera to deal with moisture condensation and thus freezing on the CCD.

For other precautions, moisture should not be allowed to enter the inside of a thermoelectric module, thus preventing both a reduction in cooling performance, and the possible corrosion of module materials through electro-chemical action or electrolysis.

When cooling below the dew point in an unsealed case, a moisture seal should be provided either on the module itself or between the heat sink and cooled object in the area surrounding the TE module. An electronic-grade silicone rubber RTV may be used to directly seal a thermoelectric module. Flexible closed-cell foam insulating tape or sheet material, possibly combined with RTV to fill small gaps, may be used for a seal between the cold object and the heat sink.

The Pin heat sink of the Genesis camera is made of black anodized aluminum. It's effective cooling area measures 80 X 80 mm with an overall height of ¾" and a 25 Watt cooling rating. This design of heat sink lends itself to the most efficient way of dissipating heat generated by the TEC.

The fan blows air on the pins of the heat sink, creating a "scrubbing" action on the pins, on all exposed surfaces. The geometry of the pin heat sink design exposes more surface area than most common heat sinks. Therefore, its efficiency is greatly increased due to this design characteristic.

This was designed in order to keep the heat sink, as close as possible, to external air temperature despite the 10.6 watts of heat dissipated by the TEC module. The Panasonic Hydro Wave fan also has design characteristics that lend itself to this function of the design. It has high airflow (33.5 CFM) with "funnel" type air pattern constructed of lightweight plastic, and has very low vibration.

If the fan is not working while the TEC is in use, possible damage can occur to the unit by overheating, then catastrophic failure will occur. Therefore, it is imperative the supply current to the TEC be lowered to 3.5 volts or .8 amp during usage of this type.

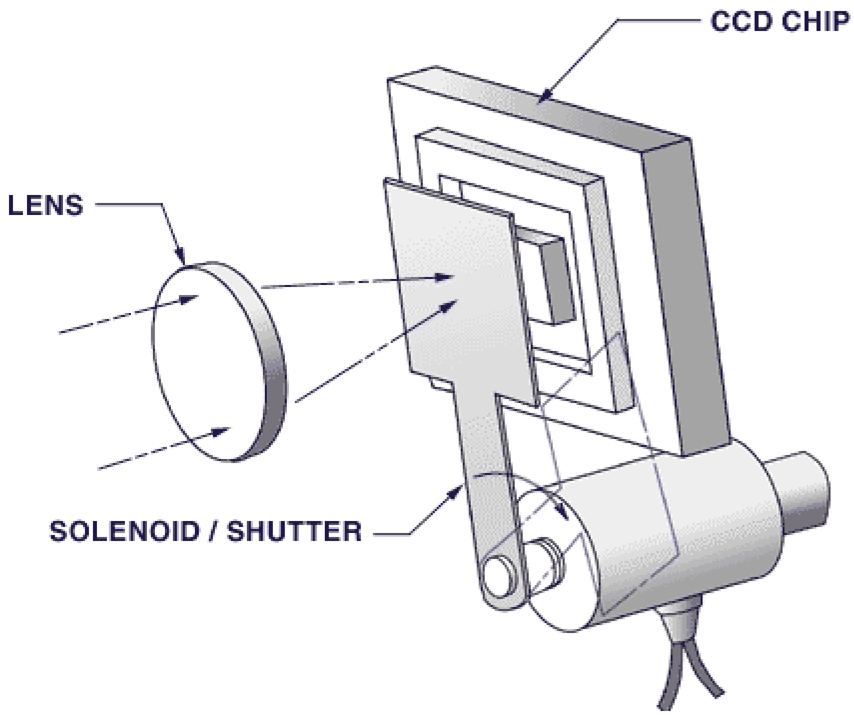
Thermal Grease

Thermal exchange compounds come in many forms and mixtures. Originally, we selected Thermstrate 2000 foil as our phase-change interface material between the heat sink, TEC, and the cold finger surfaces. Lab tests have shown this material to out perform thermal grease by 300% in similar applications. It is made from .003 thousands thick 1100 series aluminum foil coated on both sides with a phase-change compound.

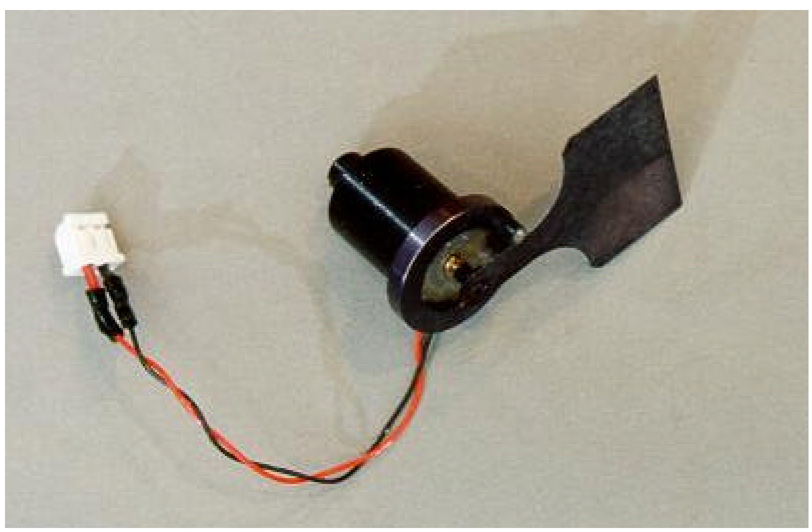
However, it has turned out not to be a suitable material for use in this application of interface. For proper installation, it needs controlled heating and must have contact pressure so it will *reflow* for its bonding to take place. This pressure and heat is not advantageous for the CCD module. It also makes it more difficult to disassemble the camera for future servicing.

For this application we will use compound thermal grease instead, which will reduce the risk of damaging the CCD module. More on the application of thermal grease will be reviewed during the assembly of the camera components.

The DACO Shutter

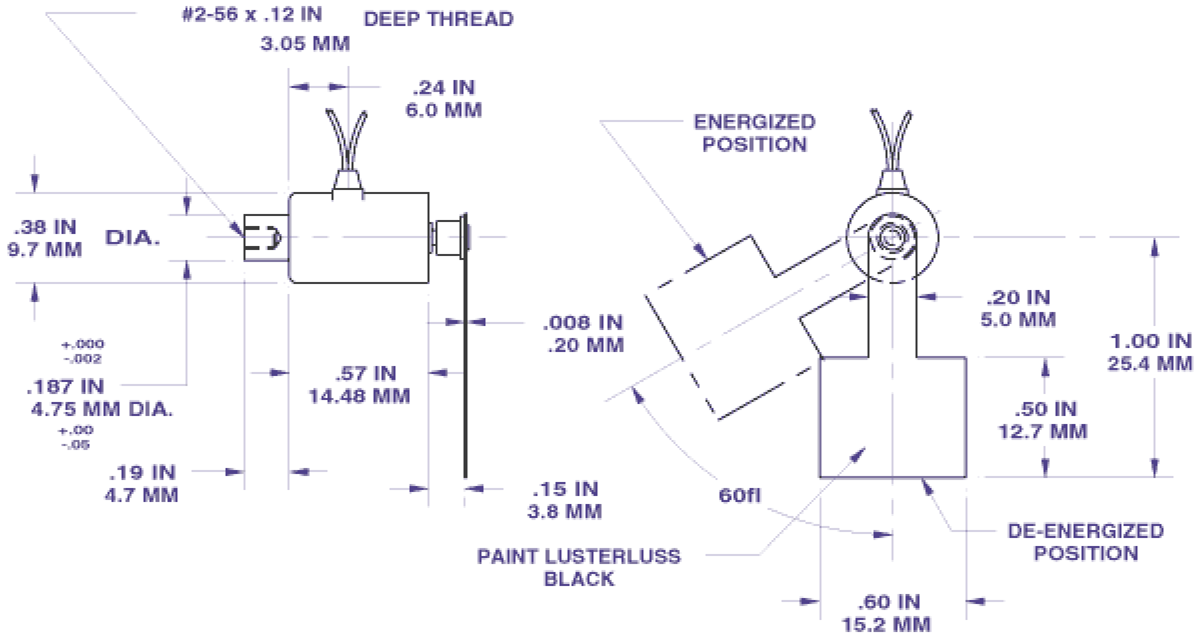


DACO Solenoid shutters are used to block or interrupt light beams



The Daco shutter as supplied from Genesis CCD with Molex wire to board connector attached.

The Daco Solenoid shutter is a built-in option of the **Genesis CCD** camera. Daco rotary solenoids were originally designed for the aircraft industry. They have also been used in aerospace satellites and other commercial CCD cameras. We will look at the options of these d evices to discern the advantages of the units offered.



1.Operating Voltage (Nominal) 12 VDC

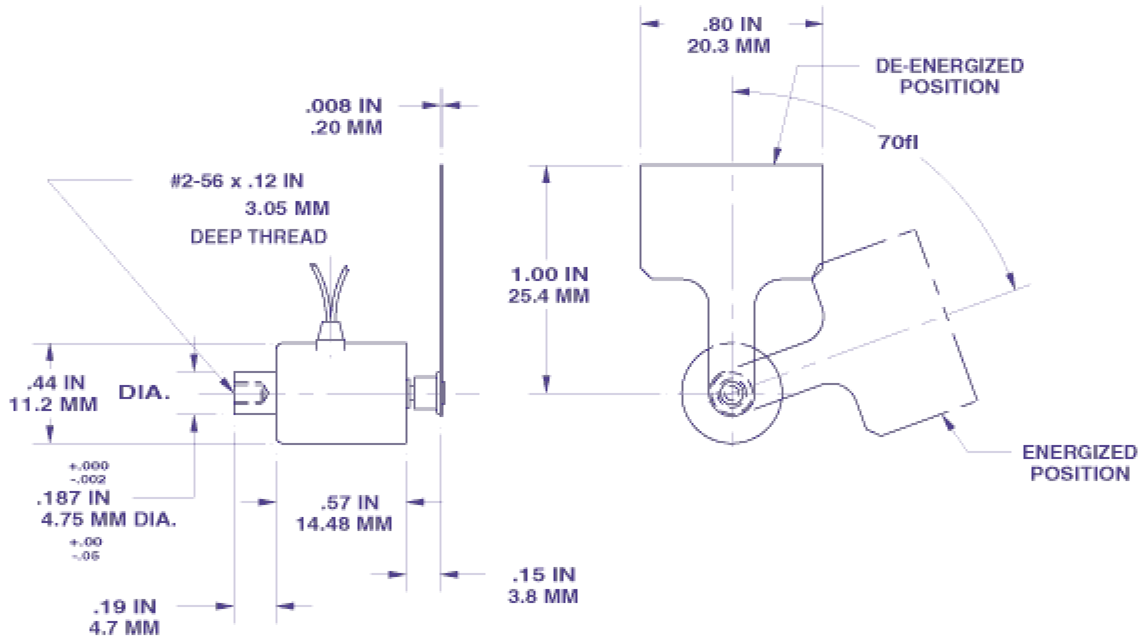
2.Coil Resistance 275 OHMS +/- 10%

3.Lead Wires Teflon Insulated. Awg #32
(1) Red, (1) Black, 2.5 Inches Long

4.Shutter Material - Aluminum Alloy Anodized Black 2024-T3

SCALE 2:1

DWG. No.
5423-458



1.Operating Voltage (Nominal) 12 VDC

2.Coil Resistance 120 OHMS

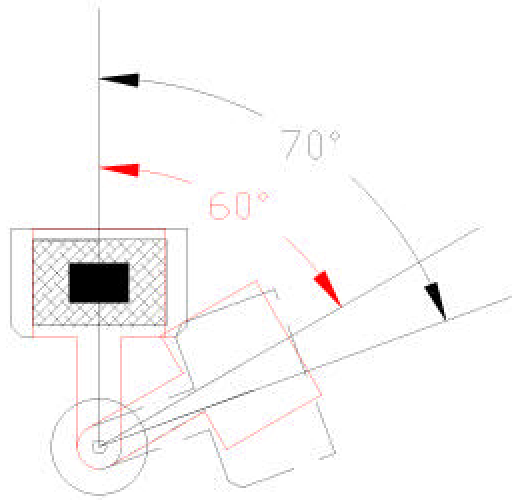
3.Lead Wires Awg #32, 5" Long Min.

4.Shutter Material - Aluminum Alloy Anodized Black

SCALE 2:1

DWG. No.
749-487

Both units can be incorporated into the Genesis CCD camera. In reviewing the drawings, we will observe some differences between the two units. First, and most noticeable, are the size differences of the flags. In combination with these differences the amount of swing travel that needs to be generated for the flag size variation. In this arrangement the coil size was made larger for the greater mass of the larger flag size. This larger unit was designed for Genesis by Daco Instruments for application in this CCD camera. By using the larger coil size the response action of the unit improved.



In the drawing above, we observe the differences in flag size to the sensor area. The actual sensor areas are defined by the solid black square representing the Kodak KAF-0400 series family of sensors. The crosshatched area represents the KAF-1600 series family of sensors. The two flag sizes shown are for the different models of DACO solenoid shutters. The one depicted in red is for the 5423-458-size unit. In the illustration we note that the flag size and the sensor area of the KAF-1600 series on the horizontal plane are approximately comparable in size. This would not be suitable for our purposes. For the KAF-0400 series of sensors this would be adequate. Additionally, the application of the larger sensor area to the smaller solenoid, the swing of 60° is not enough to clear the active area of the CCD sensor. Therefore this is not a desirable configuration. The 749-487 unit was developed by Daco to remedy these limitations of the smaller unit. The flag size area is enlarged to effectively cover the sensor area as well as the swing of the unit increased to 70° to clear the sensor area during actuation. At the same time the coil size of the solenoid was enlarged to offset the greater swing and larger flag size weight. The secondary benefit of incorporating the larger coil also improved the response of the unit overall.

In choosing the apparatus suited for your needs, consider the possibility for future upgrades of imaging sensors. As discussed, each unit has its advantages for particular applications. The cost difference between the two units is minimal. If plans are for future upgrades to larger sensors, it would be advised to use the larger unit. This would be suitable for all Kodak imaging sensors used in the **Genesis CCD** camera.

Drawings used with permission from Daco Instruments Company Inc.

PC Interface

The great advantage of using a CCD camera is that they are designed to interface to a Personal Computer (PC). Not only are CCDs extremely sensitive allowing them to adapt to photometric qualities, the PC allows the CCD operation to be greatly enhanced. By this, we mean that, the information contained in the image is enhanced to its full potential.

The computer used by the Genesis imaging system is a standard PC of the Pentium type. A 200Mhz unit would suffice and the Windows operating system should be installed. We suggest a minimumof 32 MB of RAM and spare hard drive space of a few gigabytes. A recordable CD-ROM (CD-R) would also be indispensable for storage purposes.

Installing the PC close to the telescope enables you to interface to the camera as well as the possibility of auto-guiding the telescope. For remote use, a notebook computer is indispensable. There is also the option of using multiple PCs linked through an Ethernet network. This allows the use of other makes of computers (i.e. Mac, Apple) to be used in the control and imaging process.

With the pricing of computers in today's market, the cost of a unit capable of operating the camera system with the processing software is a reasonable investment. If a network adapter is installed the capabilities increase with the use of AUD'ACE software. This allows control of the system via. The Internet interface from great distances.

The type of interface the camera uses to communicate with the PC is significant. There are two possibilities, by installing a dedicated interface board, or by using one of the input/output ports of the PC.

The first solution makes it possible to operate the camera interface with great speed of long distances. The interface for operating such systems is complex and costly. Furthermore, the use of specific solutions of this nature, make it unusable for notebook computers. The Genesis is designed to be operated by an external interface of the PC or notebook computer. This said, another possibility of using PCMCIA, as an accessible standard of computers is difficult to use. Other interfaces such as SCSI and IEE488-GPIB fall into this category also.

The RS232 interface is worthy of note. Regrettably, the RS232 interface uses a very slow communication protocol. The maximum transfer speed is frequently 19200 bits/second. At this rate, reading one digitized image of 12 bits with a size of 5.9 million bits, the transfer time would be 5 minutes!
Advancement in serial transmission now allows speeds of several megabits per second. Currently they are the RS422, Ethernet, IEEE-1394 (or FireWire, used for the transfer of digital video signals). Accompanied by these, USB is worthy of note. With transfer speeds of 12 Mbits/second and the ability to attach 127 devices on the same interface make this quite appealing.
However, all these interfaces require the use of specialized microprocessor chips to operate. Then, the implementation can be an elusive arrangement.
The only interface with the qualifications to be effective is the Parallel port interface, also known as the Centronics interface. When it was first implemented for computers, the parallel interface was designed for controlling printers. Its configuration is a 25 pin female DB connector on the back of the PC case or notebook.

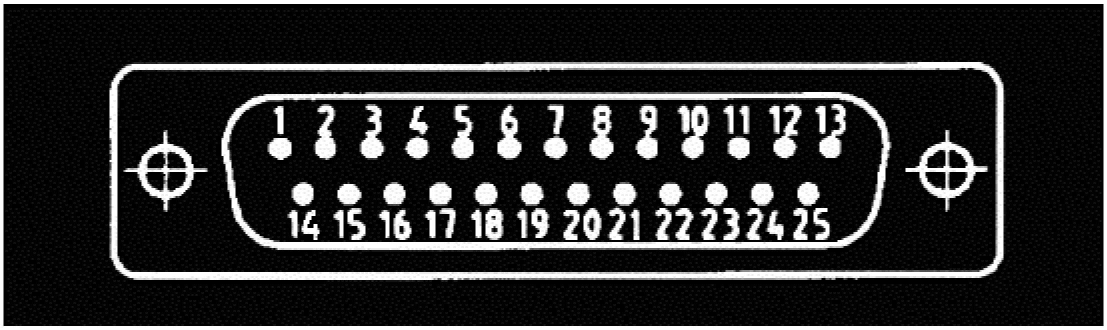
As the use of the interface advanced, it can now control many different single devices. The communication protocol is very flexible allowing it to be controlled by software. At the same time, the transfer speed of information from the PC to an external device is with 8 bit words. The return information from the device to PC is only 4 bits. As we can see, this is relatively slow by today's standards.

Advancements in the parallel protocol have introduced new standards. EPP (Enhanced Parallel Port) and ECP (Extended Capabilities Port). These standards have a significant boost in speed over the standard port. Implementation of these protocols can be unreliable with the Genesis. The synchronization of data, and the compatibility with older equipment, makes them unreliable. At the same time, clock cycles and the reading rate of the CCD is generated from the PC. Timing cycles for camera operation, generated by the software, make the parallel port an established and reliable choice.

As PCs evolve, the possibility of the parallel port being replaced by the USB is foreseeable. But, solutions ensuring adaptation from USB to the parallel port, will continue for now

This picture is looking at the DB 25 male connector from the O-ring side of the connector. This connector supplies the command signals to the camera for timing operations and data readout. This port has 17 active signal lines and 8 ground lines. The active lines are divided into 3 groups:

- 8 data lines
- 5 status lines
- 4 control lines



As a PC communicates with a printer by the parallel port, 8 data lines correspond the character code to be printed. Status lines are sent to synchronize the printer with the PC, (handshake) as they notify the PC of the status of the printer. Control lines are then used to control and synchronize the PCs flow of information to the printer.
When fully implemented the printer port is capable of fairly complex handshaking by the use of these control and status signals.
For the Genesis, twelve of the data and control (output) bits are used to control the camera, shutter and its auxiliary functions. Going in the opposite direction, four of the status bits (input) are used to convey the image data from the camera to the PC.
Since the image data from the cameras analog to digital conversion is sixteen bits wide and the port is only four bits wide, the data is first hardware multiplexed and transmitted to the PC, a nibble (4 bits) at a time. The PC software then reassembles these 4 nibbles back into single 16 bit word.

While 4 bit transmission may sound somewhat inefficient, the overall timing requirements of the CCD and analog to digital conversion actually play a bigger part, than that of the port width alone.

The printer port is managed by 3 registers of 8 bits located at adjacent addresses in the memory of the PC. In most cases the first register base memory address is called 378h, or 888 in decimal. Then, the successive two addresses that follow are 379h and 37Ah, or 889 and 890 in decimal. Therefore if a PC has multiple printer ports (LPT1, LPT1, LPT3) the base address will change corresponding to the respective port. In most cases the addresses of the various ports are as follows:

Addresses of LPT			
PORT	DATA	STATUS	CONTROL
LPT1	378H	379H	37AH
LPT2	278H	279H	27AH
LPT3	3BCH	2BDH	3BEH

Therefore, the basic address of LPT1 is 378H, in most configurations. This information briefly appears in the boot screen when starting a computer. For the 3 registers the allocation of bits that corresponds to the DB 25 connector pin-outs.

Addressing the port

378H Port: In this address the CPU writes the DATA to be sent to the printer port. It is an output port. The eight data bits (D0-D7) are latched to appear in the output connector. In the table we can see which pins of the connector are used.

Data Bits Table		
BIT	FUNCTION	PIN
D0	Data 0	2
D1	Data 1	3
D2	Data 2	4
D3	Data 3	5
D4	Data 4	6
D5	Data 5	7
D6	Data 6	8
D7	Data 7	9

379H Port: This is the input port (STATUS). These signals are used by the CPU to know the state of the printer port.

Status Bits Table		
BIT	FUNCTION	PIN
D0	RESERVED	
D1	RESERVED	
D2	IRQ	
D3	ERROR/	15
D4	SELECT/	17
D5	PE	12
D6	ACK/	10
D7	BUSY/	11

37AH Port: In this port the computer writes the signals that CONTROL the printer port. Therefore, it is an output port.

Control Bits Table		
BIT	FUNCTION	PIN
D0	STROBE	1
D1	AUTO FD	14
D2	INIT/	16
D3	SELECT IN/	17
D4	Habilitation IRQ7	
D5	DIRECTION	
D6	not used	
D7	not used	

Pins 18 through 25 are connected to ground.
As the parallel port is used to control the printer, here is the meaning of the command signals:

- Select In (Select Input) tells the printer that it is selected.
- INIT makes it possible to initialize the printer.
- AUTO FD controls paper feeding.
- STROBE changes the low level when a character is sent.
- PE Paper empty.
- ACK Acknowledge that the printer has received the character sent.
- BUSY indicates the printer is not ready for receiving characters.
- SELECT indicates the printer is on line.
- ERROR warns a printer error has occurred.

NOTE: The bits associated to the logic of interruption are not used in the Genesis. (No correspondence on the connector).

In setting up your PC, to ensure proper communication with the Genesis camera, some steps must be taken to verify proper operation.
You will first need to check your PC bios settings. As your computer boots there is an opening screen. Usually pressing the delete key for desktops or F2 for notebooks will allow access to open this menu for editing. Many manufacturers of motherboards or notebooks use different access keys. Check your user documentation on how to access your bios information.

Once you do have access, you will need to check the settings of the parallel port. This will usually be found in the peripheral tab setting. For proper operation of the Genesis the setting will need to be IBM standard (normal) or Bi-directional with an address of 378. Any other settings will cause unreliable results in the operation of the camera. Once you are assured the settings are properly set, save the information and exit the bios program.

Reboot your machine and let Windows start.

Windows should automatically register the new settings on startup.

If they do not, you can manually change them in Control Panel.

To access Windows Control Panel, select the Start tab, then the Settings tab, then Control Panel.

Double click on the System icon.

Select the Device Manager tab.

Double click on the category Ports (COM & LPT) then again on printer port (LPT 1).

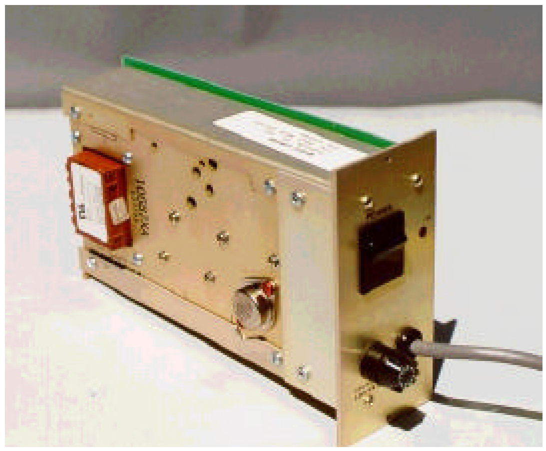
Finally select the tab Resources. Note the first window of information. You are going to find for example: 0378 - 037F. The address of the port is 378 in hexadecimal, or 888 in decimal. Then, at the bottom of the tab check to see if conflicting Device List has listed No Conflicts.
If all is in order the software should communicate with the camera.

Power Supply

The electronics of the Genesis camera necessitate a symmetrical power source of +/- 15 Volts DC.
The total consumption is on the order of 30 mA on the positive voltage and 10 mA on the negative voltage. Ripple peak to peak must be lower than 5 mV. To minimize the electronic noise, use a linear power supply. Switching supplies requires supplementary filtering to lower their output ripple current for use in susceptible electronic circuits of this nature.

To construct a supply, much the same way as in the Cookbook style of camera; use an assembly of components consisting of regulators of the type 7815 for the positive voltage and 7915 for the negative voltage. A transformer, some capacitors and correction diodes, together with heat sinks, and a case, for the components to reside in. Trouble shooting supplies of this type could prove difficult for some.

Then again, it is simpler to use a commercial linear unit that will cost around $55.00. For this price you are guaranteed of a working supply that is both regulated and filtered. In checking second hand or surplus sources, the possibility of obtaining a unit for far less is possible. In this case, building and trouble shooting a homemade supply does not seem to be profitable. At the same time, output ratings of some commercial units are adjustable, and can be beneficial in the fine-tuning of voltage and amperage.



Adjustable linear power supply with +/- 15 volt and +5 Volt at 3 Amps.

Scientific lab desktop power supply with three separate voltage supplies.

Another alternative is to use scientific or bench top supplies. The current and voltage can be monitored and adjusted using analog meters. many types are manufactured that have dual or triple output with over current protection. The more sophisticated types of today have LED metering. These tend to be cumbersome, and are not appropriate for field use. In addition, the price tag of units with this superior quality can cost hundreds of dollars.

Finally, using supplies of this type there is always the possibility of error in the output of voltage. In a moment of distraction, improper voltages applied to the camera circuitry could be devastating.

With the choice being made of a suitable power supply, strict attention should be observed when interfacing polarities of the power supply to the camera. Always think before supplying electronic equipment with power! Polarities of camera supply voltages must be observed.

For the supply of peltier module, an uninterrupted DC voltage of 5V with a minimum of 2.7 Amps is needed. Some have found that a surplus PC power supply works sufficiently. This type of supply has a dual advantage. For supplying the 5 Volts, there is more than enough amperage. Then again, the same supply will also provide the 12 Volts DC necessary for the cooling fan and the Daco shutter, if installed. Consideration should be made when using this supply for **peltier** operation.

It should be noted that these are switching DC power supplies. Another alternative is to use a 12-Volt wall wart supply for the fan and Daco operation. The supply current from one of these units of approximately 900 mA should be sufficient to supply both apparatuses. For the 5 V supply, a linear unit with 3 Amps output, preferably adjustable for voltage and amperage. Again, surplus or used units will perform admirably. It should be noted that if a PC power supply is used, the type that is preferred is for the AT class of machines. Power supplies used in the ATX class of computers will need modification of the external wiring connector for them to supply the 12 V necessary. To efficiently connect a PC power supply an extension power cord used for connecting peripherals (hard drives, CD-ROM, Floppy, etc.) would be advised. If servicing is needed the connector is easy to disconnect.

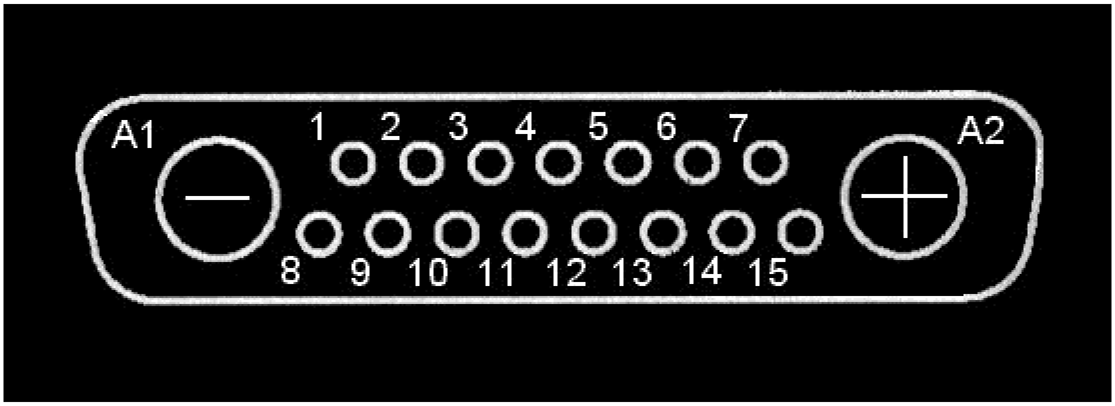
Color-coding for the PC connector would be red for the +5 V, yellow for +12V and black for ground. It is likely that the +5 and ground are doubled wired to handle heavy currents.

DB15 Molex Connector

PIN #	FUNCTION	COLOR CODE
1 to DB15-7 (Audine-DB-15-14)	Thermal Sensor CL1/CU1-12 (TB3-2)	Brown
2 to DB15-8 (Audine-DB-15-15)	Thermal Sensor ,R5, CL1/CU1-13TB3-3	Purple
3 to DB15-9 (Audine-DB-15-12)	AUX1/VDD-CONTROL,CL1/CU1-12 (U5-11) U1-2<U1-1,P9, DB25-10 (strobe)	White
4 to DB15-10 (Audine-DB-15-10)	AUX2: U2-10<U2-11 (init)	Grey
5 to DB15-11(Audine-DB-15-9)	AUX3: U2-12<U2-13, DB25-17 (select)	Yellow

DB15A Molex Connector

PIN #	FUNCTION	COLOR CODE
1 to DB15-1 (Audine-DB-15-3)	-15Volts	Black
2 to DB15-2 (Audine-DB-15-2/13)	Ground Logic (+-15V)	Green
3 to DB15-3 (Audine-DB-15-1)	+15V	Red
4 to DB15-4 (Audine-DB-15-8)	+12V (Fan/Shutter)	Orange
5 to DB15-5 (Audine-DB-15-6/7)	12V Ground (Fan/Shutter)	Green
6 to DB15-6 (Audine-DB-15-11)	Shutter Control,TB3-1(optional hookup on upper board) CL1-14, R1, U2-8<U2-9, DB25-14 (autofeed)	Blue



Shown above, is the connection pin-out of the DB 15 power connector, for the Genesis camera. This view is of the end of the connector looking at it from the O ring seal side of the connector. The color code shown in the table above the picture is for the internal wiring of the camera as supplied in the kit from Genesis. This would be for connecting the detachable Molex connector mounted on the PC board to the camera case sealed DB 15 connector. The +5 volt supply for the peltier will be connected to the high amperage pins of the DB 15 connector (reference A2). You will notice that ground supplies for all voltages are isolated. This will assist in controlling undesirable signal noise from the camera board circuitry. It is also recommended that the grounds for the + and - 15 volt supplies are common (shared) in the supply of these voltages. It is never advisable to have only one of these power sources running when supplying sensitive electronic circuitry, as in the Genesis camera.

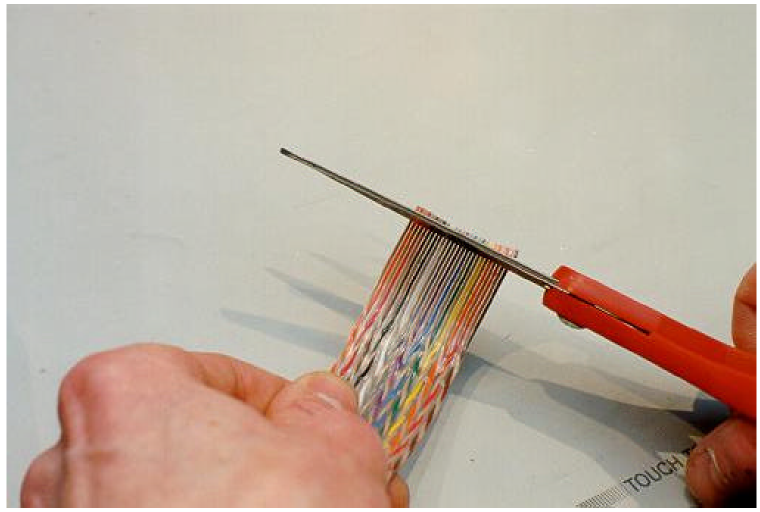
In this configuration, both supplies will run simultaneously while delivering power. When assembling your power cable it is suggested that you double check all connections with an ohm meter before supplying the camera circuitry with power. For security it is also suggested to wire the hookup cable symmetrically to the external DB power connectors. This will prevent the chance of incorrect supplied voltages to the camera.
For portability a single case is built to house all the different power sources.

Assembly of the power cable is desired before assembly of the boards. The picture shown has the lower amperage supply currents being fed through one cable. The peltier supply uses high amperage and is isolated for precautions of transmitting unwanted electrical noise to the sensitive electronics of the camera.

Cable Assembly

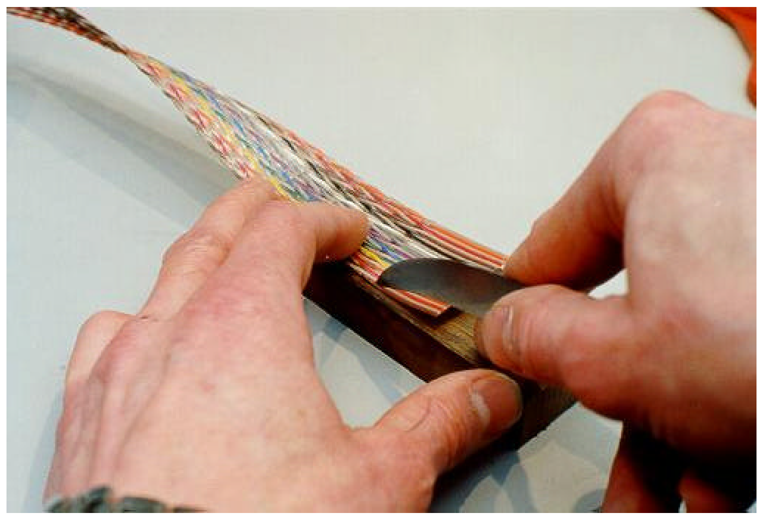
Before beginning tests of the board assemblies, it will be necessary to construct a cable for communicating between the PC and camera. The cable is made from color-coded twisted pair IDC ribbon cable. We will use 26 conductor .050" centerline wire for this cable that will have 18 inches between the flat terminal areas of the cable.

It is advised to use a cable of this configuration to pair a signal wire with a wire of ground for clean communication of the data transported. The configuration of this type of cable with the DB25 ribbon cable connectors provides a straightforward solution for assembly. Mount on one end of the cable a DB25 male connector, and on the opposite end a female DB25 connector. [It should be noted that the maximum length of 22 feet 11 inches is recognized before the loss of signal is approached.] For most cases the cable will be of shorter lengths for better manageability. This type of connector has serrated clips that make assembly without soldering possible.



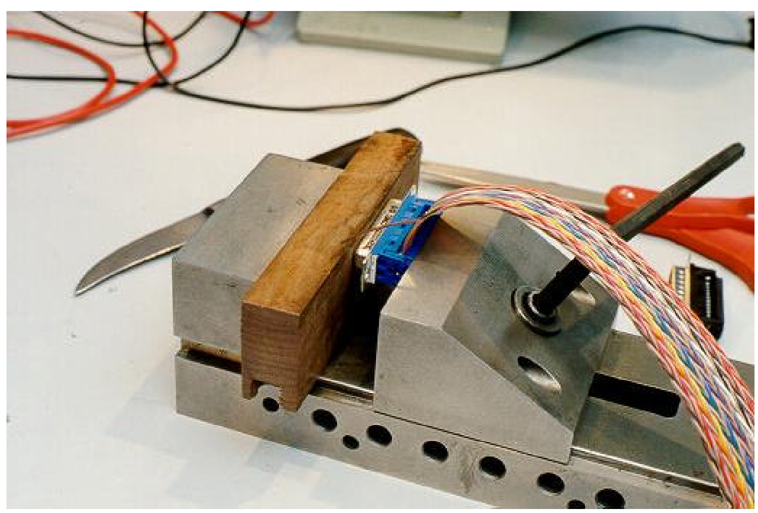
Here is the procedure to construct a cable assembly.

Cutting the straight section of twisted pair cable square.
The first step is to cut the cable on the straight sections where it is not twisted. Using a sharp pair of scissors cut the cable at a right angle to the length of the strip. *It is important to insure after the cutting operation is completed that the copper wire in the individual wires is cut clean.* This will prevent a short circuit between two adjacent wires.



Separating one wire to arrive at the 25 total count of conductors needed.
The cable is composed of 26 wires structured in 13 twisted pairs. On the other hand, our connectors are made up with 25 pins. Therefore, it will be necessary to separate one wire, before attaching the connectors. Cut on the outside length of the end approximately 3/4 of an inch. Using a razor or sharp knife will cut the plastic binder without difficulty. On the opposite end of the cable determine the color of the wire cut on the first end and repeat the procedure.

We will not cut the extra wire of the cable. [The possibility of using it as a ground wire for the metal shields of the connectors will be an option or for supply of a non foreseen signal not in the current plan of the camera.] A good vice or arbor press will be needed for the clamping of the connectors to the wire cable. This is also a good time to examine closely the numbering configuration of the connectors to the color coding of the wires. Once the connectors are assembled onto the wires, disassembly of the two will most likely cause unreliable final results.

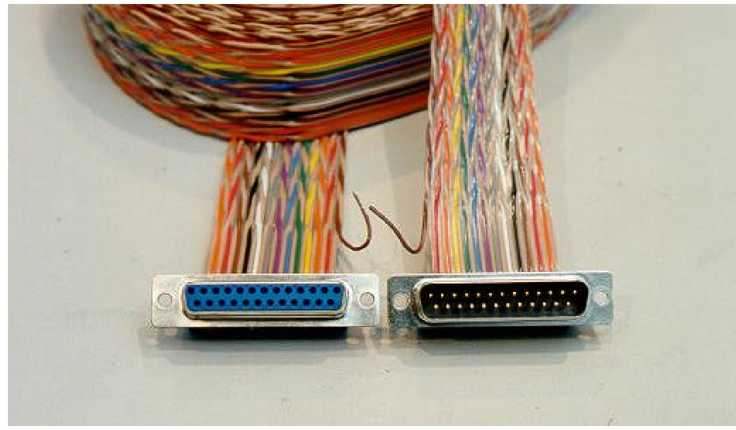


Clamping the connector in a vice using a piece of wood to protect the shell face during compression of the connector.

We will use a piece of hard plastic or wood against the jaw of the vice to protect the fragile edge of the metal shell of the connector. By slipping the wires through the connectors opening, we will notice the serrated clips aligning with the individual wires. Locate the cut end so that it does not extend past the plastic housing of the connector. Placing it in the vice, we can compress the assembly. This should be done with an *even steady pressure until the compression is complete*. **Do not over tighten the assembly**.

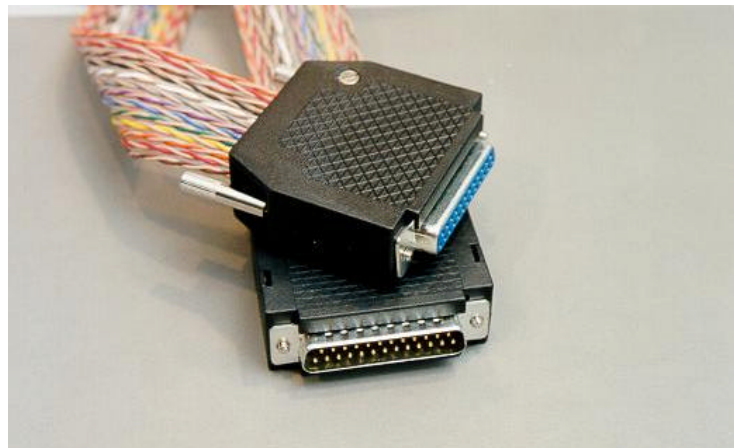
In some configurations of connectors, the wire ribbon is doubled back and a plastic security clip is additionally fastened. This operation would require a second clamping in the vice.

This is the moment of truth! As the second connector is prepared to be applied we must be absolutely sure the convention of the pin assignment of the connectors and the color coding of the cable correspond properly. Nothing will be more frustrating than to attempt to communicate with a camera that will not respond. Once you are assured that the orientation is satisfactory, proceed to assemble the second connector. The construction process is carried out in the same manner as the first connector

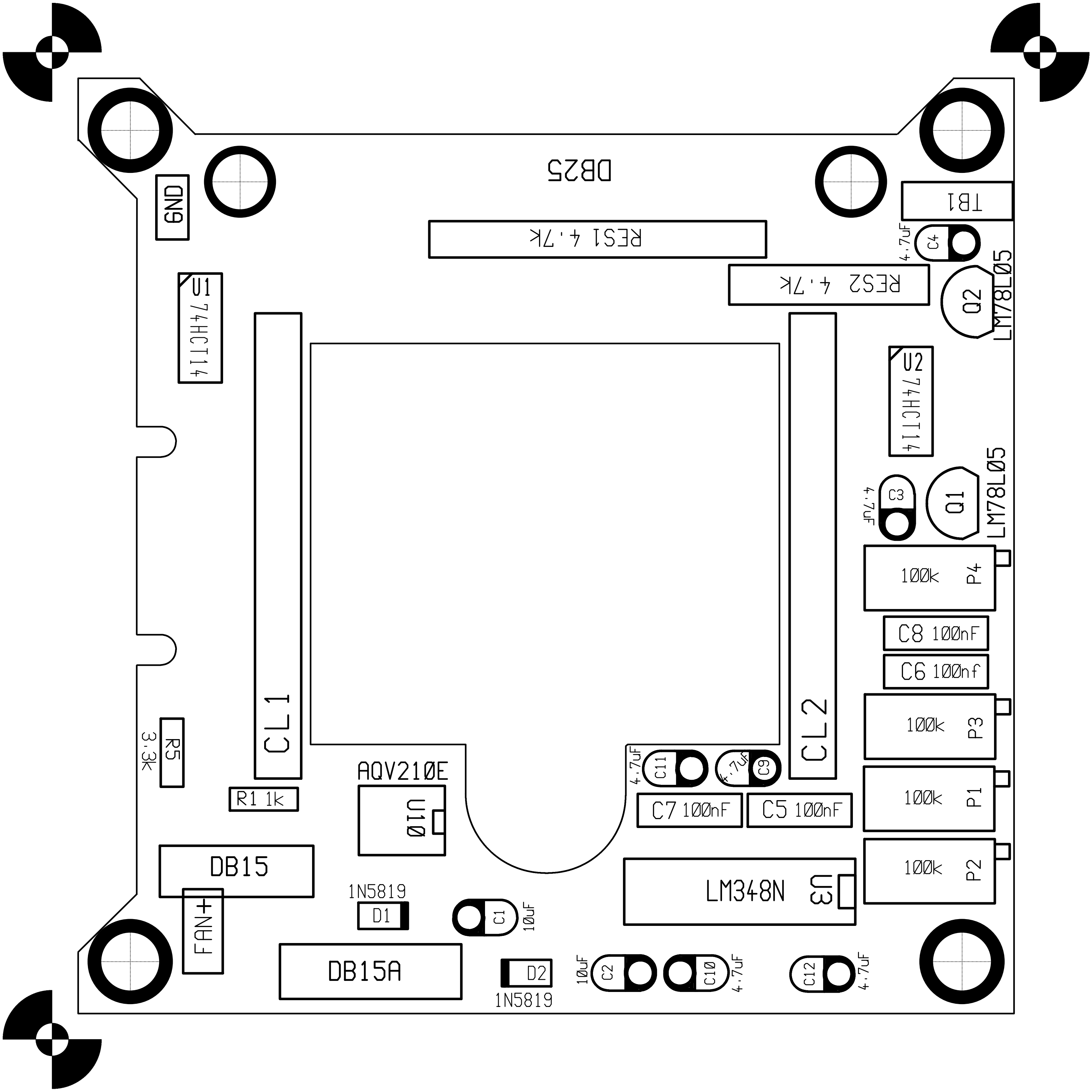


Connectors attached to the twisted pair cable. Note the point of reference of the spare wires in relation to the connectors pin orientations.

With the cable assembly completed, as a precaution, probe with an ohmmeter the electrical continuity of the two cable ends. Double-check your pin 1 location to the color code of the cable. Although time consuming, a pin by pin check will assure you of a sound communication between the PC and the camera.

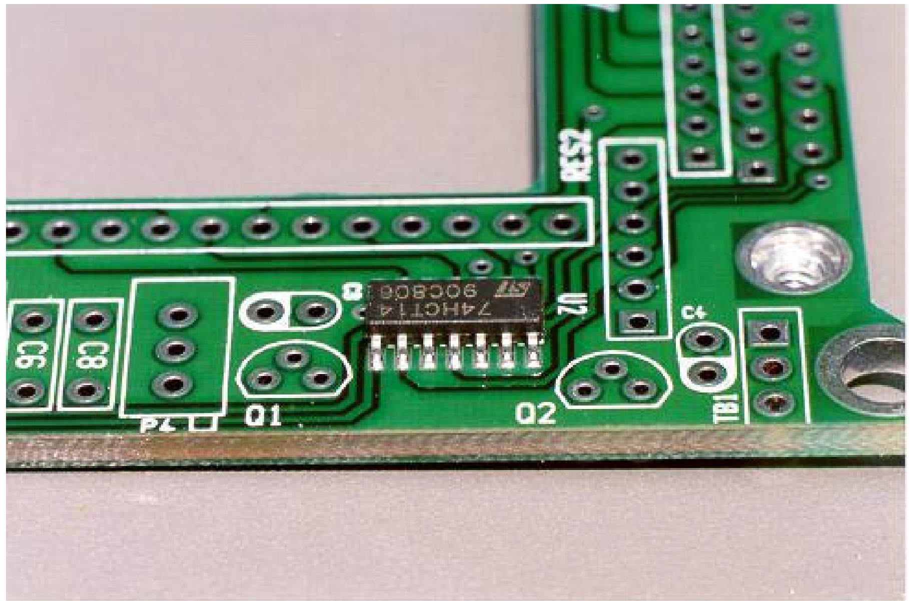


The finishing touch to our cable will be to attach plastic protective hoods with thumbscrews for secure mounting to the PC and camera.


DB25
GND
TB1
RES1 4.7k
RES2 4.7k
C4
4.7uF
Q2
LM78L05
U1
74HCT14
U2
74HCT14
C3
4.7uF
Q1
LM78L05
100k P4
C8 100nF
C6 100nf
100k P3
100k P1
100k P2
CL1
CL2
R5
3.3k
R1 1k
AQV210E
U10
C11
4.7uF
C9
4.7uF
C7 100nF
C5 100nF
DB15
FAN+
1N5819
D1
C1
10uF
LM348N
U3
DB15A
D2
1N5819
C2
10uF
C10
4.7uF
C12
4.7uF

For an aid during the assembly process check boxes ☐ are provided to help keep the confusion down.

The lower card of the **Genesis CCD** camera will support the interface circuits for control to and from the PC. It contains the components necessary for the supply voltages used on the upper board components. In addition, the shutter control circuit resides here. This PC board has the largest rectangular hole in the middle. It will have two SMD components (Schmitt triggers) pre-installed on the component side of the PC board. These two components contain six individual circuits each, which provide for the switching of signals sent from the PC into logical on/off signals used by the electronics of the camera.

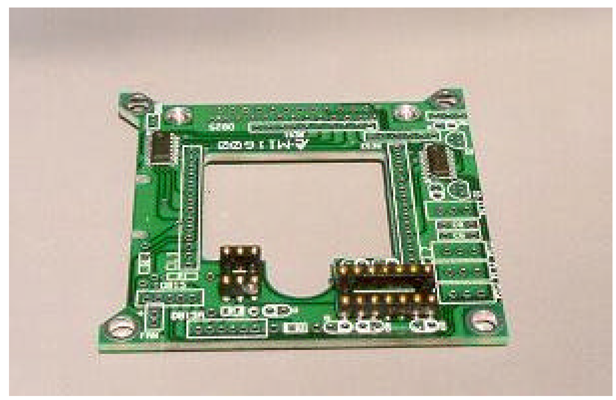


This photo shows one of the two SMD components pre-installed on the lower board.

Lower Card Assembly

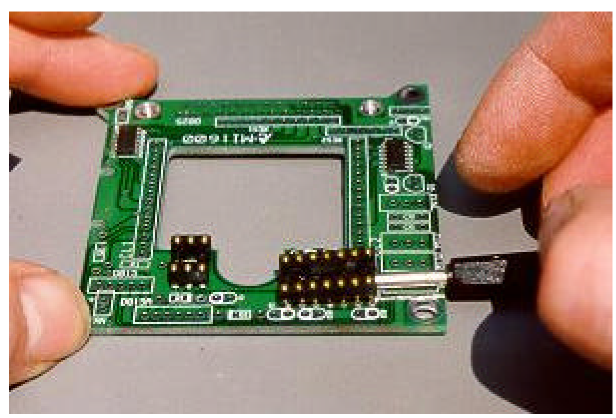
The first components we will solder to the lower card will be the Mill-Max Dip carrier sockets. The first one we will attach will be for ☐ **U3,** a 14 pin carrier. Install this component from the component side of the board. [The side with the silk screen legends on it.] By laying the board down on the bench, with the solder side facing up and the dip carrier underneath, the bottoms of the pins will be exposed. Solder all 14 pins noting the solder flowing evenly around the pads and pins. *Use only enough solder to do the job.* Attention should be taken to keep the tip of the iron clean for bright shiny bonds.

Once this task is completed, we will attach ☐ **U10**, a 6 pin carrier connector in the same fashion. After completing the soldering of the two carriers, firmly grasp the black plastic modules from the component side of the board and remove them. Or the use of a jeweler screwdriver underneath the carrier as another method to remove them. The pins we soldered will remain on the board.


Mill-Max Dip carrier sockets installed on lower board.

Following the **ESD** precautions remove the ☐ **U3** and ☐ **U10** IC's from their protective tube. We will lay the component on its side, grabbing it by the ends with the index and thumb of your finger tips. Applying even pressure to the IC, slightly bend the leads towards the center of the module. Repeat this step for the second side.

Looking at the component from the ends, the leads should be approximately at a right angle to the top surface of the module. Try not to handle the IC's by their leads to minimize the risk of damage from **ESD**.



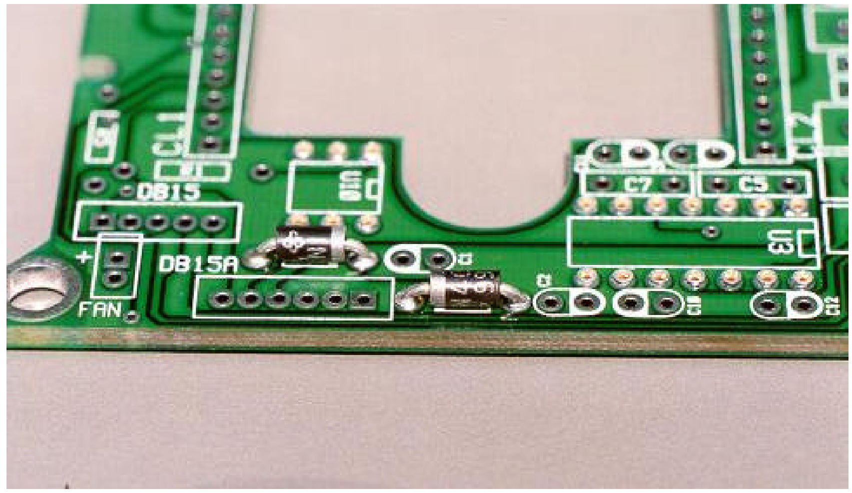
When we are satisfied with the results, we will then place the component onto the PC board for fit. The IC should seat all the way to the bottom of the notch cutouts of the leads with some pressure applied. Once this is completed, remove them and place them back into the protective tube. *[Removing them requires a little effort at times]*

[Suggestion: we have found using a small jewelers screwdriver or wood dowel with a small diameter works well. Working the IC from both ends gently prying it up will set it free from the pins soldered to the board. The reason for doing this, as we have found, makes final assembly of the IC's to the boards a simple process when other components are in close proximity.]

The first components we will solder are the diodes ☐ **1N5819 on D1 and D2**. After bending the leads of the diodes so they will fit properly onto the boards, we will pay special attention to place the diodes with the proper orientation as to polarity. As discussed on the components web page, the silk-screened outline will guide you as to the proper placement of diodes.

Diode D2 will need some extra attention as to how it sits down on the PC board. Later in the assembly process, we will need to do some adjustment to the height of the Daco shutter. An adjustment screw on the delrin standoff will need to be accessed. If diode D2 is not setting flush to the PC board it will make this task more difficult.

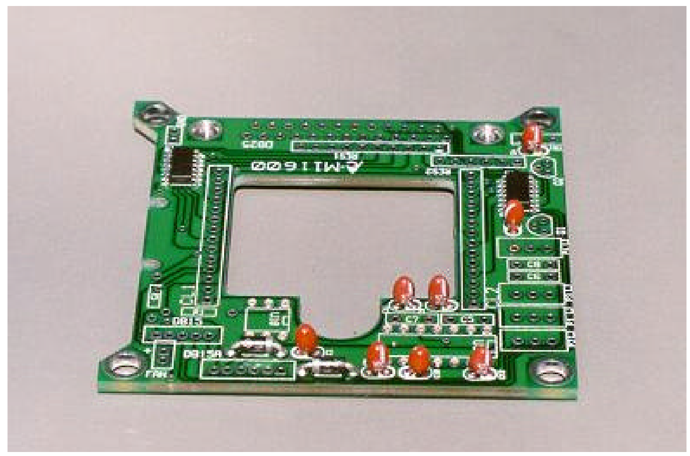
After the diodes are in place snip the excess leads protruding from the solder side of the board.



Lower diodes D1, D2 mounted on the lower board by their correct orientation.

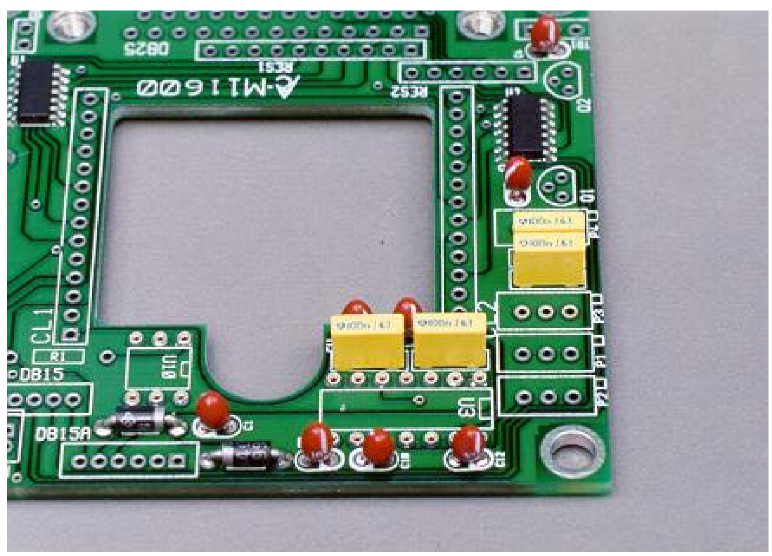
The tantalum capacitors ☐ **C1** and ☐ **C2** with a value of 10µF will be soldered next. Tantalum capacitors do have polarity! Again, we will have to pay careful attention, as to the mounting of these components. The silkscreen outline on the boards clearly outlines the orientation of these capacitors. (Refer to the **components** page for detailed information on the identification of polarity, and the board marking.) If by chance, they are installed improperly, the first time the camera is powered up a puff of smoke will often rise from the circuit boards. Now, we will attach capacitors
☐ C3, ☐ C4, ☐ C9, ☐ C10, ☐ C11 with a value of 4.7µF. Again, verify the polarity of the capacitors during placement.

Special Note: For the placement of ☐ C12 the polarity must be reversed from what the silkscreen legend shows on the board. The picture depicted below shows this capacitor installed improperly. An error was made during the layout of the board and reversing the polarity will correct it.



Tantalum capacitors mounted on the lower board with the correct polarity observed.
Except for C12 that is wrong in this picture

Now to solder the metallized polyester film capacitors ☐ **C5,** ☐ **C6,** ☐ **C7** and ☐ **C8** with a value of 100nF. These components have no polarity as to their mounting. All the same, overheating these components as they are being soldered will melt the plastic case. [Once again when this task is complete snip the excess leads from the solder side of the board.]

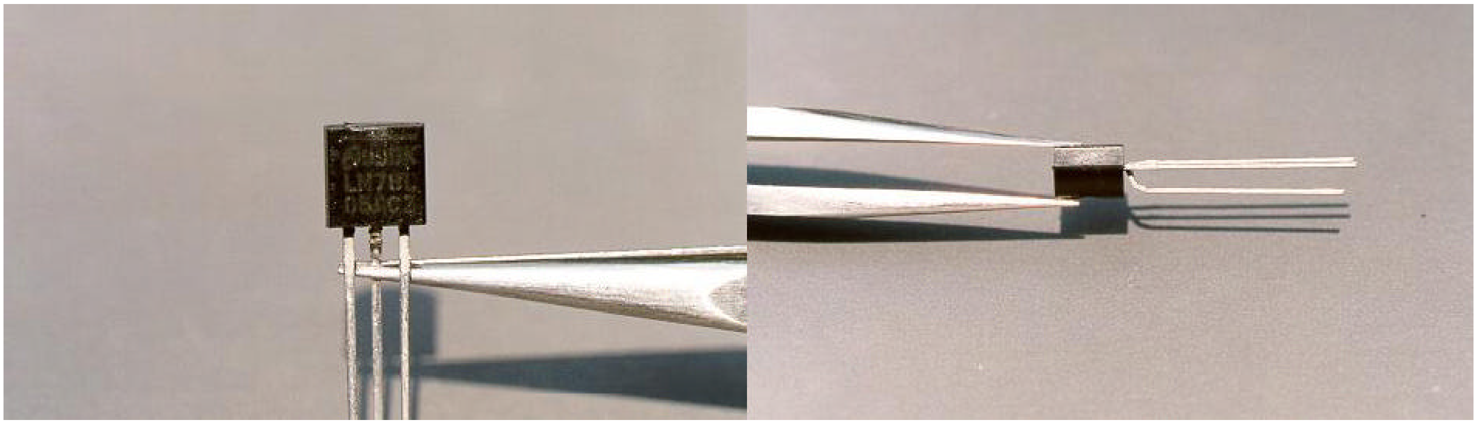


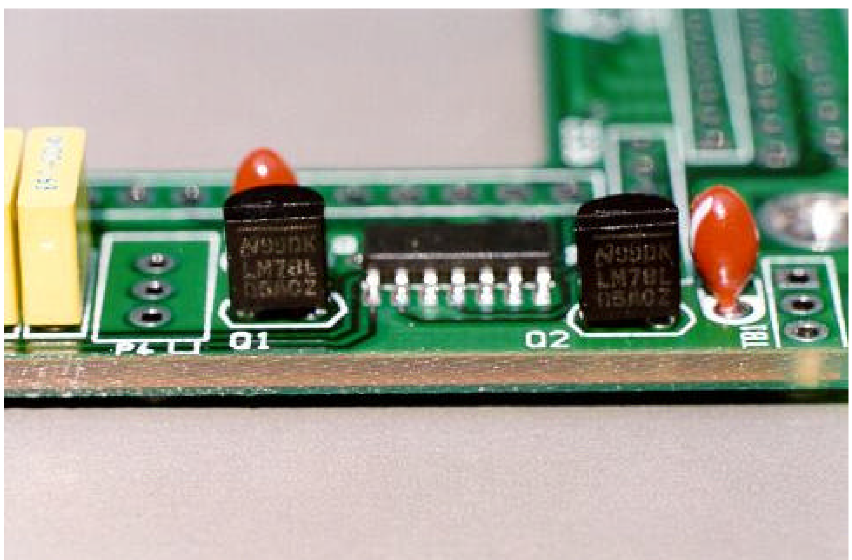
Metal film capacitors mounted on the lower board.

Finally, it is time to insert the two 5 volt regulators. They are ☐ **Q1** and ☐ **Q2** with the value of 78L05. It will be necessary to verify that the parts are indeed 78L05's. *Another component used in the Genesis looks identical*. Careful examination will be needed with a magnifying glass to assure yourself that the proper component is being used. Once this is achieved, we will proceed with the installation.
You will need to bend the legs of the regulators so they will adapt to the hole pattern of the circuit board. Using fine tipped needle nose pliers or tweezers carefully bend the center leg away from the flat that has the identification marking on it.
Then bend it straight so it is parallel again with the unbent leads.

Check to see if the spacing is sufficient for the part to fit properly. Again, the silk screen outline will guide you to the proper orientation.
It will also become apparent at this point in soldering these components, why a fine tipped soldering iron is recommended.

Regulator with the leads bent for proper fit to the hole pattern on the lower board.





Lower board +5V analog and digital voltage regulators set.

Lower Card Assembly – Step 2

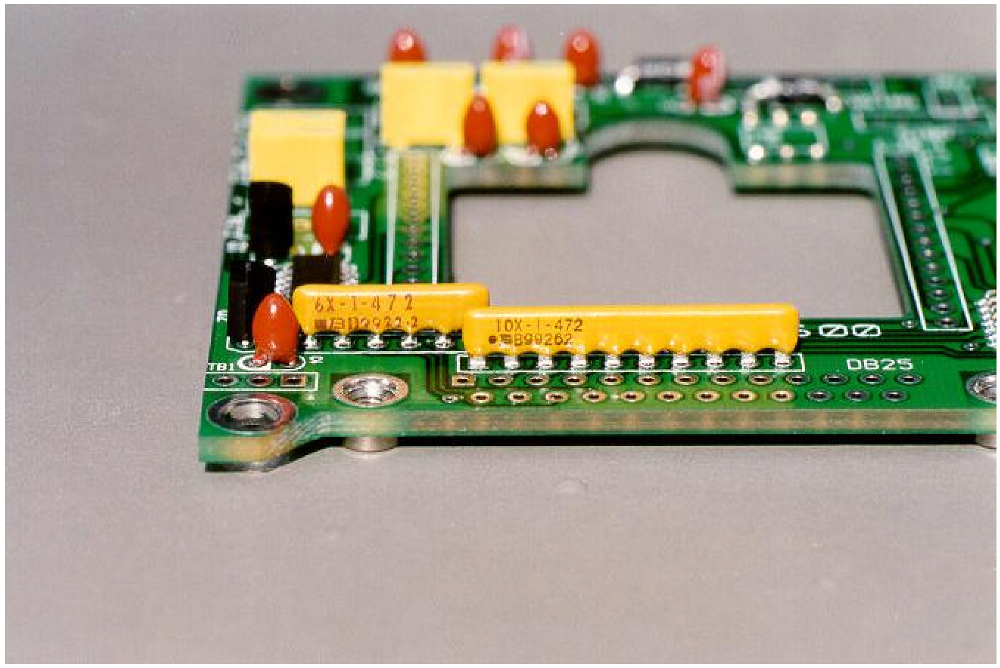
As we perfect our soldering technique, the board obviously becomes more populated. The next task will be to place the resistor networks in place. These components have polarity. Refer to the Components page for proper orientation and placement.
The networks ☐ **RES1** and ☐ **RES2** with a value of 4.7k have multiple pin arrangements. The technique for attaching them will also be used in the placement of other similar components during the assembly process.

Once you are assured of the correct placement, solder only one lead on the end of the part. Check to see that it is sitting the way that it suits you. If not, reheat the solder and move the part until its placement is proper. At this point solder the lead at the opposite end of the part. Then check again. If all is well, finish soldering the remaining leads of the part.

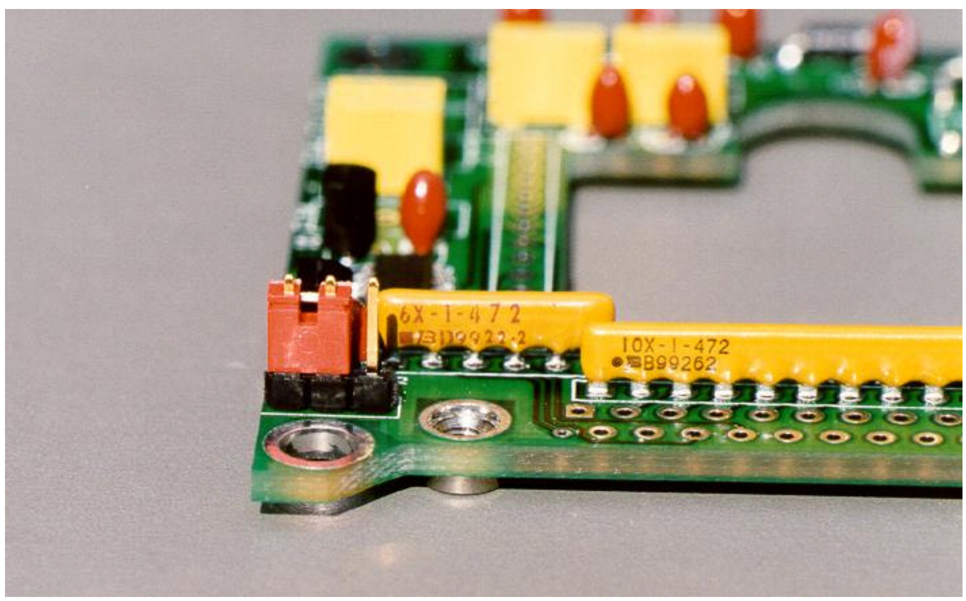
We will now attach the two Mill-Max single row pin headers. The first part will need 3 pins and is for placement on TB1. *Take note of the square solder pad of TB1, this a ground pin that will be used later in testing.* The purpose of TB1 is to pull the signal coming from the PC through DB25 and the resistor network RES1 up or down. By pulling it up (pin strap over pins 2 and 3) ,we are joining it to the +5 VDC provided from Q2 on the digital power plane. In most cases, this is the preferred configuration. There is also the option in some cases to pull it down (to digital ground) for your PC to communicate with the camera properly

RES2 is for the auxiliary signals for future enhancements of the Genesis. This would include driving a filter wheel or command of a second camera from the DB15 power connector auxiliary pins.

The second pin row header (2 pins) is for placement on GND. This gives us the option to ground the case of the camera and the DB25 connector shell to the ground plane of the circuit boards. This configuration, in some cases, will aid in removing unwanted electrical noise and provide a simple way of isolation, if desired.



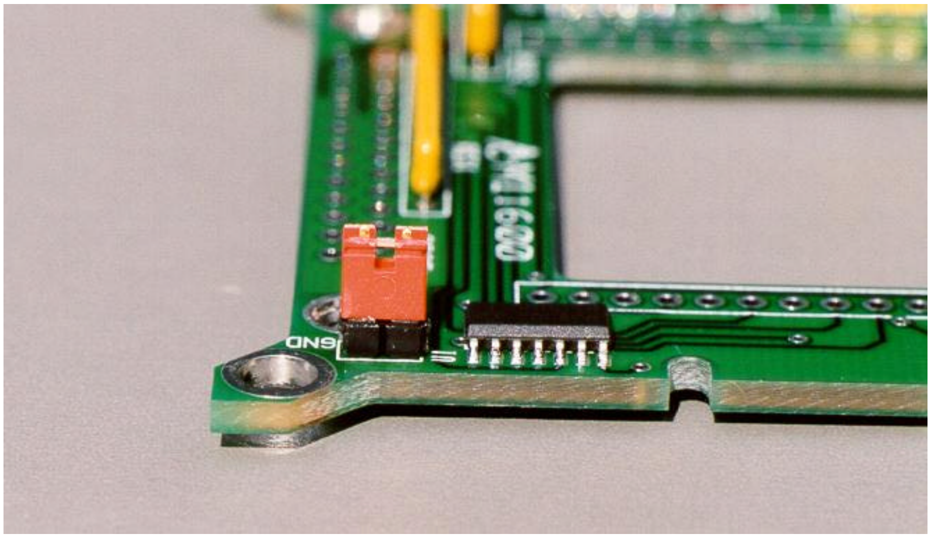
The resistor networks set on the lower board with proper orientation.



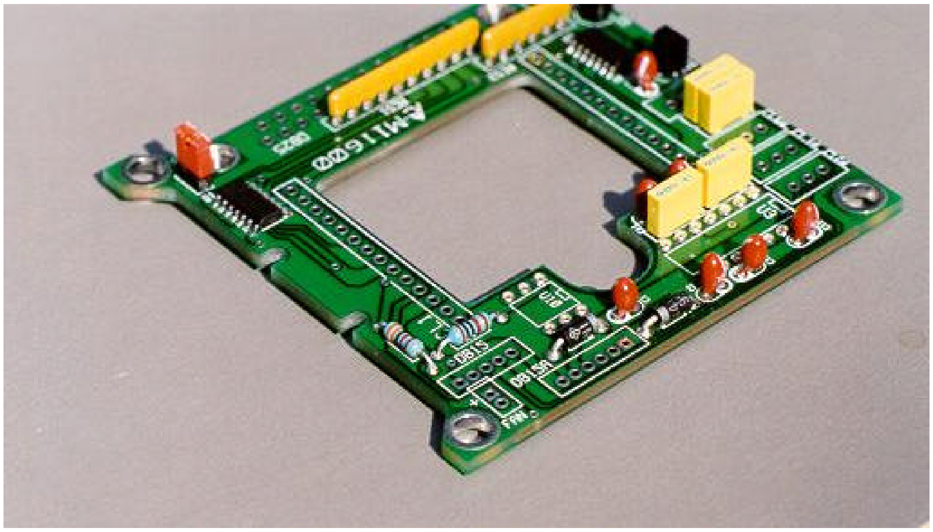
TB1 jumper on the lower board mounted with suggested pin strap configuration.

Resistor ☐ **R1** with a value of 1k is used in the shutter circuit. This limits the signal coming from the Schmitt trigger to the Photomos relay used to drive the shutter. Using the Speedy bend lead former, or fine tipped pliers, bend the leads for placement into the PC board. Resistors of this type have no polarity.

The only other resistor ☐ **R5** is *optional* with a value of 3.3k. This resistor will be used if you install a thermal probe using a LM35CAZ for Centigrade or a LM34CAZ for Fahrenheit measurement. These components are supplied with a TO-92 case style that allows them to be mounted into the cold finger with the holes provided. Considering the placement of this resistor, it may prove difficult to access at a later time if it were needed for use with the thermal probe. Therefore, we recommend that you install it, even though you do not make use of it.



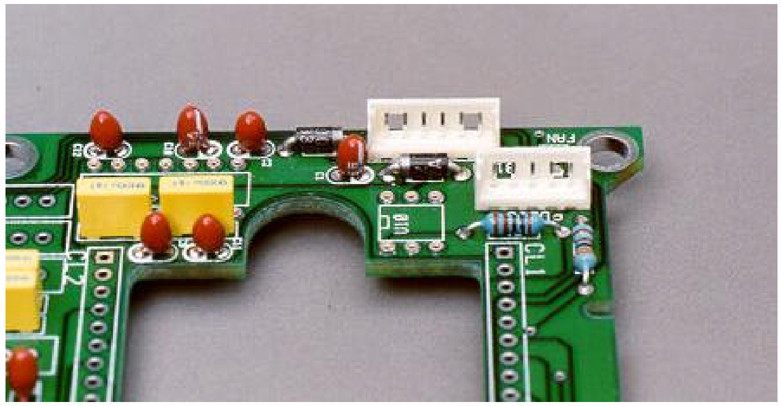
GND pin jumper on the lower board installed.



Resistors mounted on lower board for shutter and thermal probe operation.

Lower Card Assembly – Step 3

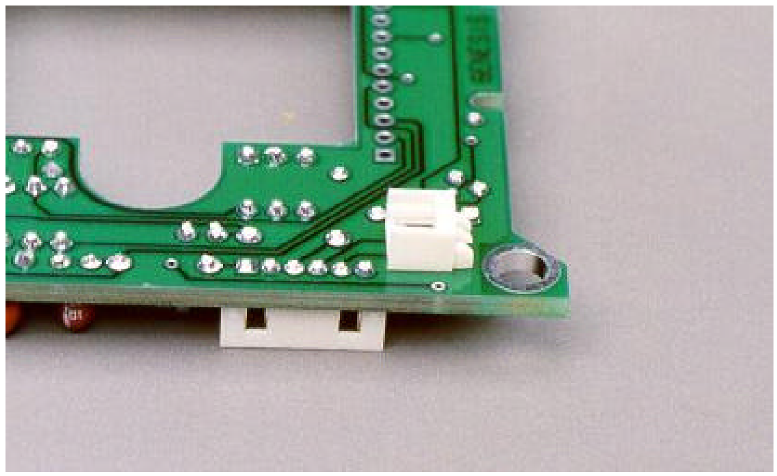
At this point, all of the discrete electrical components have been installed. The next installation will be the Molex power pin connectors. The six-pin connector ☐ **(DB15A)** is for supplying the necessary operating power voltages to the electronics of the camera. The open end of this connector should face towards the cut out square hole in the center of the PC board. *You will notice the square solder pad on the right side of the line of solder pad holes. This is for the supply of the -15 VDC of the camera. We will need to remember this later on in the wiring of the DB15 power connector.*



Lower board Molex attached with correct orientation for wire to board harnesses

Solder the connector to the board first by soldering one pin. Check position and, if all is well, solder the opposite end. Finish the remaining pins of this connector when satisfied with its placement. Again, it should be noted, that excess heat applied to the installation of these parts will melt the plastic and damage the connector. Proceed to installing the 5 pin ☐ **(DB15**) Molex connector using the same procedure as the last component.

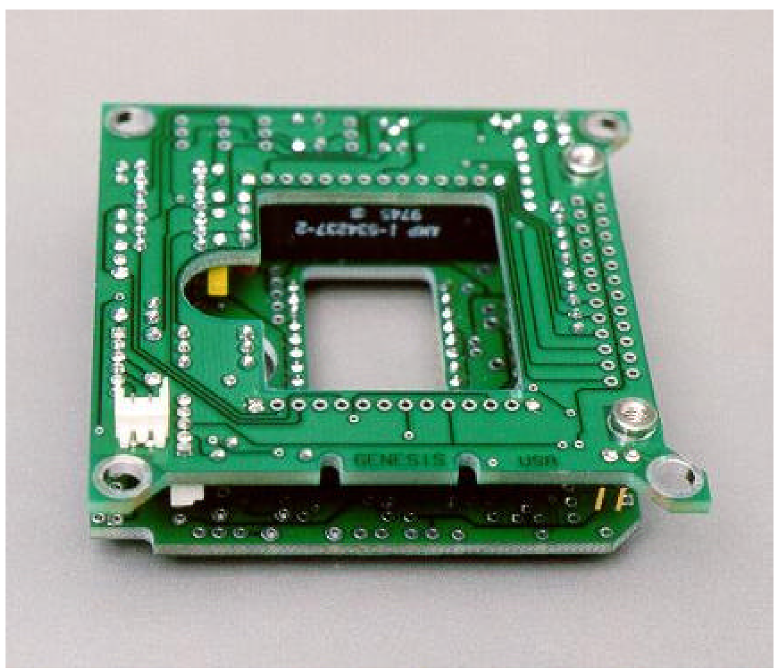
The fan connector is a 2 pin Molex right angle configuration. This connector is mounted from the solder side of the PC board. The direction the open end is facing is towards the DB15A connector pins. Soldering this component is done from the component side of the board.



Fan Molex connector mounted on the solder side of the lower board.

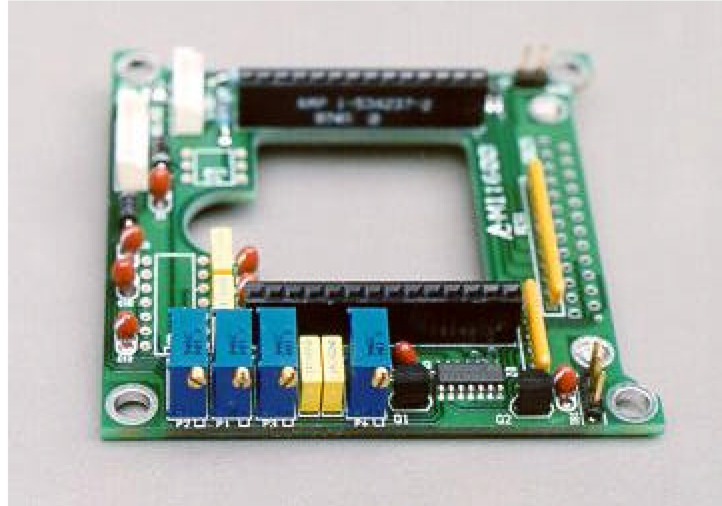
We are ready to install the **AMP** single row 14 pin board interconnects on ☐ **CL1** and ☐ **CL2**. This requires some patience and precise setting. It is essential that these connectors are properly placed to allow the final assembly of both cards to take place. The connectors must sit flush and square to the lower PC board. We have found it works best by assembling the connectors with their mating socket header strips. Then place the assemblies onto the component side of the lower board. With the upper board orientated correctly, place it onto the inter-board connectors to complete the assembly. Then flipping the boards, so the solder side of the lower board is up, as the upper board is laid down on a flat surface. Solder one pin on the ends of each connector. Check that the connector is seated properly on the ends that were soldered.

If all is well, repeat the same process on the opposite ends. Again, check for placement, and for the connectors sitting square to the board plane. If you are satisfied with the placement, solder the remaining pins on the connectors.



Lower board inter-board connectors as they are tack soldered. Note the two end pins are the only ones soldered for both connectors before finial soldering is done to the connectors.

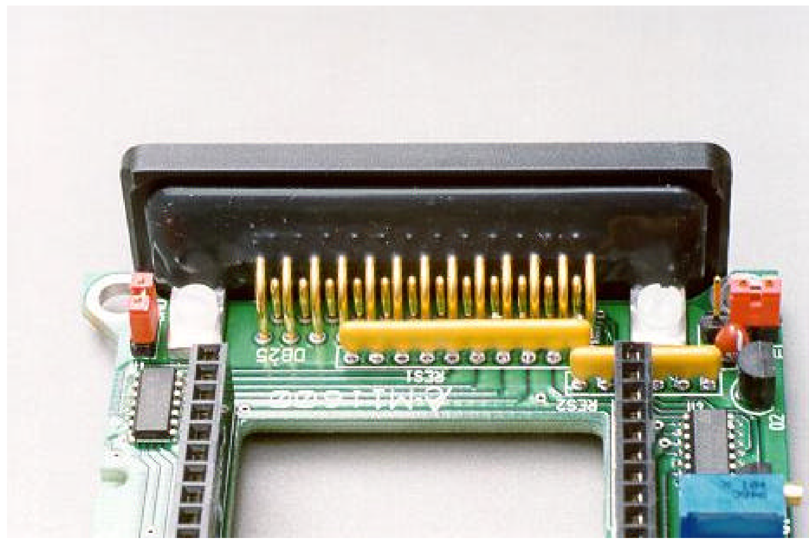
Addition of the four 3296X-104 potentiometers ☐ **P1,** ☐ **P2,** ☐ **P3** and ☐ **P4** with a value of 100k will now be done. Orientation of these components is set so the adjustment screws are facing toward the outside of the circuit board. The silk screen outline will confirm proper placement. The potentiometers are used for setting the clock voltages of the CCD. They are multi-turn (25 turn) to allow fine adjustment of these voltages. As was done with the resistor networks, solder one pin, check for placement before finishing the soldering of the last two pins.



Potentiometers set on lower card. Also note the inter-board connectors set on the lower board.

We are very close to the end of the wiring of the lower card.
The last component that needs to be attached is the ☐ **DB25** sealed connector. First mount the connector to the board from the component side. Using the two ☐ **4-40 X 1/4"** fillister nylon slotted screws, attach the connector to the board through the mounting legs to the Pem nuts that are preinstalled on the board.
Once this is accomplished, the connector will remain in place so soldering will be a simple process.

Now that all components have been placed on the board, cut any component leads extending from the solder side of the board. *Before any electrical testing is done, we advise cleaning up all the loose cut leads from your bench area. As tests are being done, one dead short from a cut lead possibly will prove to be disastrous.*



Sealed DB25 connector mounted to the lower board using the two 4-40 fillister nylon slotted screws.

Lower Card Assembly – Step 4

The next step is to wire the DB15 sealed connector so that power can be provided to the camera electronics for testing. Using the Molex 6 pin wire to board connector we will cut the wires to their proper length and strip the ends for attachment to the connector. The wire color codes for the Molex connector relate to power supply polarity of different supply voltages. This will correlate to the wiring to done to the power supply cable. This is the final link to providing power for operating our camera.
DB15 Molex wire to board connector

PIN #	COLOR CODE
1 to DB15 pin 1	Black
2 to DB15 pin 2	Green
3 to DB15 pin 3	Red
4 to DB15 pin 4	Orange
5 to DB15 pin 5	Green
6 to DB15 pin 6	Blue

This configuration is for the DB15A, a 6 wire to board Molex connector.
We will start with the black - 15 VDC wire. ☐ Cut the wire measuring 2 3/8" length from the Molex connector.

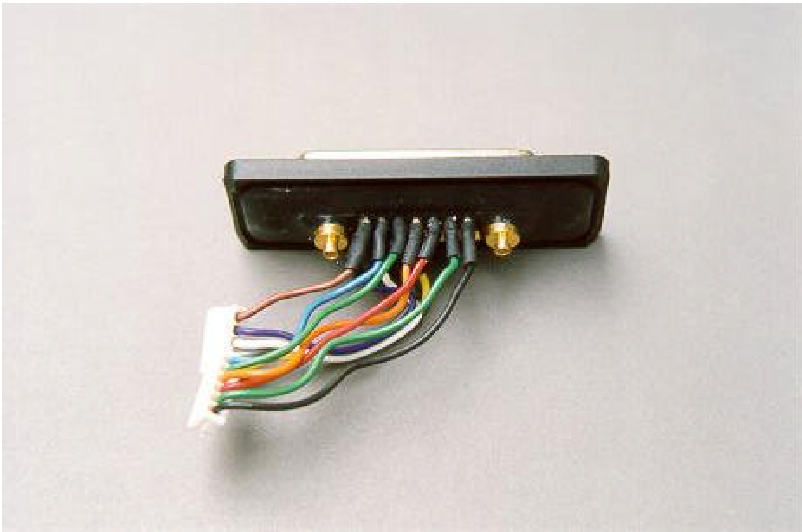
☐ Green wire 2 5/16" long.
☐ Red wire 2 1/4" long.
☐ Orange wire 2 3/16" long
☐ Second green wire 2" long.
☐ Blue wire 1 15/16" long.

Strip approximately 1/8" maximum from the ends of the wires, and twist the stripped ends between your fingertips.
We have also found that using approximately 1/4" length of shrink tubing with an I.D. dimension of 3/32" an advantage. This aids in giving strength to the solder and wire intersection. Small amounts of flexing in this area will likely produce a fracture at the connecting point.
Once this is accomplished, proceed with soldering the wires to the DB15 5 power connector. It is recommended to verify pin 1 of the connector before assembly is started. First presolder all of the DB15 power connectors mounting solder cups. Following the color-coding of the wires, solder them in place onto the sealed connector. Holding the connector in a vice or bench clamps will make the task smoother giving you an extra set of hands. If using a vice do not over tighten the connector when restraining it, the plastic housing could be permanently damaged. The metal shell housing is also easy to distort.
After DB15A Molex connector and the DB15 power connector are soldered, it would be a good time to set up the Molex wire to board connector DB15, 5 pin connector. The wire configuration lengths recommended for the application of this wire to board connector are:
DB15A Molex wire to board connector

PIN #	COLOR CODE
1 to DB15 pin 7	Brown
2 to DB15 pin 8	Purple
3 to DB15 pin 9	White
4 to DB15 pin10	Grey
5 to DB15 pin 11	Yellow

☐ Brown wire cut to 1 5/16" long.
☐ Purple wire to 2" long
☐ White wire to 1 15/16" long
☐ Gray wire to 1 7/8" long
☐ Yellow wire to 1 13/16" long

We have now completed the assembly of the lower card!



DB15 sealed power connector with wire to board Molex connectors attached. Note the use of heat shrink tubing to relieve stress at the soldered joints on the connector.

Power Cable

As discussed on the Power Supply page, we will assemble the power supply cabling for the lower current supplies of the camera. This cable will consist of supply voltages for the + and - 15 VDC and also the 12 VDC for the fan and shutter supplies. *At this point we only really need the 15 VDC supplies, but we will make up the whole cable at one time.* The length of cable needed will be dependent on the users' needs. Consideration should be taken into account for your particular setup to allow ample room for various configurations. We chose 15 feet as a good compromise for our setup.
In this photo we can see the power cable assembled.

Using the table and picture of the DB power connector from the power supply page we will assemble the cable paying close attention to the pin assignments. Color coding of the wires makes for easy hookup. The traditional color assignments are as follows.

- **Pin 1 - 15 VDC Black**
- **Pin 2 0 V Green**
- **Pin 3 +15 VDC Red**

For the 12 VDC supplies, the color will be your choice.

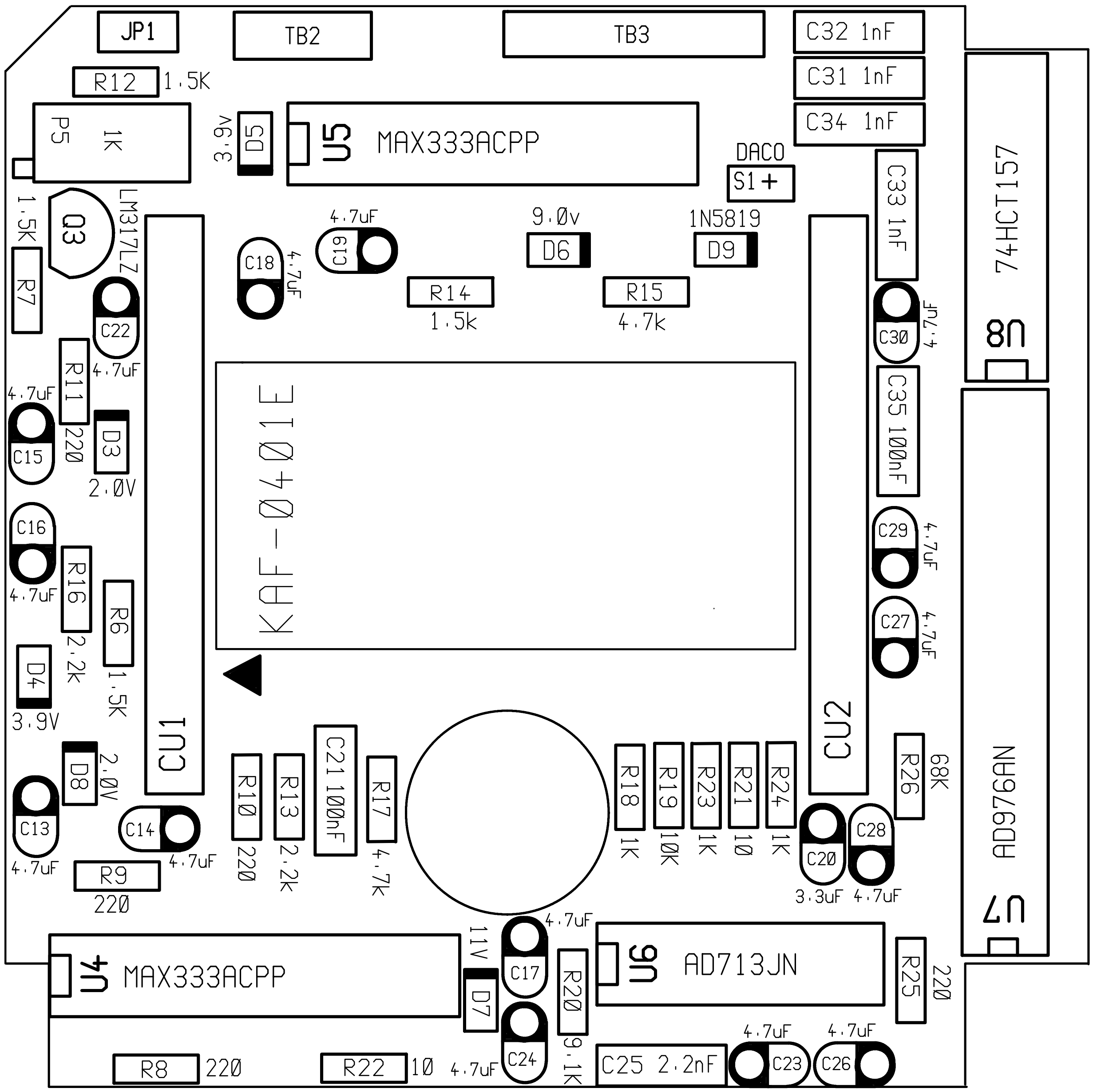
☐ 1. First: strip the ends of the wires approximately 1/8 of an inch. *[In the photo we will use the shield braid of the cable as the ground supply.]*
☐ 2. After the wires are stripped, we will tin the wire ends with solder to keep the small wires of each individual lead from fraying.
☐ 3. Once this is accomplished, we can undertake the final placement of the leads to the DB power connector. A vice or clamp is really necessary to hold the connector in place as the soldering is done to assure a good bond. Any movement during the soldering process could potentially produce a cold solder joint. As you become accustomed to soldering the process moves along at a better pace.

We will now take some tests to assure that the work completed is satisfactory. With the completed power connector wired, and soldered, plug the Molex wire to board connectors onto their board sockets.
Attach your power cable to the DB15 sealed power connector.
Lastly, attach the opposite cable end to the power supply.

☐ *It would be wise once again to verify that all connections are properly made before applying power to the completed circuit board of the camera.*

Now, set the multi-meter to 20V. If the supplied voltages for the + and - 15 volts are not correct the D1 and D2 diodes will protect the circuit board components. Although the diodes are in place for protection, they will only handle 1 amp of power. If a laboratory power supply is used, they will normally have built-in limiters present to shut off power in the case of dead shorts.
In the case of open frame, linear supplies, these protection devices are not in place. Again it is important to be sure that all is well before applying power! If the hookup is not properly done it will be easily changed by switching the hot positive and negative leads of the 15 volt supply.
☐ With the negative multi-meter probe (black) touch the free pin (TB1-1). This is the ground pin on the boards and is the most easily identified.
☐ With the positive probe (red), touch the positive leads of C3 and C4 capacitors. You should find a reading of 5 volts or there about.
☐ Now test with the negative probe still on TB1-1, using the positive probe check U3 pin 4. You should find the voltage of about +14.7.
☐ Then check U3 pin 11, where we will find -14.7V or there about.

If all these tests are conclusive, the lower card is ready for service.
As you prepare to construct the upper card, the lower card should be placed in the **ESD** protective packing that it was shipped in to protect the components, until additional testing is required.


JP1
TB2
TB3
C32 1nF
C31 1nF
C34 1nF
R12 1.5K
P5
1K
3.9v
D5
U5
MAX333ACPP
DACO
S1 +
C33 1nF
74HCT157
1.5K
Q3
LM317LZ
4.7uF
C19
C18
9.0v
D6
1N5819
D9
R7
R14
1.5k
R15
4.7k
C22
C30
U8
R11
C15
D3
220
2.0V
C35 100nF
KAF-0401E
C16
R16
R6
C29
C27
2.2k
1.5K
D4
3.9V
CU1
CU2
R26
68K
AD976AN
D8
C13
C14
R10
R13
C21 100nF
R17
R18
R19
R23
R21
R24
C20
C28
1K
10K
10
3.3uF
R9
U7
11V
C17
R20
U6
AD713JN
R25
U4
D7
C24
9.1K
C25 2.2nF
C23
C26
R8
R22

For an aid during the assembly process check boxes ☐ are provided to help keep the confusion down.

Upper Card Assembly

The chart provided will aid in the placement and orientation of specific parts. The placement of components on the upper card is much the same as was performed on the lower card. The differences are, that the upper card has more components and the signal operations are more complex. In building the upper card, the component placement will be done from the silk screen side of the board.

It is recommended to thoroughly read the assembly instructions for this board before starting assembly. There are some differences in the assembly configuration. Having a clear understanding of these differences will make your desired results obtainable.

We will start for a second time with the placement of the Mill-Max DIP carrier sockets. On the upper board there are 5 sockets to position on the board, ☐ **U4**, ☐ **U5** 20 pin carriers, ☐ **U6** a 14 pin carrier, ☐ **U7** a 28 pin carrier and ☐ **U8** a 16 pin carrier. Install these components from the component side of the board. This will be the side with the silk screen legends on it.

By laying the board down on the bench, with the solder side facing up and the dip carrier underneath, the bottoms of the pins will be exposed. Care must be taken handling the upper board during assembly as to not damage the premounted Mill-Max pins for mounting the CCD sensor. Solder all pins on one DIP carrier at a time noting the solder flowing evenly around the pads and pins. *Use only enough solder to do the job.*

Attention should be taken to keep the tip of the iron clean for bright shinny bonds. Once this task is completed we will attach the succeeding DIP carrier connectors in the same fashion. After completing the soldering of the 5 carriers, firmly grasp the black plastic modules from the component side of the board and remove them. The pins we soldered will remain on the board.

Following the **ESD** precautions, remove components ☐ **U4**, ☐ **U5**, ☐ **U6**, ☐ **U7** and ☐ **U8** IC's from their protective tube. We will repeat the bending of the leads of the IC's the same way as was preformed as we assembled the lower board.

When this task is completed, the next components to secure are the resistors.
With the Speedy bend lead former, or fine tipped pliers, bend the leads of resistors ☐ **R6** and ☐ **R7** with values of 1.5k and solder them to the board.

Then proceed to:
☐ **R8**, ☐ **R9**, ☐ **R10** with a value of 220Ω.
We will not install R11 with a value of 220Ω and R12 with a value of 1.5k at this time. We will **discuss** this in detail later in the instructions.

☐ **R13** with a value of 2.2k
☐ **R14** with a value of 1.5k
☐ **R15** with a value of 4.7k
☐ **R16** with a value of 2.2k
☐ **R17** with a value of 4.7k
☐ **R18** with a value of 1k
☐ **R19** with a value of 10k
☐ **R20** with a value of 9.1k
☐ **R21** and ☐ **R22** with a value of 10Ω.
☐ **R23** with a value of 1k
☐ **R24** with a value of 1k
☐ **R25** with a value of 220 Ω.
☐ **R26** with a value of 68k

After soldering is completed, cut the excess leads from the components.
The tantalum capacitors are the next components to solder to the upper board. As has been referenced to previously in the assembly instructions of the camera, the polarity of tantalum capacitors must be observed during construction.
It is always better to double check yourself, than to have the misery of removing a soldered component. A slow and steady pace in the installation of these components has the effect of keeping your blood pressure low!

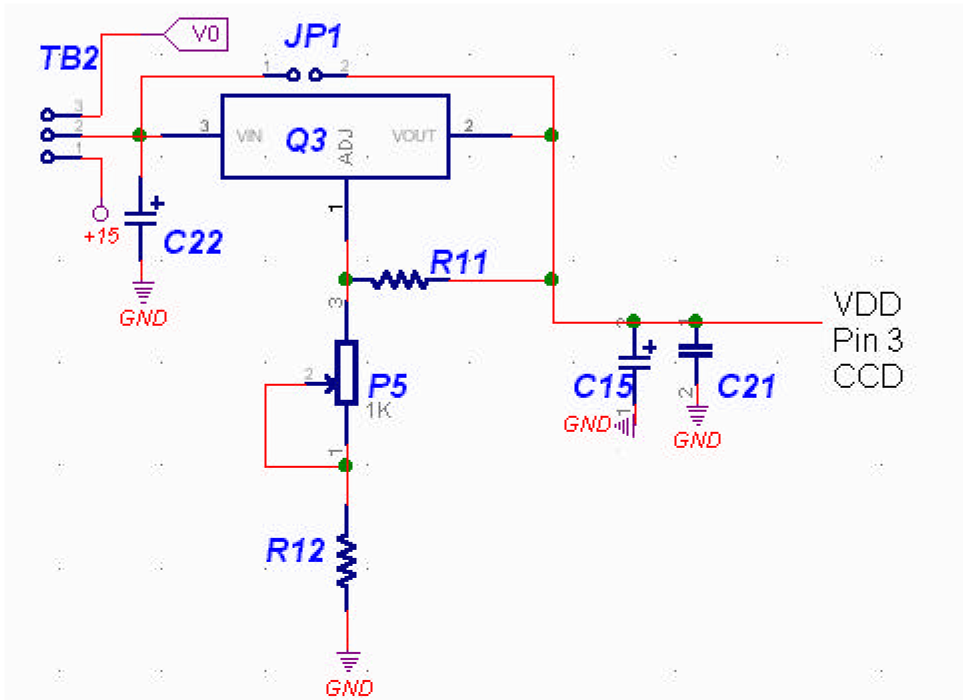
Start with ☐ **C13**, ☐ **C14** ☐ **C15** with values of 4.7µF.
Then, solder capacitors ☐ **C16**, ☐ **C17**, ☐ **C18** and ☐ **C19** with values of 4.7µF.
Capacitor ☐ **C20** has a value of 3.3µF.

We will not install C22 at this time. We will **discuss** this in detail later in the instructions.
Then ☐ **C23**, ☐ **C24**, ☐ **C26**, ☐ **C27**, ☐ **C28**, ☐ **C29** and ☐ **C30** with values of 4.7µF.
You have noticed that there are some tantalum capacitors that have not been set. This will be addressed in more detail later on in the assembly, as well as some choices that you will make for different options of operation of the camera.

Upper Card Assembly – Step 2

The next step will be to affix the metallized polyester film capacitors on the upper board. We will start with ☐ **C21** with a value of 100nF. Then ☐ **C25** with a value of 2.2nF**.** ☐ **C31** through **C34** with a value of 1nF. And last ☐ **C35** with a value of 100nF. As previously noted, in the instructions, metallized polyester film capacitors do not have polarity in the context of their installation.

The moment has come to make the decision if we will install the components we just spoke of a few paragraphs ago. You will notice in the picture below a diagram of the camera circuit.



We have three choices of generating the supply voltage necessary for VDD pin 3 of the CCD sensor. This is a critical voltage for it supplies the output amplifier of the CCD sensor. In this sense, performance will depend upon, in part to the overall noise reading of the sensor, dependant on the voltage supplied.

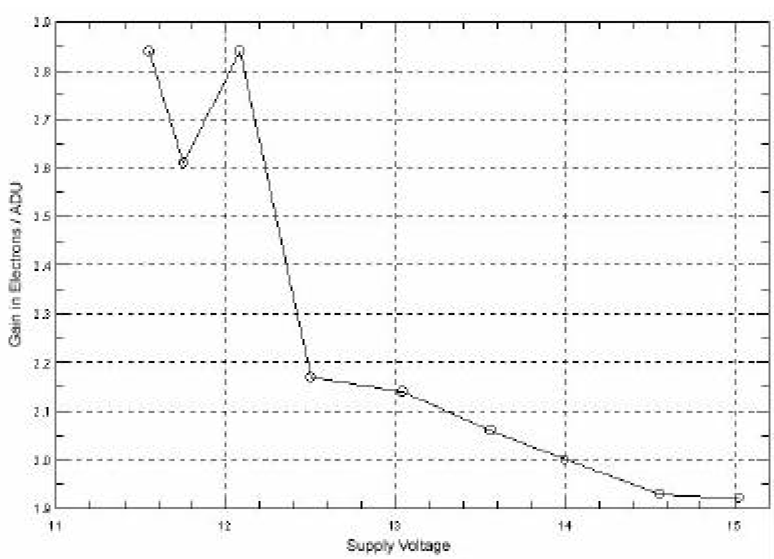
The voltage recommended by Kodak for the KAF-0401 sensor for the output amplifier is a nominal +15V with a maximum of +15.5V and a minimum of 14.5V. Indeed, this is a very tight tolerance, and much success in the performance of the camera depends on it.

Let's examine the selections that follow and choose the best possible option for stable low noise operation.

First you will notice the jumper selector TB2 at the top left of the picture. This jumper enables the selection from the +15V supply or to receive it from the VO signal. The VO signal is supplied from the U5 (MAX333ACPP) at +15V. This configuration of supply works by the one of the analog switches in U5 controlled from PC commands. This will cut the +15V supply to the VDD pin of the CCD sensor during times of integration. This has very beneficial results in circumventing the phenomenon of electroluminescence.

The term electroluminescence means that the amplifier of the CCD will emit a very weak detectable light in the image zone of the CCD sensors images. This is not a desirable function in the operation of the camera

In examining the graph diagram at the right, we notice the gain in electrons, in reference to the supplied voltage to the VDD pin of the CCD. At the region of +14.5V and then to lower supply voltages we see a rise in ADU (Analog Digital Units) noise. The lower the voltage, the more the noise increases. As stated before, Kodak's reference to minimum voltage for VDD is +14.5V for optimal operation.

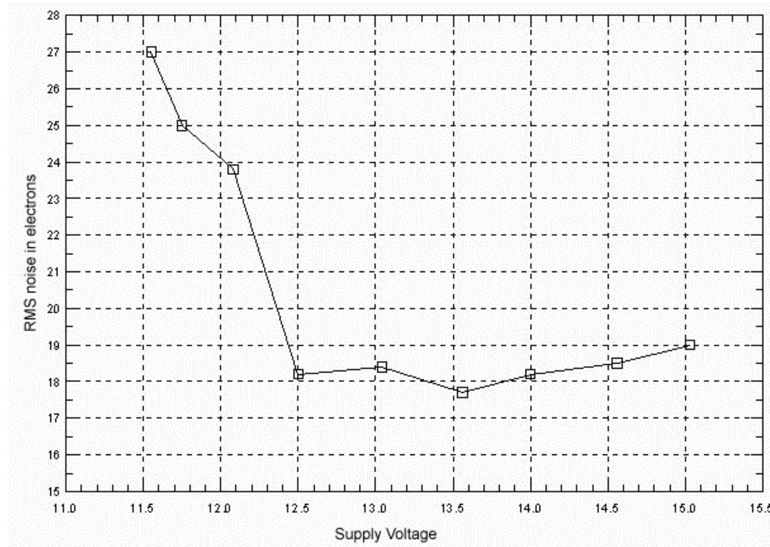


Taking this all into account we will reflect back to our voltage test of the lower card after assembly. If the supply voltage to the camera is +15V, then we will surmise that the D1 diode will drop the supplied voltage in the order of 0.25V. This will deliver a voltage to VDD pin of the CCD at approximately +14.75.

We are working on the low end of the suggested margin provided by Kodak. In the prototype testing of the Genesis, we found more stable results at the closest achievable voltage bordering the +14.5 to +15V. The setting of this voltage to the recommended value will provide us with the lowest ADU that the CCD is designed for.

This graph diagram show's us the RMS noise levels in relation to the VDD voltage. As shown in the previous graph, a notable dysfunction occurs when voltage drops below 12.5V. As shown in this graph, noise greatly increases at voltages lower than 12.5 V.

At the 15V level we see on the order of 19 electrons RMS. To surmise this data, a voltage of +14.5V to +15 V would be the desired voltage to supply to have optimal results. Now that we have a clear understanding of the voltages necessary for the VDD supply of the CCD sensor, we will review the 3 options of supply available.



- Option 1: To use an adjustable open frame linear power supply delivering +15V using the VO signal supplied from U5 (MAX333ACPP). This will turn off supply voltage during integration.
- Option 2: To use an adjustable open frame linear power supply delivering +15V directly to the VDD pin of the CCD.
- Option 3: Using the voltage regulator Q3 (LM317) to supply the +15V using the VO signal supplied from U5 (MAX333ACPP) with a supply voltage to the camera greater than +15V.

The advantages and implementation of these choices are as follows:

Option 1

Advantages	Disadvantages
If a linear power supply is used, it will deliver +/-15V to the camera. After passing through diode D1 and D2 the voltage will drop 0.25V. This will leave a supply of +14.75V to the VDD pin 3 of the CCD. At the same time by jumper configuration on the upper card this power can be delivered from the VO signal of U5. The benefit of this configuration is the supply of the amplifier is not used during periods of integration of the CCD. This will aid in the control of the phenomena of electroluminescence. Surplus regulated linear supplies of +/- 15V are fairly common.	The exit amplifier of the CCD has no protection from accidental over voltage. Therefore, an adjustable lab power supply is not suggested. Kodak's recommendation of a VDD maximum supply of +15.5V must be well regulated to avoid permanent damage to the CCD. An adjustable linear supply recommendation of 2 mV output ripple RMS Peak to Peak that will be clean and stable. We have tested switching power supplies and have found them to have higher noise levels that degrade image results.

Option 2

The direct supply of +/-15V to the camera after passing through D1 and D2 will drop 0.25 volts. This will deliver +14.75V to VDD pin 3 of the CCD This will be within the recommended voltage levels stated by Kodak for safe operation.	The supplied voltage is within recommended by Kodak for proper operation of the exit amplifier. In this arrangement we do not have the use of VO switching on IC U5. This presents the possibility of electroluminescence with no control of eliminating it using the hardware of the camera.

Option 3

The possibility of supplying the camera with a voltage other than +/- 15V. As an example, we could use a supply of +/-18V and use adjustment from the multi-turn potentiometer P5 to set our final voltage to +15V to VDD pin 3 of the CCD. The regulator LM317 has the task of settling voltages if the power supply is not of good quality. Any fluxing in supplied voltages to VDD ,during the reading of the CCD, will possibly create horizontal line noise in the picture. We additionally have the option of using jumper TB2 pin configurations on the upper card. The power supplied in this configuration will be delivered from the VO signal of U5. The benefit of this arrangement is the power supplied to the VDD amplifier is not used during periods of integration of the CCD.	If the camera is supplied with +/- 15V, the voltage after passing through this arrangement of components it will be considerably weaker than the specified voltage of +15V. For example, after passing D2 our voltage drops to 14.75. Then, the multi-turn potentiometer has it fall another 1.6V, so the adjustment of the potentiometer has the LM317 correct zero. Our final voltage supplied to VDD would be 13.15V. This is well below the recommended values. Therefore this option should be rejected if a +/-15V supply is used.

For the overall expense of the camera and for achieving the maximum performance possible, it is therefore recommended, to use ***Option 1*** of these configurations. The acquirement of an adjustable regulated linear power supply for supplying the +/-15V for operation through surplus sources is a minor investment compared to the cost of the CCD and camera. The voltages produced are stationary and clean, that will avoid the possibilities of undesirable results provided by other power sources.

We are going to describe the assembly instructions depending on your chosen option. Once again, it is noted that pin 1 of the jumper strips has a square solder pad.

Option 1

The following components **will not** be installed with this option. R11 and R12, C22, P5 and last Q3.
The red pin jumpers configuration will be, ☐ **TB2** pins 2 and 3, and a pin jumper over ☐ **JP1**

Option 2

The following components **will not** be installed with this option. R11 and R12, C22, P5 and last Q3.
The red pin jumpers configuration will be, ☐ **TB2** pins 1 and 2, and a pin jumper over ☐ **JP1**

Option 3

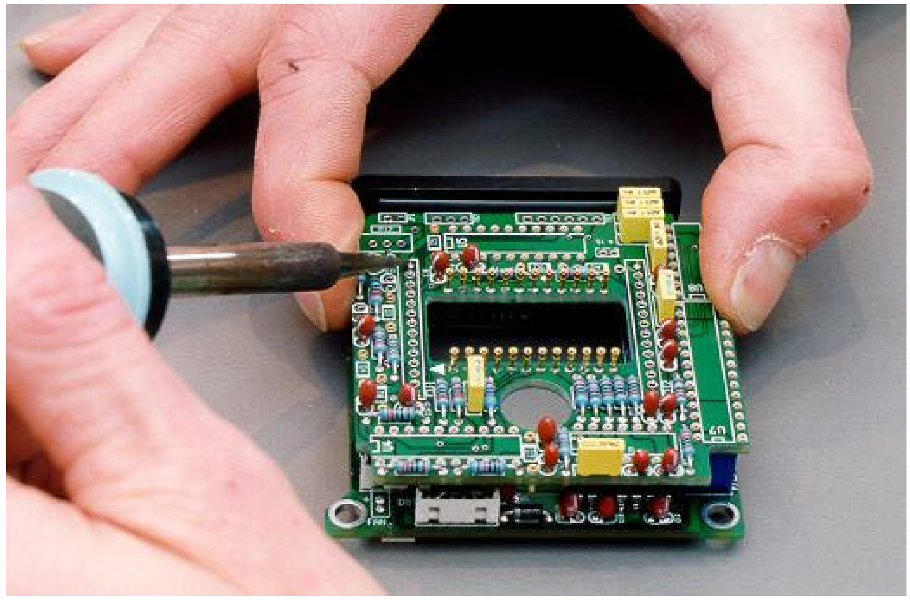
The following components will be installed with this option. R11 with a value of 220Ω, R12 with a value of 1.5k, C22 with a value of 4.7uF will be installed with regards to its polarity. Then we will install Q3 a LM317LZ regulator the same as was done on the lower board. Bending the center lead to the back of the part and then parallel to the unbent leads to align with the holes in the board. Using the silk-screened outline orientated the part to fit properly. And last, mount the P5 a 3296X-102 1k multi-turn potentiometer so that its orientation is the same as the silk-screened outline.

The red pin jumper’s configuration will be, TB2 pins 2 and 3, if using the VO signal of U5. Or the option of the pin jumper over pins 1 and 2 for direct power from the power supply for the regulation circuit. ***There will be no pin jumper over JP1 for this configuration***.

Upper Card Assembly – Step 3

We will now solder in the single row pin header strips for the jumper pin configurations. This would be a two-pin header row for ☐ **JP1**. Then a three pin row for ☐ **TB2**. Although supplied with the kits we will not set the six-pin row for TB3 at this time. TB3 is an option and if not needed we suggest that it not be added.

The next parts to solder are the two ☐ **14 row inter-board single row pin header strips**. This will require the use of the lower board. First, fit the two pin header strips onto the AMP inter-board connectors mounted on the lower board. Then align the short side of the pins with the solder side mating holes of the upper board.

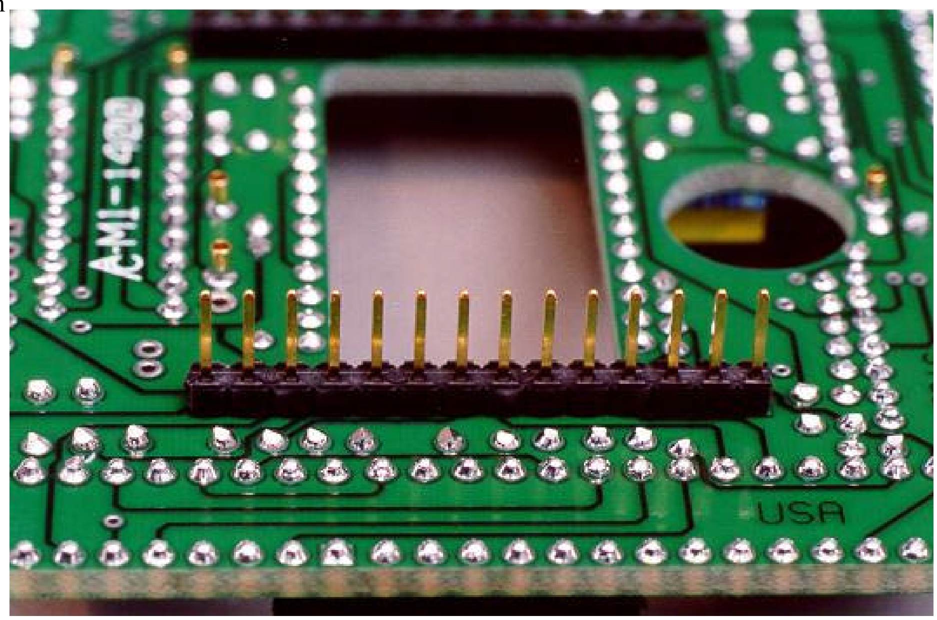


After soldering the first pins check to see if the tack job is satisfactory.

Now we will assemble the two boards together so the alignment with access holes for the Daco shutter and the AMP single row interconnects on the lower board will match. Using the same technique as other components with multiple pins, we will solder one pin on the end of each row applying a slight amount of pressure to the component side of the upper board. This is somewhat of a squeezing fashion between the two boards. This will aid in the strips we are soldering to sit square and flat to the upper board.

If all is well, proceed to the opposite ends and repeat the procedure.

Do not disassemble the boards until all pins have been soldered. Visually look at the connectors from all angles for proper fit and placement. When you are satisfied with the placement, finish soldering the remaining pins of the header strips.



Upper board pin header row seated square and flush with the solder side of the board.

Separate the two boards by gingerly working them apart and once again store the lower board in its protective packing bag.
The last components to place on the board before electrical testing are the diodes. The Mill-Max solderless pin connectors pre-mounted on the boards will make the task of applying and future removal of the diodes a simple task.

It will be necessary to apply different voltages depending on the CCD sensor used in the camera. This will also change some of the tested voltage values during the next stage of assembly.

We have prepared page links for the different CCD sensors and their diode selections, as not to be confusing. We will add the diode components and print out work sheets for the particular sensor you have selected. This will make the testing straightforward and decisive.

- **KAF-0400**
- **KAF-0401**
- **KAF-0401E**
- **KAF-0401LE**
- **KAF-1600**
- **KAF-1602**
- **KAF-1602E**
- **KAF-1602LE**

Click on the sensor type you will be applying to the camera to obtain the diode information and worksheet.

Upper Card Assembly – Step 4

Having our work sheets handy, we will reference the diode part numbers and match the proper values to them. Again, it is very important to respect the orientation of the components polarity during the insertion process. The diodes supplied in the Genesis kits are special ordered.

The set values of the components are specified to be within 0.18V of their numerical rating. Indeed, this will be a great assistance for holding the individual recommended tolerances specified for the CCD voltage supplies. It is also noted that the marking on the diodes, with the exception of the polarity ring, is difficult to discern.

It is strongly advised not to mix them once removing them from their packaging. It will be extremely difficult to identify them under these circumstances.

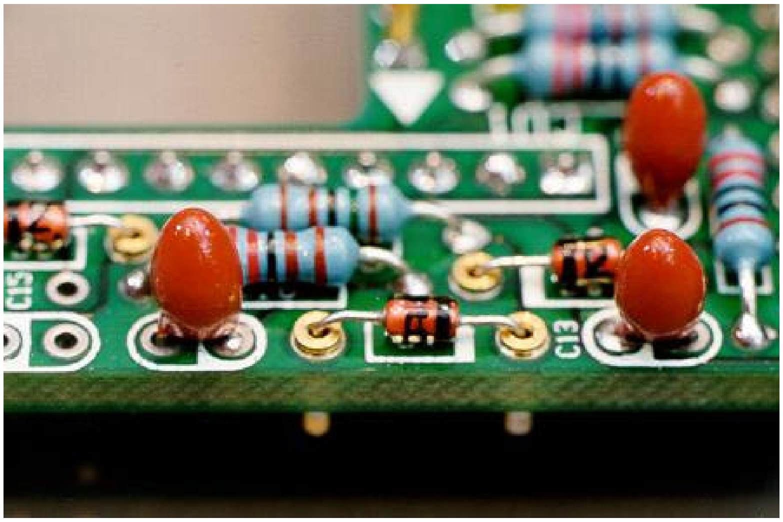
We will bend the leads of the diodes with our speedy lead former or a pair of fine tipped pliers.

To place them in the solderless sockets, push one lead through until it begins to protrude out the bottom of the solderless socket.

Repeat this step with the second lead. Using the fine tipped pliers pull on the lead to draw the component towards the board. Work it from each side a little at a time until the diode sits on the component side of the board.

First insert diode ☐ **D3**

Then ☐ **D4**
Then ☐ **D5**
Then ☐ **D6**
Then ☐ **D7**
Then ☐ **D8**



Diodes D4 and D8 shown in the Mill-Max solderless sockets.

We will then cut the excess lead flush with the bottom of the solderless socket.
The last diode to solder onto the circuit board is ☐ **D9**, a 1N5819 for the Daco shutter. Bend the leads and solder this last diode to the board.

The last component to add to complete the assembly of the upper board will be ☐ **S1** the Molex two pin wire to board receptacle for the Daco shutter hookup.

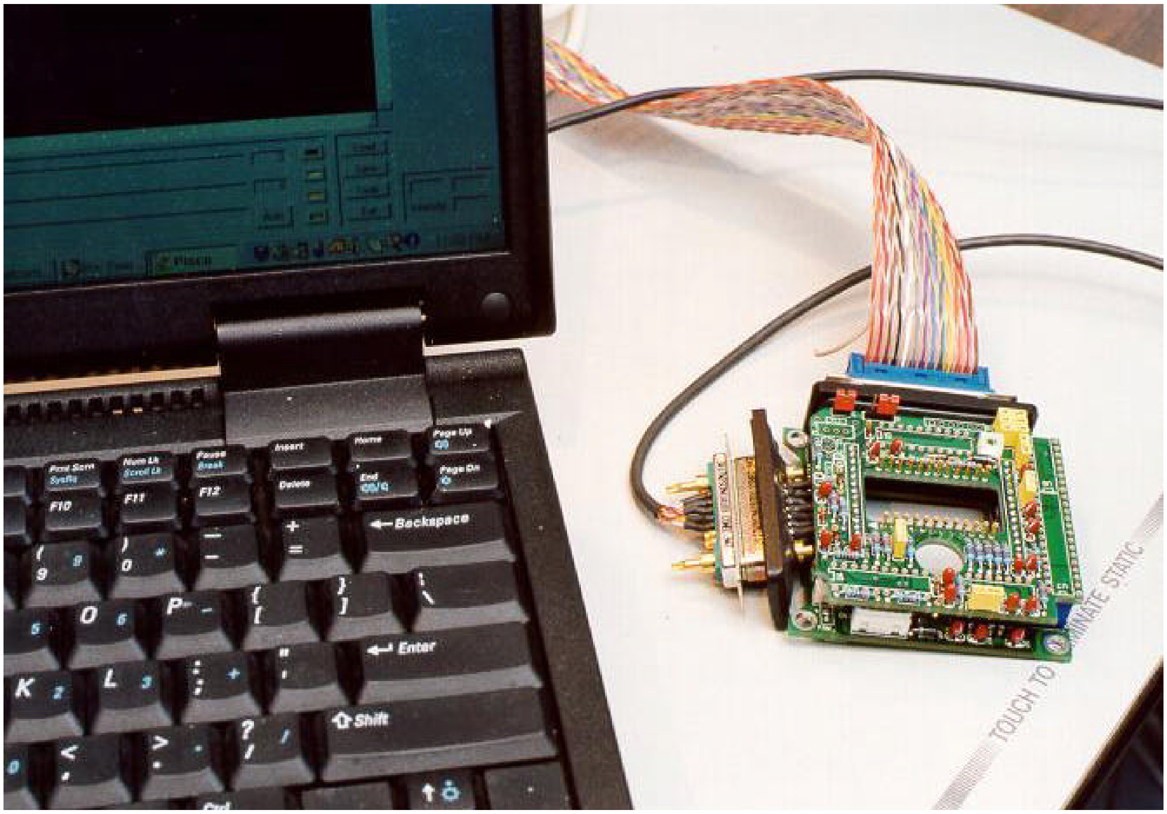
Solder this receptacle from the component side of the board with the opening of the connector facing the center cut out of the board.

With the assembly process completed for the upper board, we will store this board in the anti-static protective bag until we are ready for the electronic testing.

Testing of the Cards

Now that the cards have been fully assembled, along with cables for PC interface and power supply, we will proceed to test the cards. Our basic tool for testing will be the digital Multimeter. Again, we will have our Multimeter set at 20V.

The first step will be to install ☐ U3 (quad LM348 amplifier) on the lower card. If you have not as yet completed the preliminary tests of the lower card, it is advised to do so now.



The lower board without IC placement on the upper board. PC and power connectors are installed for the following tests.

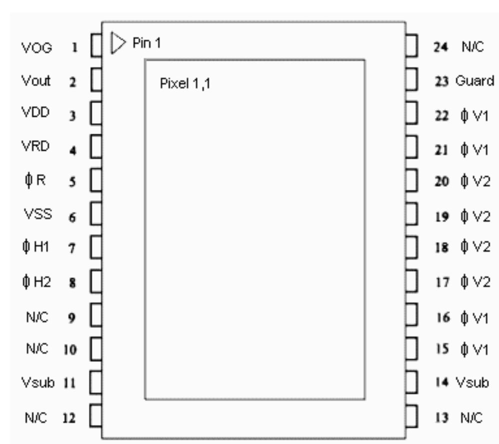
The placement of all IC's of the camera will be done without power supplied during the time of installation. The placement of this IC will be in tight quarters if referenced to the other mounted components. It will be simplified by the pre-bending of the components leads during assembly of the lower board. *It is noted again to examine the IC's closely for identification marking as well as orientation during insertion.* Some firm pressure will be needed to enable the part to seat fully in its socket. The other IC, ☐ U10 will also be installed at this time. Before assembly of the cards we will install the wire to board DB15 power connector for voltage supplies.

We will now assemble the upper and lower cards to their stacked arrangement. At this time IC's will only be installed on the lower card. During the assembly of the cards one should take note of the cards relation to one and another. A good reference will be the cutouts on the cards for the Daco solenoid insertion. It should also be noted that the inter-board assemblies are joined to the corresponding pins to their mating connectors. It is entirely possible to join the two cards in opposite orientation due to the symmetrical placement of the connectors on the boards.

The assembly of cards with correct orientation

We will now supply the cards with the +/- 15V voltage supplies. If all precautions were taken during assembly of our power cable and hookup of the DB15 power connector we will proceed with the testing.

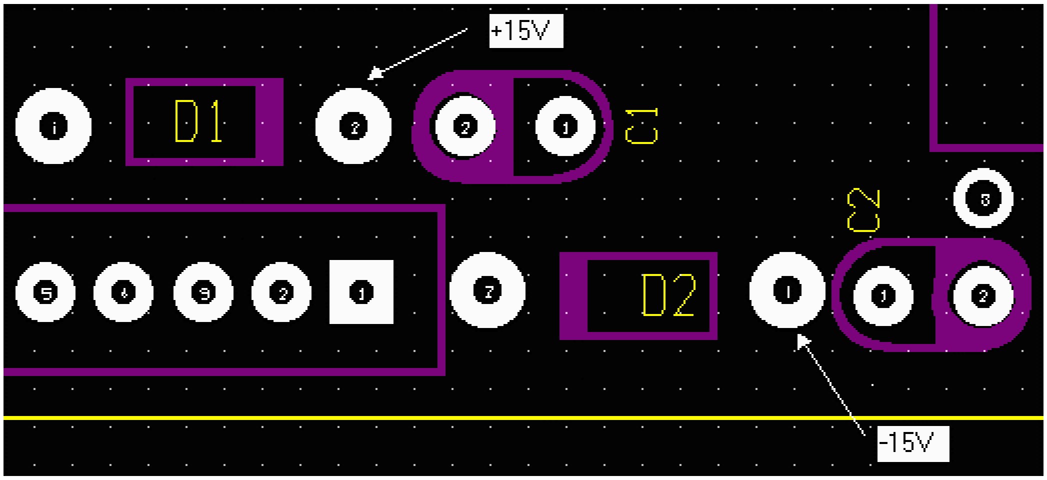
In the picture right, we see the pin-out of Kodak CCD sensors. The numbering convention for IC packages uses the same standard. As we probe the pins of the IC sockets, it will be helpful to have a reference to the numbering relationship of the packages. Take note of Pins 11 and 14 in the picture. These are connected to the ground plane of the boards and will be a good reference point during the testing.



Kodak CCD pin-out

Before the first tests are taken we will adjust the voltage levels of our linear power supplies. This will be done only if the supplies chosen are of the adjustable type. Using Multimeter probes we will place the ground probe on TB1 pin 1. The positive probe will be placed on the D1 pad shown in the picture below to set the +15V voltage. By turning the potentiometer mounted on the PC board of the power supply the voltage will increase on this leg of the diode.

Reference the documentation of the power supply for the proper voltage adjustment potentiometer. In some cases there is adjustment for both voltage and amperage. This will offset the loss in voltage due to the diodes. The maximum adjustment of the potentiometer will possibly not meet the +15 volt value. After adjustment of D1 is completed, repeat the steps for adjustment of D2. This will show as a negative voltage on the Multimeter. It is preferred to match the set values of the plus and minus voltages.



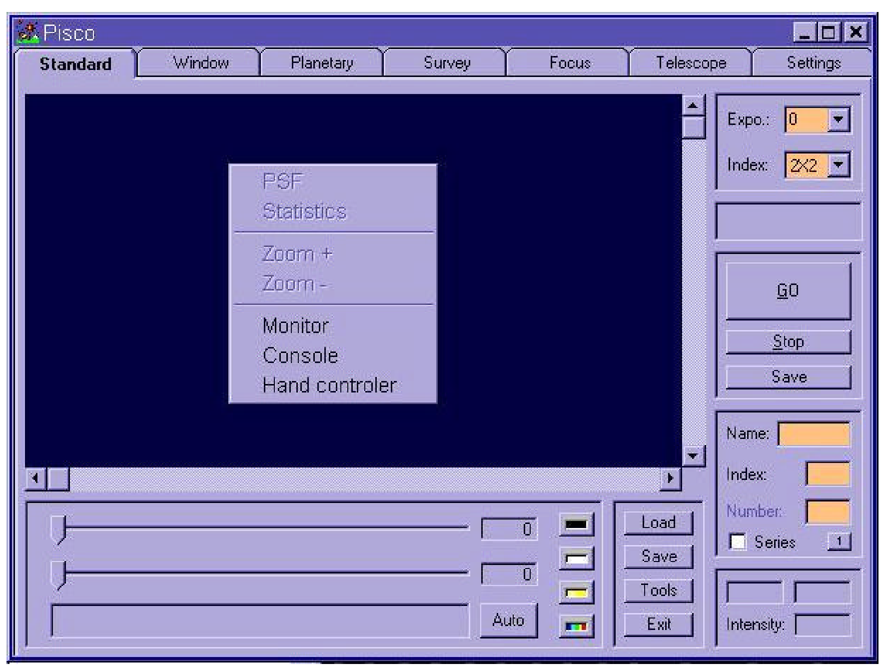
The first tests we will take are for the supply voltages of +/- 15V and +5V to the IC modules. The chart below will be the pin assignments and the value to be measured.

Circuit	Pin #	Voltage
U4	16	+15V
U4	5	-15V
U5	16	+15V
U5	5	-15V
U6	4	+15V
U6	11	-15V
U7	28	+5V
U7	27	+5V
U8	16	+5V

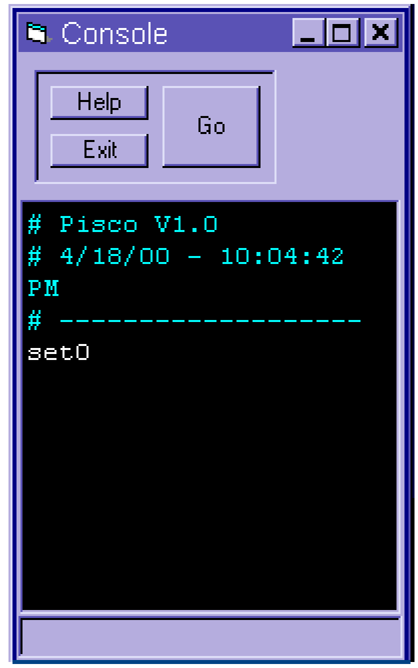
The values that are measured will vary from 5 to 10% because of the general differences in the components. This is not critical. With this test completed we have verified the continuous voltage supplies to the IC circuits. We will now verify that the command signals delivered by the PC arrive at their destinations. We will now attach our twisted pair ribbon cable for the link of the PC to camera. By plugging the DB25 connectors to the parallel port of the PC and the DB25 connector of the camera we will begin further testing.

To do the tests on the camera, we recommend that the software is **Pisco** installed on your computer.

After starting the Pisco program place your mouse pointer in the picture zone (area where menu is shown in picture). Then click with the right mouse button to make the menu open. Point your mouse curser on the "Console" option and left click to start the option.



Testing of the Cards – Step 2



It is from this console, commands will be manually entered for PC control of the Genesis. These commands can also be given from the software IRIS. For the testing of the Genesis, Pisco has all of the routines needed for the complete testing. We will have the twisted pair 25 pin cable and +/-15V power applied to the boards for the next set of tests.

With the console open you will be able to drag it anywhere on your screen that will suit your needs. We will type the command **SET0** (zero) on the console screen. Then register the order by pressing *Enter* on the keyboard.

The **SET0** command puts all the low level bits of the register to data stream of the printer port. What this means is the 8 bits of command have the value of 0. In basic, under DOS, this order would result in the very short program: OUT 888,0

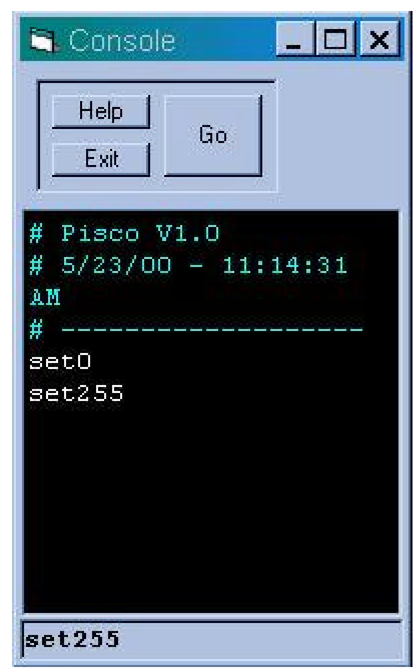
This command will result in the writing to the address 888 in decimal (or 378 in hexadecimal) of the value 0. However, the address 888 on most PCs results to the data register of the printer port.

Attention: In rare occurrences the address of the printer port is not 888. To know the base address of your printer port refer to the **PC Interface Page** . Also, consult the notes on use of the software Pisco, and the setting of its interface parameters.

As we recall, the interface circuits of the 74HCT14 CMS (U1 and U2) commands the reversal of the logical state of signals as applied to their submission. Consequently, if you put all bits of signal to zero with Pisco, the logical signals corresponding in the electronics of the camera are set to the high level.
After supplying the camera with voltage and executing the **SET0** instruction, measure with the multimeter the signal on the Mill-Max socket pins of the respective IC's below.

Circuit	Pin	Type of signal
U5	1	P1: V1 clock
U5	10	P2: V2 clock
U4	1 &10	P3: H1&H2 clock
U4	20	P4: Reset clock
U4	11	P5: Clamp clock
U7	24	P6: Clock conversion
U7	23	P:7 Byte clock
U8	1	P8: Nibble clock

For all these signals you must find +5V
Now we will broadcast the **SET255** command in the console window. As you suspected, this command places the low level of all bits of the data register of the printer port.



In the next test, we will use the same chart above and test the signal on the Mill-Max socket pins of the respective IC's once again. This time we should find 0V on all the pins. If these tests are achieved satisfactorily, the PC converses adequately with the camera.

If this is not the case, it will be necessary to deduce the mistake in the assembly. This will be a logical backtrack of the assembly process. If the **SET0** and **SET255** commands are issued successively and no change of signal is measured, verify the twisted pair cable is connected and seated correctly.

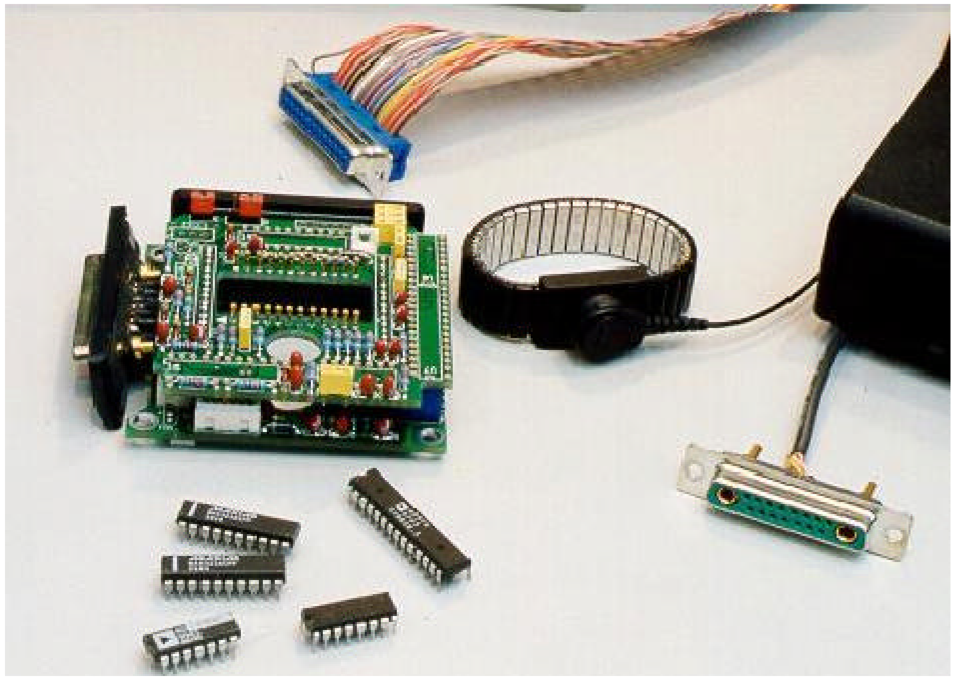
If this is the case, check to see if one of the IDC connectors is not reversed in orientation to pin 1 of the ribbon cable. Verify that the address of the printer port used by Pisco is set correctly and that the BIOS of your PC is set to standard for parallel port operation. If only one set of signals does not respond, it will be quite possible that there is a broken link in the individual circuit from the DB25 connector to the pin measured on the IC.

For this we will separate the cards. (First cut the power!) It will help to use the charts on the **Inter-Board Pin Out** Then apply power again and probe the path of the suspected circuit from the DB25 connector to the inter-board connector. Using the **SET0** and **SET255** commands to locate the source.

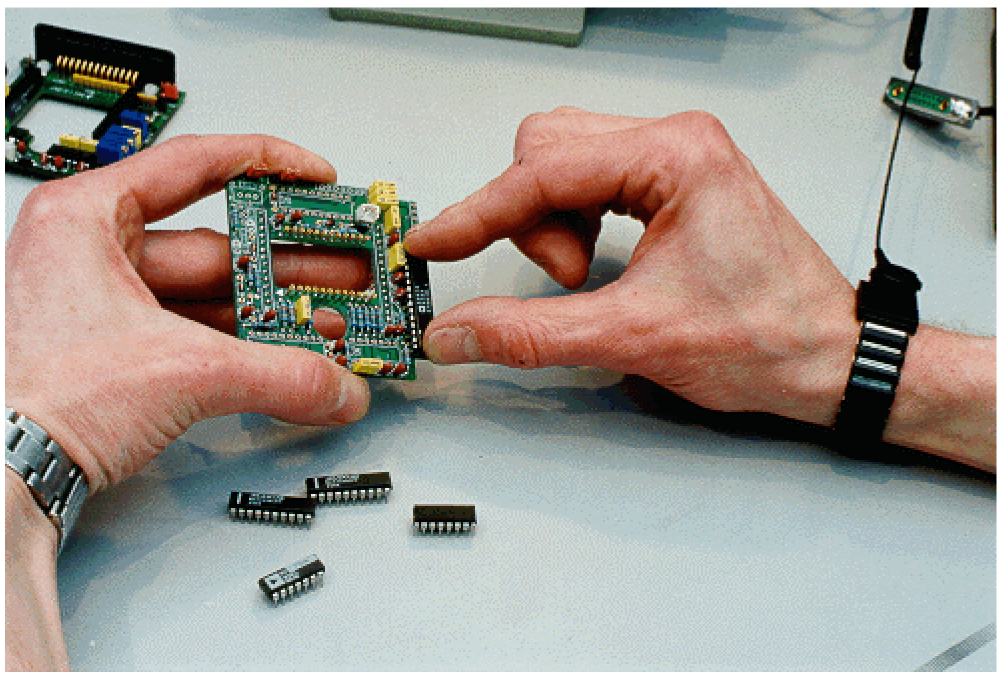
If you are assured the lower card functions properly, we will shut down the power supply, assemble and test again the board assembly.
If all tests were achieved in certainty we are ready to insert the remaining IC's on the upper card. Except the CCD.

Before insertion of the IC's it will be necessary to separate the two boards. Before doing this we will shut down the power to the boards. We remind you to work the boards apart gingerly as to not bend the inter-board header pin strips. Once the boards are separated, proceed with the insertion of the remaining IC's.

It is recommended to observe **ESD** precautions, specifically with the AD976 analog numeric converter. Contact with your finger tips to the IC leads should be avoided. Use of a grounding wrist strap should be applied as a beneficial routine.
Once the IC's are placed and seated on the upper card, it is still possible to check voltages on the pins. If this is done, care must be taken not to short out the neighboring pin during testing.



The 5 IC circuits of the upper card pre-bent are ready for insertion



Testing of the Cards – Step 3

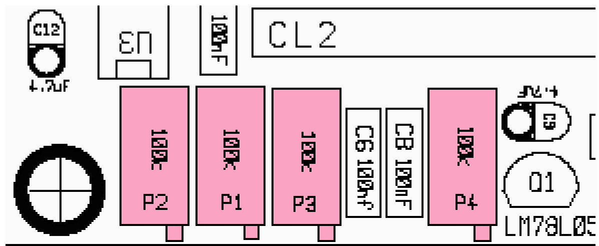
It will now be necessary to set the voltages of the signals applied to the CCD. This is a significant stage taking into account the cost of the component. We will be using our printed work sheets for the selected CCD for your configuration in the Genesis. For our example we will use the values for the KAF-0401 CCD. If the CCD you are installing is different substitute the values from your worksheet for the value given. The work sheets have a column provided to enter in your measured voltages during testing.

We are going to adjust the voltages concerned with all the high and low clock levels. This will be accomplished by adjusting the 4 multi-turn potentiometers that are placed on the lower card.

With the cards under voltage; start the Pisco program and broadcast the command **SET0** from the console.

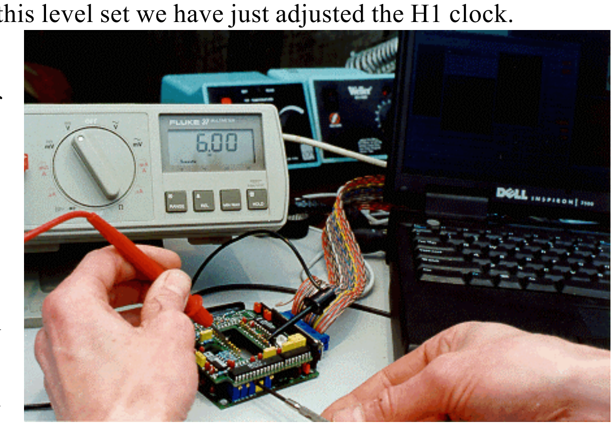
Measure the voltage on pin 7 of the CCD support using pins 11 or 14 on the support pins for ground. This will adjust the H1 clock transfer loads in the horizontal register.

We are going to find a positive voltage of some value when first tested. By using a jewelers screwdriver we will adjust potentiometer P3 to a value of +6.0V.



View of the lower board layout diagram showing the potentiometers location.

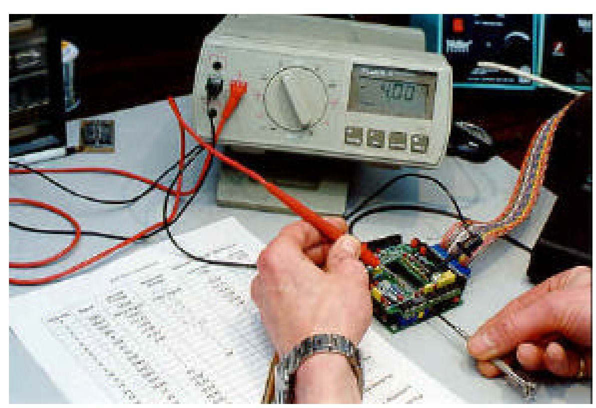
By turning the small brass screw, protruding from the case of the component, the voltage value will change. The amount of adjustment will be, in some cases many turns. If the voltage value you are reading is not coming closer to the voltage of +6.0V, turn the screw in the opposite direction. Several attempts will probably be needed to arrive at the desired level of adjustment. It is possible to set the voltage as fine as 0.01V A few tenths of a volt are well within the specified tolerances given by Kodak. With this level set we have just adjusted the H1 clock.



Using a small jewelers screwdriver adjust the potentiometer screw to set the voltage value. The total extent of adjustment of the potentiometer corresponds to 25 turns of the screw.

We will now test pin 8 of the support pins of the CCD. This pin will read a negative voltage. This is the low-level clock of H2. Produce a result on the P4 potentiometer to bring this voltage to -4.0V

We are now going to adjust the levels of the high and low, V1 and V2 vertical transfer clocks. By measuring the voltage on pin 22 of the CCD support pins the value to be set is +0.5V. Adjust potentiometer P1 to set this voltage. Once this is completed, verify that pins 15,16,17,18,19,20 and 21 are additionally the value of +0.5V. To adjust the low level of V1 and V2 we will broadcast the command of **SET255** from the console of Pisco. The pins of 15 to 21 are now supplied by a negative voltage of -10.0V. Adjust potentiometer P2 to arrive at the specified voltage.



The preset voltages of the reset clock (pin 5 of the CCD support pins) is not adjustable. The voltage level set is determined by zener diodes D3 and D4 . To verify their voltage levels, issue the **SET0** order in Pisco. The voltage value measured should be +4.0V Then with the **SET255** command, the voltage value measured should be -2.0V.

By referencing our work sheets, you will notice the recommended maximum and minimum voltage levels for all values that were just set. These parameters are Kodak's suggested operating values for reliable performance.

We will now verify the continuous voltages supplied to the CCD during operation. The VDD voltage of pin 3 of the support pins of the CCD is directly related to the options list. If option 1 or 2 was chosen the only adjustment for this voltage is by your supply voltage value. If you adjusted your linear supply voltages, the value measured on diode D1 will be approximately what is measured on this pin.

If your option was number 3, and you are using a voltage supply of +/-18V or more, you must now adjust potentiometer P5. The voltage value set for pin 3 of the CCD will be +15V. Option 3 is not a good candidate for voltage supplies of +/-15V. The maximum value settable by using P5 in this arrangement is +13V. This is far below the recommended values of optimal operation of the CCD.

The other set voltages regulated by zener diodes are determined by your type of CCD sensor. The worksheets reference these values. For the KAF-0401 pin 1 of the CCD support pins (VOG) we should measure +4.0V.

Then pin 4 (VRD) will measure +11.0V.

Pin 6 (VSS) will measure +2.0V.

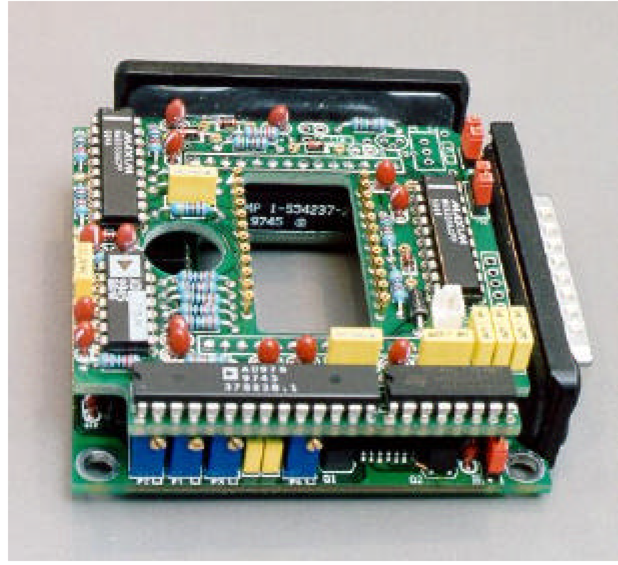
Pin 23(Guard) will measure +9.0V.

Pins 11 and 14 are connected to ground.

Then last, pin 2 (Vout) is the exit video signal of the CCD. Without the CCD set in the support pins we must find 0V on this pin.
If, after all tests are performed on the camera, your results will now match your worksheet recommended levels. If you did not recover these values, the most common reason would be the inversion of a polarized capacitor. This would produce a short in the circuitry that in turn impede voltages.

This would result in the failure of regulators Q1 and Q2 by overheating. An easy test is to touch with your finger tips Q1 and Q2 for excess heat buildup. Another cause is the possibility of reverse polarity of a diode in its setting.

Testing of the Cards – Step 4



The video signal test for the Genesis. Note in the picture the CCD is not present at this time of testing. The output pin 2 of the CCD (Vout) is consequently not connected.

Before the installation of the CCD chip onto the circuit board, we will need to verify the correct operation of the electronics that process the video signals. If a problem arises it will not therefore be associated to the CCD sensor.

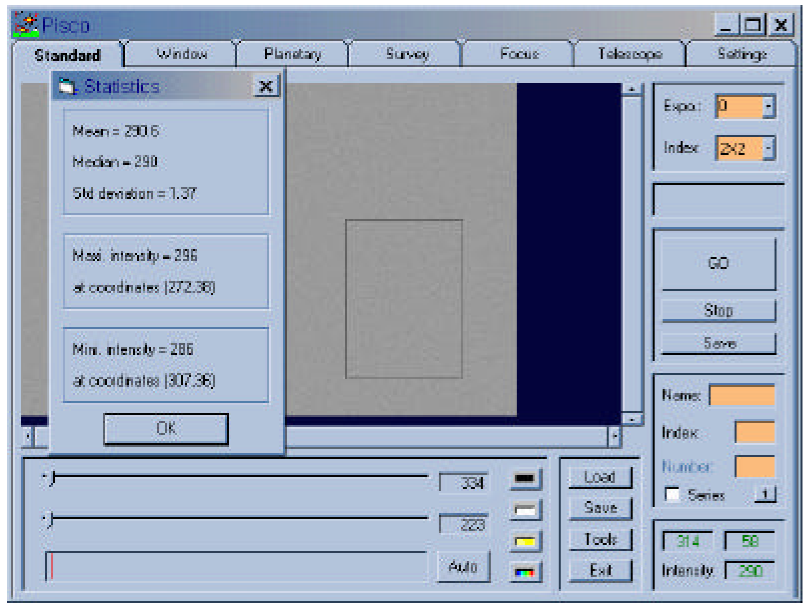
Without the CCD present a small offset signal is created by the video signal chain. This signal is digitized in shape and can therefore be visualized on the computer. In this method we will test the amplifier, the ADC and the PC to camera link.

Start the Pisco program and connect the 25 pin twisted pair communication cable to the camera and PC. We will then apply power to the card assembly.

We will begin with an acquisition using Pisco, an integration time (**Expo**:0) of zero seconds and 2X2 binning (**Index:2X2**).

To start the acquirement press the GO button on the right side center of the window (Standard tab submenu). After 5 seconds an image will appear on the screen. If all is well, the image pictured will be uniform and have an average digitized level of approximately 300. This value may vary by +/- 30 or so.

To view the image offset adjust the threshold level scroll bars at the bottom of the screen. Then with the right mouse button point your cursor in the central left of the image window. Click and hold the right mouse button.



Draw the cursor while holding the right button to the right bottom of the window drawing a box. Release the mouse button. Then press the right hand button to make the menu appear. Point and click with the left mouse button *Statistics.*

Pisco will then calculate and display a noise level of the image in the top window *Standard deviation*. Generally this value should be represented between 1.0 and 3.5.

It should be noted, that the size of the box you draw in the image will reflect different values in the deviation number. Also notice the color of gray in relation to the slider bars at the bottom of the window. These all have an impact on the number displayed in the Standard deviation value.

If you have chosen to use Option 1 of the configurations of camera control we will test the amplifier power control option. To test it issue the command in Pisco **AMPLI_ON** in the command console. Check pin 3 of the CCD mounting pins (VDD). You should find between +14.5V and +15V.

Now we will issue the command **AMPLI_OFF** in the command console. You should find a voltage of less than 0.3V

If using the shutter in your camera operation we will now test its operation of the optoisolator/driver. You will need to measure the positive and ground from the Molex 2 pin connector on the circuit board or plug in the shutter for testing. Issue the command **OBTU_OFF** in the command console. Then measure the voltage across the shutter connector. We should find 0V.

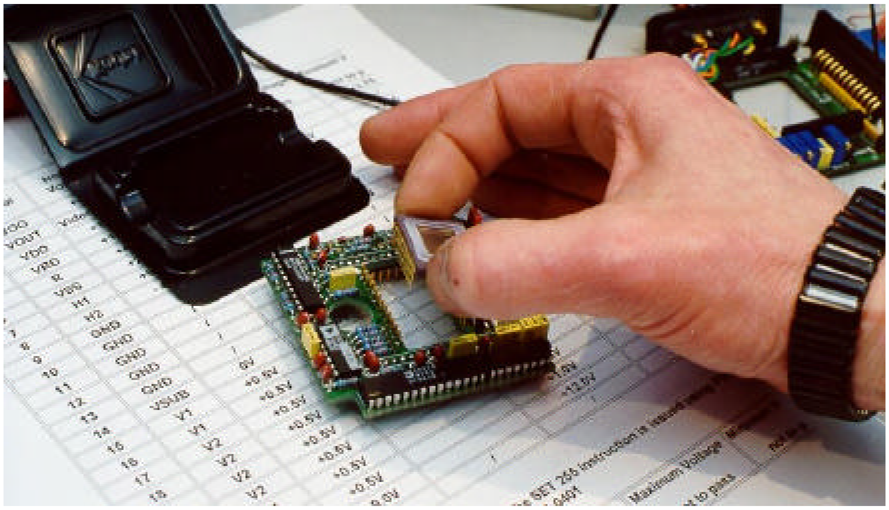
Now issue the command **OBTU_ON** in the command console. The voltage measured should now be 12V.

If you have obtained the above results, and the values have been obtained, then your camera is operating successfully! We can proceed to the next stage, electronic testing with the CCD in place.

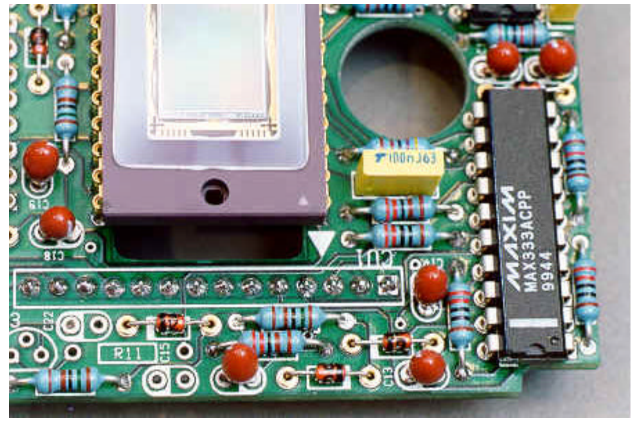
If this is not the situation the image level will read 32767 for all pixels in the image in the statistics window. First verify the connection of the computer to the camera and check your twisted pair data cable for bad pins. Then check all voltages again for IC's U4, U5, U7 and U8. It will then be necessary to verify again that pin 11 of U4, then pins 23 and 24 of U7 and pin 8 of U8 change states properly as the **SET0** or **SET255** commands are issued from Pisco.

If problems still persist, verify the electronic continuity of the circuits. If you have at your disposal an oscilloscope, check the following after issuing a command from Pisco and a reading is in progress. We would test for signals being broadcast from pins 15 to 23 of U7 and pins 4,7,9 and 12 of U8. These signals will change state very rapidly. This is a sign that the analog conversions are working properly. Then on pin 1 of U7 (entry of CAN) we must find a very small voltage on the order of 50mV on average.

If you've reached this far, and each of the prior tests have passed with success, you have achieved the primary goal at this stage. Well done! Now install the last electronic component, the KAF-0401 CCD. *It is absolutely imperative that proper precautions be taken for **ESD**. Although **ESD** precautions may seem to be moderately inconvenient, it is strongly advised to heed this reminder before handling the CCD sensor. We therefore recommend to avoid touching the pins of the sensor package*. If the CCD is to be removed from the circuit board support pins, replace it back to the protective foam-shipping container.



Grasp the CCD by its sides, as it is removed from it's protective packaging. Notice the ESD wrist strap procedure used during handling.

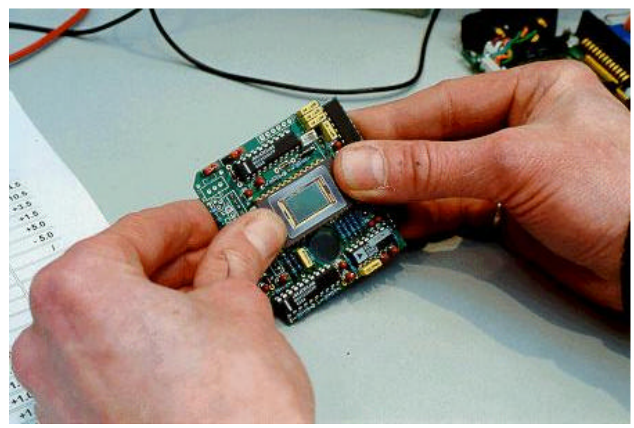


The triangle pad on the CCD sensor along with the triangle silk screened legend on the circuit board identify pin 1 of the CCD.

NOTE: Before inserting the CCD identify the for pin 1 on the sensor, and on the printed circuit board before insertion.
The triangle pad on the CCD sensor along with the triangle silk-screened legend on the circuit board identify pin 1 of the CCD.
Inserting the CCD into the circuit board support pins will require a little patience and some adequate lighting. Bending of the CCD leads will not be necessary for insertion.

After the proper orientation is established, the CCD leads will need to be centered in the small holes of the support pins. The first application of the CCD to the support pins will require a fair amount of pressure to seat the CCD. Apply even pressure, *simultaneously*, to all sides, to avoid twisting during insertion.

Do not rush or force the sensor into the pins. When all pins have registered into their support pins apply a steady even pressure to fully seat the CCD.

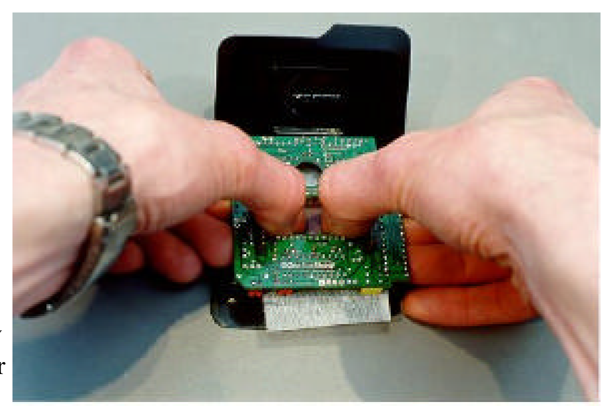


Even pressure on the ends of the CCD module once the leads are engaged will seat the sensor

For some tests, the CCD will need to be removed from its mounting. We have tried this technique and have found this to be effective.

1. Separate the upper board with the CCD mounted from the lower board.
2. Next, place a piece of lens cleaning tissue on the protective foam in the shipping box of the CCD.
3. Then place the face of the CCD (optical window) on the tissue/protective foam in the shipping packaging.
5. Place your thumbs through the access hole for the cold finger onto the bottom of the CCD sensor. Grasp the outside edges of the board with your fingertips and apply a steady even pressure on your thumbs while lifting the edges of the board with your fingertips.
6. Pull straight up until the CCD is free from the pins.

We have found this method will release the sensor without bending the pins that is sometimes encountered by prying the module out. What ever method is used the object of removal is to avoid twisting or bending the pins.



Removing the CCD by applying even pressure to the bottom of the sensor.

Testing of the Cards – Step 5

We are now very close to powering up the CCD and taking our first image.

It will be necessary to take this image in complete darkness. It will not have any adverse effects to use the CCD in daylight. But for these first tests, it will be important for them be done in absolute darkness. The sensors are exceptionally sensitive to light, for this will be our main objective in obtaining the faintest recordable light in deep space.

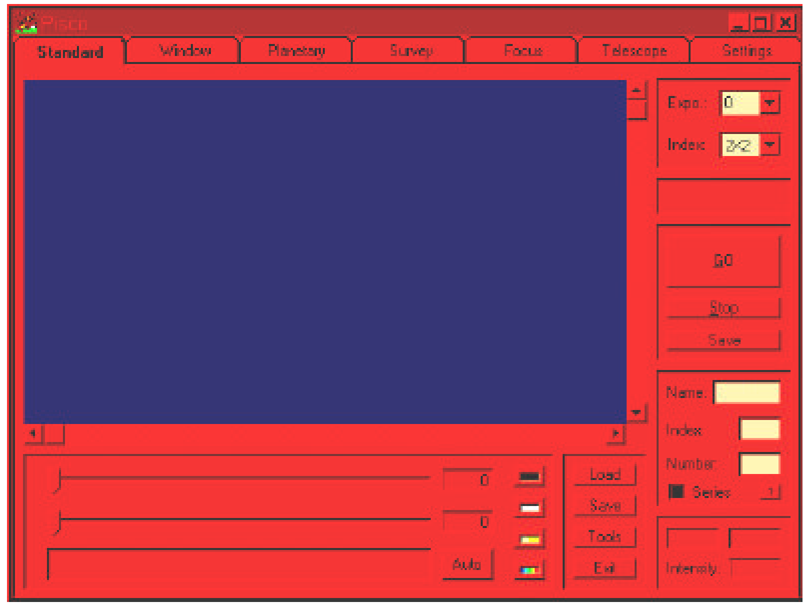
For these tests placing the camera in dim light will not be sufficient. The work area must be dark with all lights turned off. Working at night is ideal, or in a basement with no windows during daylight testing. The PC or notebook monitor should be dimmed as well. A black cloth to cover the electronics will prove to work admirably in blocking stray faint light.

The software Pisco also has a feature to run in night mode. To access this feature select the *Settings* tab in Pisco.

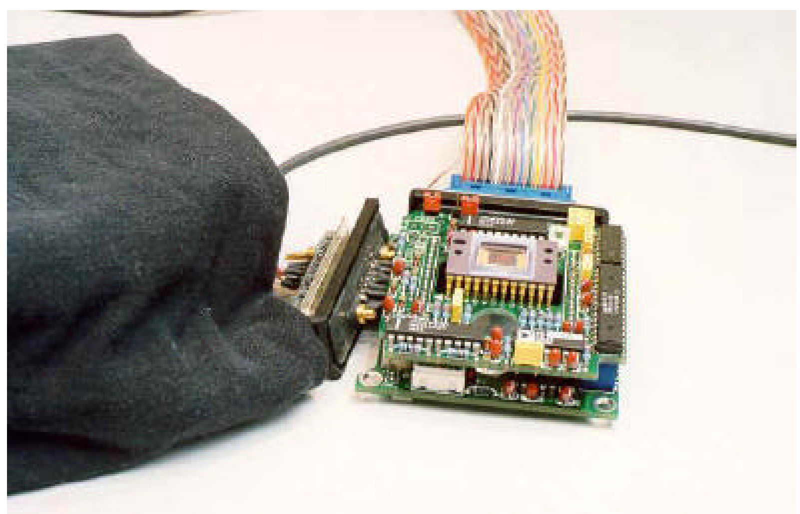
On the right side center of this window select the *night* check box. Also on this tab are settings for the default directory for your saved images to be stored in. We have a choice of the sensor implemented that interfaces with Pisco and the parallel port settings, as well as amplifier shutdown during imaging. This will all be found by selecting and clicking on the *Advanced Settings* tab.

We are now ready for our first testing with the CCD sensor.
Before beginning, check one final time that the CCD orientation in mounting is correct.

Start the Pisco software and supply power to the electronics. Cover the electronics with the black cloth and turn out the lights. If the light is too dim in the room, you will need the aid of a flashlight for navigation of the keyboard for setting the parameters in Pisco.



Pisco with the night option engaged found in the settings tab



Camera electronics with the CCD mounted and interfaced with the twisted pair cable for PC interface. We also see the black cloth used for blocking stray light

Set Pisco for an exposure of zero seconds with a binning mode of 2X2 in the *Standard* window.

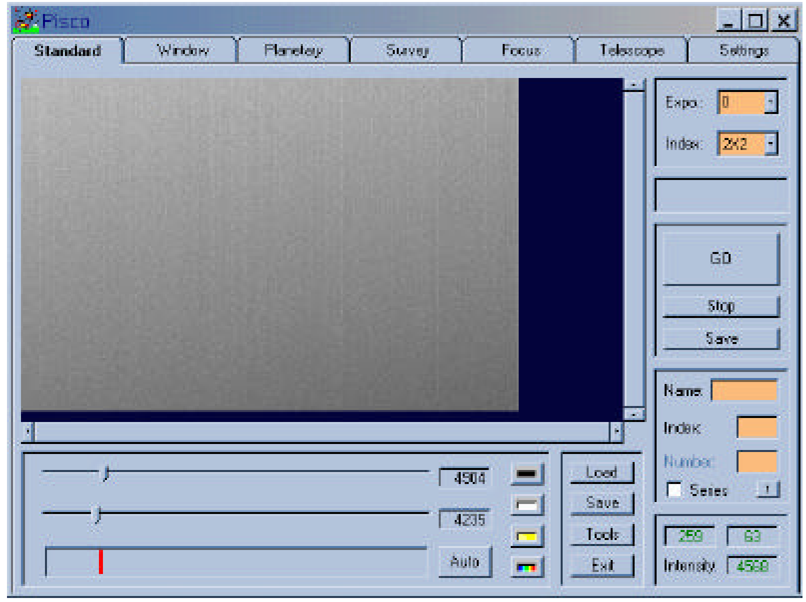
Take a deep breath, cross your fingers and select the *GO* button to start the exposure.

In the window below the binning mode, you will notice first the message "CLEAR" then after a few seconds "READ" will appear. The next 5 or 6 seconds will seem like an eternity!

You can exhale now.

When Pisco finishes reading the image it will display the image reading automatically to the image window. If all is working properly we will see in the histogram bar of Pisco (red bar in photo below) the intensity of pixels to group itself at levels that will range from 2000 to 7000 steps of quantification. This is the level of offset of your camera. Adjust the cursors above the histogram bar to all sides, high and low of this value. This adjustment will be very fine and will show dramatic changes in the image displayed with slight adjustments. Once the sliders have been adjusted and the picture appears uniformly gray as in the picture below.
We have success, you now have an operational CCD camera!

The test in total darkness that we just captured is telling us some characteristics of the working camera. The next test to be performed will tell us if our camera is working properly.

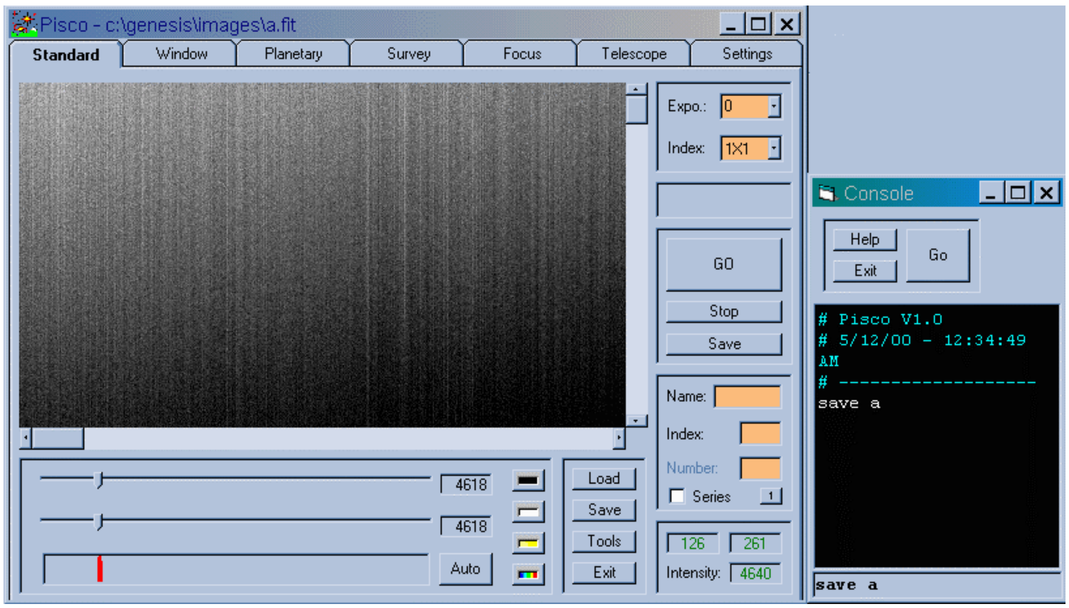


This is what your first image will resemble

We notice ,in looking at the picture taken, that it is lighter in the upper left hand corner and darker in the lower right. The differences are not attributed to light entering the CCD because this image was captured in total darkness. What we are seeing is the confirmation of thermal signal or dark current inherent of the CCD. The longer a packet of signals moves through the structure of the CCD, the more thermal noise it will collect.

This being understood, the pixels in the lower right corner are read first and the upper left are read last. This variation is caused by the image delivery of 5 seconds differential from beginning to end. It should also be taken into account the CCD is not being cooled at this time.

We do not regard this gradient in the image to be a defect, if anything it is a sign of good health! We will also notice some faint vertical lines that will appear from individual pixels. This will be the result of hot pixels. These pixels are affected by dark current much more than normal pixel. These characteristics will cease to exist as the CCD is cooled.

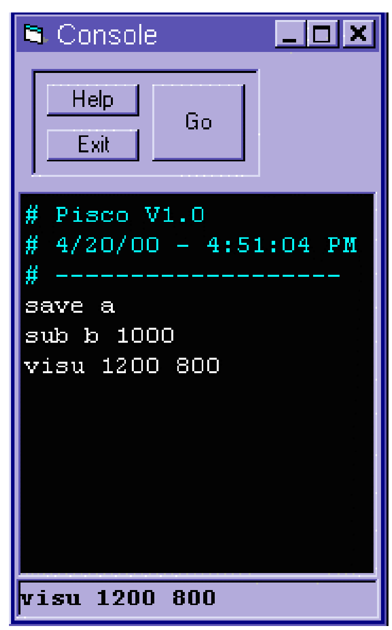


After digitizing and capturing the image in Pisco we will save it to our hard drive.

To continue our testing we will capture two exposures. These will be taken one after the other in succession.

We will use the camera in 1X1 binning mode. Your installation of Pisco will save files to the root directory of Pisco unless the default is changed. This can be changed by clicking on the *Settings* tab and selecting a new default directory.

To start imaging we will select zero seconds (**Expo:0**) for integration time and a binning of 1X1 (**Index:1X1**). This image will take approximately 20 seconds to complete. We will use the *Console* mode of Pisco for this task. Left click in the image window and point to *Console* and select it with the right mouse button.



This will be accomplished by typing in the name of your file in the console window. Point your mouse to the window and right click on it. Type the command *save a* and hit enter on your keyboard. This will save the file as "A".

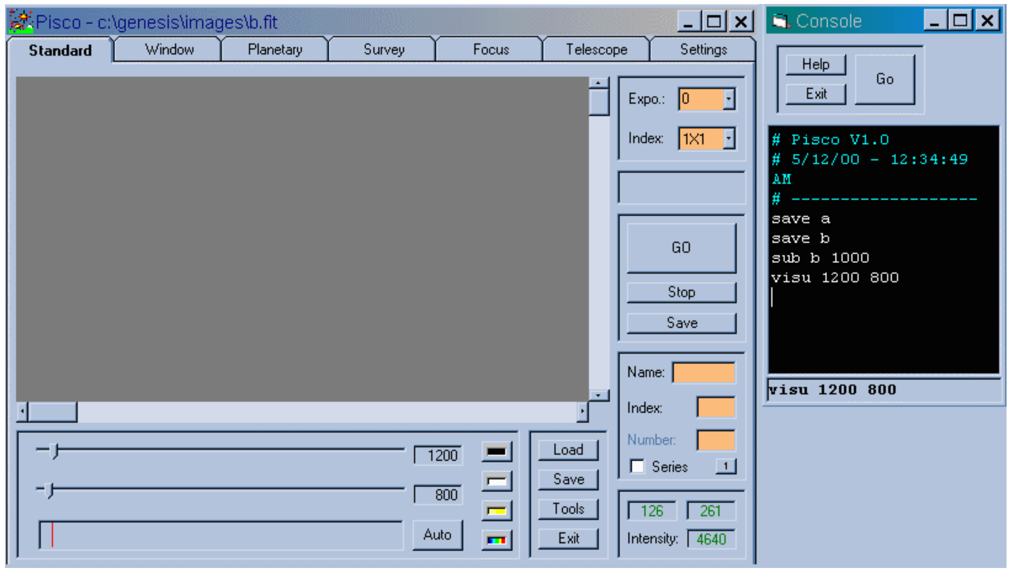
Now we will acquire our second image and save it as "B".

As we subtract the first image from the second that is in memory we will add a constant of 1000 to the result. This constant prohibits pixels with a value closer to zero getting negative values. This is taking into relation the similarity of the two subtracted images. To do the subtraction, we will type the command **SUB A 1000** in the Console window, and hit enter on our keyboard.

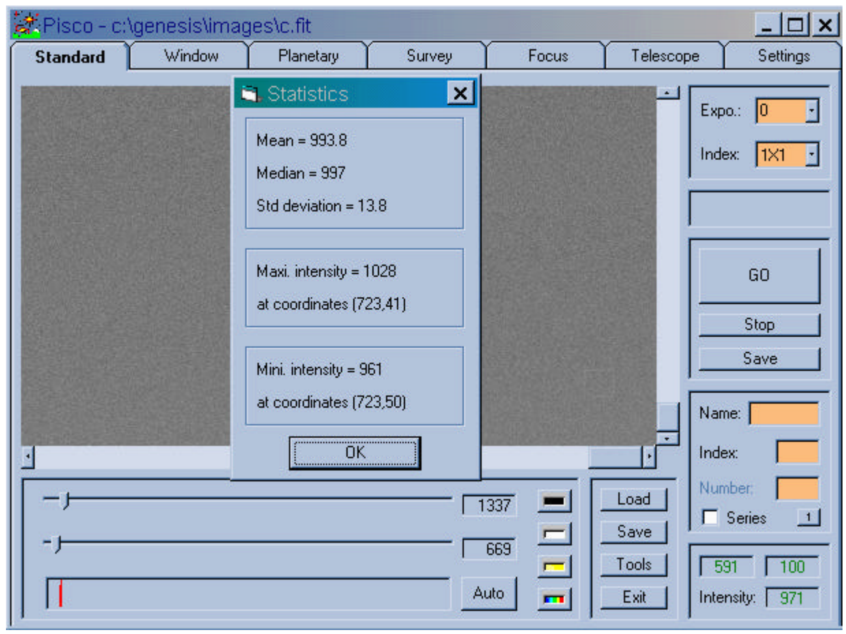
To view the results of the subtraction type the command **VISU 1400 800** in the console window. The two parameters in the **VISU** command are respectively the high and low thresholds for visualization.

The image we now see is much more uniform than the individual images. By subtracting the two images you have eliminated their systematic defects. For example, the gradient and hot pixels. Only the noise, that is different from image to image, remains. The absence of vertical or horizontal parasitic artifacts and periodic structure is a very good sign.
The results of the subtraction of the two images should look very uniform. The granulation shows the noise, and is completely normal. Although slight, the noise increases if you look in the upper left corner.

We will select a rectangle in the lower right hand corner of the image a few hundred pixels wide, using the curser while keeping the left mouse button pressed.



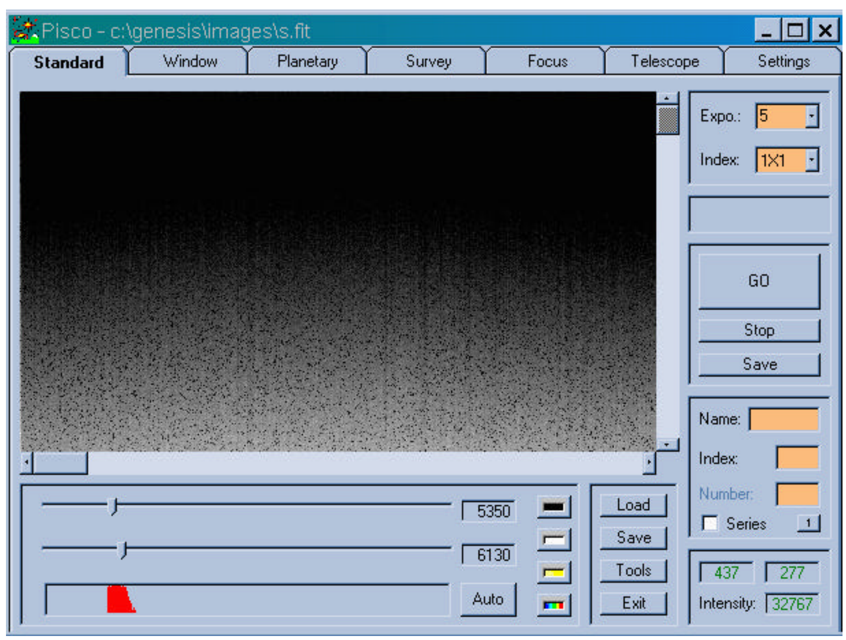
Next, with the curser still in the image window left click the mouse and select the *Statistics* option. Pisco will open another window that will report the statistical information in connection with the selected area in the rectangle. The important value is the *Standard Deviation*. The value reported should be between 9 and 15. It is the measurement of the noise in the image expressed in conversion steps or ADU for Analog to Digital Units.



In the example we see a noise of 13.8 conversion steps. We are reminded that we have subtracted two images, and the result of the noise from both images is raised to a square. In the end, the noise of a single image is the noise from the result of subtraction, divided by the square root of 2, e.g. 1.414. Therefore, in our example the noise is 13.8/1.414 = 9.75 ADU.

This is a low value for the Genesis and will vary, but all the same respectable. This is called the readout noise of the camera. It will decrease further when you cool the camera, typically between 8 and 9 ADU. This is equivalent to a noise reading of 16 to 18 electrons RMS (for the Genesis 1 ADU equals a signal of 2 electrons).

An image in a weakly illuminated CCD. It will be normal to see a non-uniform illumination in the image due to the method used in acquiring the light.



We are assured all is well if the camera is sensitive to light and when the dynamic range is proportional to the amount of light. When the sensor is light saturated (full well) the pixel values will be 32767.

We have completed a very important step in the construction of the **Genesis CCD** camera. Most important, we now have a fully functional electronics assembly that will interface with the CCD sensor and a PC computer.

Our congratulations to you on a job well done!
The next task will be to install the electronics assembly into the metal case for interface to our optical system.
Store your electronic assembly in a safe location until installation into the metal case is performed.

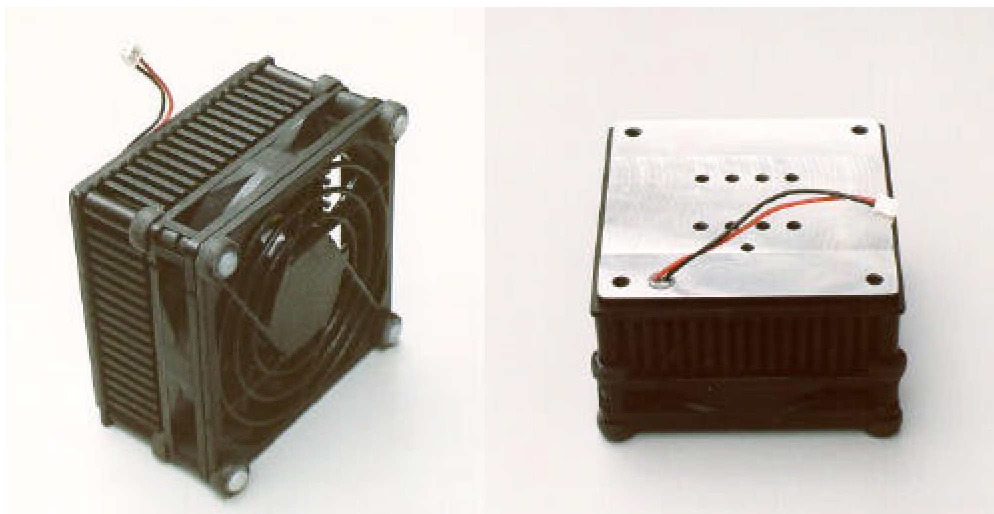
Case Assembly

Now that the electronics assembly has been completed and tested, the next step in completing our camera will be to house the electronics in the machined metal case. The assembly process is straightforward. There are quite a few individual parts, so we will guide you throughout this procedure step by step. Many parts are custom made for this housing, and the final assembly container tolerances are designed as a package fit for the air-tight housing. Drawings are provided if you choose to machine your own camera housing.

We will start with the heat sink assembly of the camera. As stated in the **tools** needed to build the Genesis, we will need a set of allen wrenches. If the case kit is purchased from Genesis the heat sink assembly will be fully constructed. This will include the fan stand-offs, fan, Sorbothane shock mounts, fan guard, with associated hardware. Wires for the fan power will be mounted through heat sink with Molex connector and the access hole sealed with metal based epoxy.

The Genesis assembled camera housing

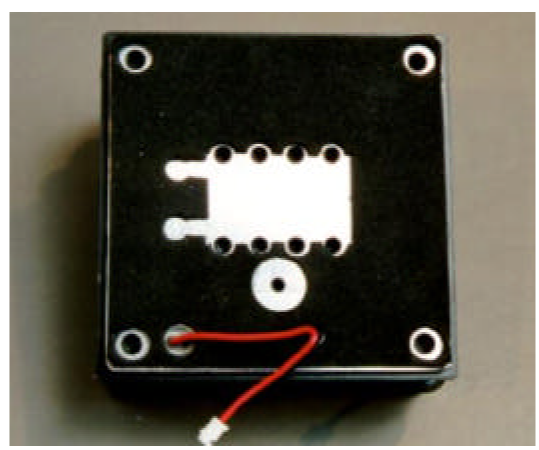
For the first part of building our camera housing, we will construct the peltier module and cold finger assembly. Before starting the assembly work we can improve thermal transfer by preparing the interface surfaces of the CCD and peltier faces. Lapping these surfaces for flatness and finish will greatly improve their conductivity by keeping air gaps, and the thickness of thermal grease to a minimum. We have found that using a piece of clean window glass, and the utilization of automotive rubbing compound to be effective. By placing a small amount of rubbing compound on the glass, and lapping in a figure eight motion, with some patience and effort you will achieve a smooth and flat surface free of machine marks. The only way to get a high shine on the aluminum will be to buff it with cotton or felt pads. Metal buffing rouge works for this as well. This will also have a benefit in thermal conductivity. Shiny surfaces reflect heat, if you do not plan on insulating the cold finger.


Fan assembly as shown provided assembled in the Genesis kit package.

Lapping the cold finger on a piece of window glass to obtain flatness of the interface surfaces.

Another builder option is to insulate the inner, exposed surfaces of the heat sink face and cold finger. are provided to aid in the manufacture of the insulating material. NOTE: The template file is a .pdf file. To have it print the proper size turn off the (scale print to size check box) in the printer dialog box before printing. [A very good material to use for this insulation mask is a craft foam called Foamie.] It can be purchased in many different colors and thickness. For the Genesis we found the material of *2 mm* thickness to be suitable as it allows the extra clearance needed for the assembly of the camera. Black foam is used on the heat sink face template and white foam is applied to the cold finger sides. [It should be noted that this material has no adhesive backing.] Therefore, an adhesive will need to be applied for affixing the foam to the surfaces to be insulated. The type of adhesive used should take into account the amount of time out gassing, which will take place during the curing phase. This could present a problem if the camera is sealed up and out gassing is still taking place. The curing process varies from different adhesives and may react detrimentally with the foam. Some experimental application on scrap foam is advised for adverse reaction.

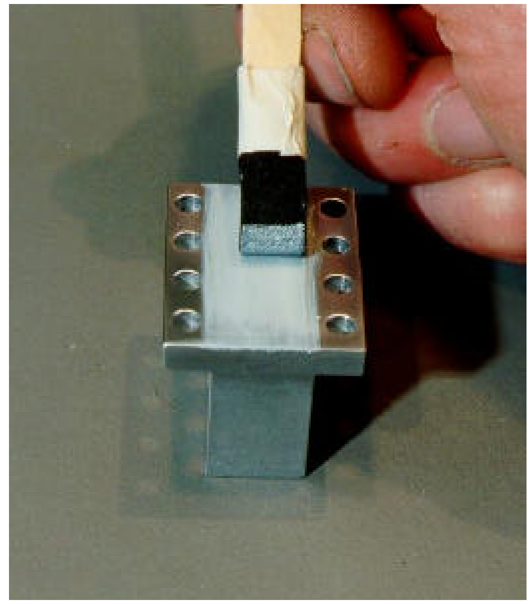
A slight warming of the assemblies usually accelerates the curing process. The top of a warm oven, or a spot in the sunlight should suffice


Foamy template applied to the heat sink for thermal insulation.

The stock length of the supply leads for the peltier should be cut to 2 ½” length to facilitate the area needed during the final assembly of the case tube to heat sink. Once the supply leads are cut, strip the ends about 1/8 of an inch.

Once the surfaces of the cold finger have been prepared we can start assembly of the cooling interface. Eight 6-32 X ½” socket head nylon set screws are used to mount the cold finger to the heat sink. The peltier module is sandwiched between the two parts. First apply a small amount of thermal grease to the heat sink and to the cold finger interface surfaces. Only use enough thermal grease to do the job. Excess material does nothing but make a big mess. It will also be wise to have some paper towels and rubbing alcohol handy for cleaning your hands and parts of excess thermal grease. This material has a tendency to get everywhere but where you want it. In looking at the peltier, the voltage supply wires will be attached to one side of the ceramic surfaces. This is the hot side of the peltier and will be mounted on the heat sink side of the assembly. Orientation of the cold finger, heat sink and peltier supply wires

Orientation of the heat sink, in reference to the wires of the peltier will be, looking from the top down. The holes for the mounting of the Delrin standoff and the wires for the fan power supply will be facing towards you. The power wires for the peltier and the mounting holes for placement of the cold finger will run horizontal to you. In this configuration, the wires for the peltier will be on the left side.

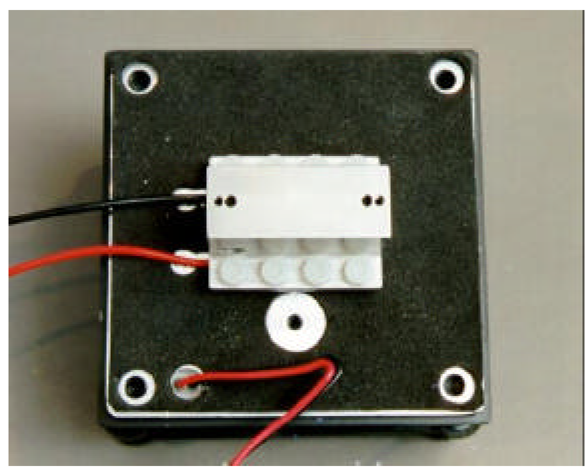


Foamy applicator applying a uniform layer of thermal grease to the cold finger

A handy tool can be made from a Popsicle stick or tongue depressor with its end cut square. Then apply a scrap piece of Foamie craft foam with some masking tape. Once assembled it will look much like a miniature foam paintbrush. This small tool will allow a thin, uniform application of thermal grease during different construction segments. A second one should be made for the application of Parker Super O ring lube for the sealing of the camera.

For assembly, we will place the peltier on the cold finger, and with some finger tip pressure on the peltier push down and gently twist to squeeze out excess thermal paste and air gaps. Once this has been achieved, place this assembly onto the heat sink and repeat the same process. The idea is to keep the surfaces of the materials parallel and square to the mounting holes while having the peltier module central to the cold finger base and the mounting holes of the heat sink.

When we are satisfied with the placement, start to insert the socket head nylon set screws. Thread them in with the allen wrench end *without tightening them down. When they are all inserted, tighten them each a small amount at a time to keep the pressure even across the entire face of the peltier*. This process is important for two reasons:
The cold finger base parallel to the heat sink face will give us the highest thermal conductivity because the amount of thermal grease and air are at a minimum (squeezed out).



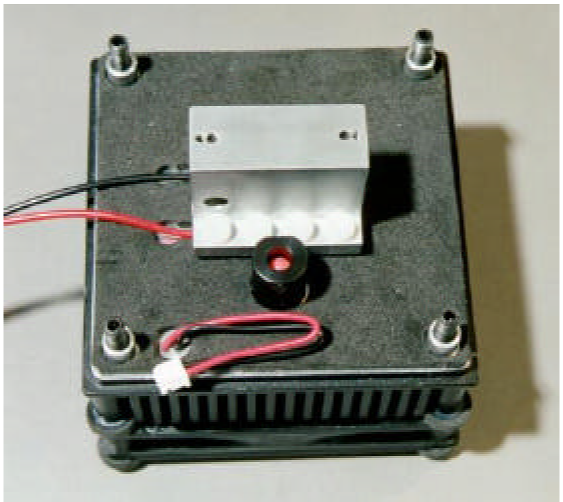
The final assembly of the heat sink, peltier and cold finger

The cold finger mounting holes for the CCD (on top) will not align properly with the board assembly if the cold finger is “cocked” from the screws not tightened evenly. *We also advise not to over tighten the nylon screws. At some point they will not have anymore holding power from tightening them down, they will just stretch and become weakened.*

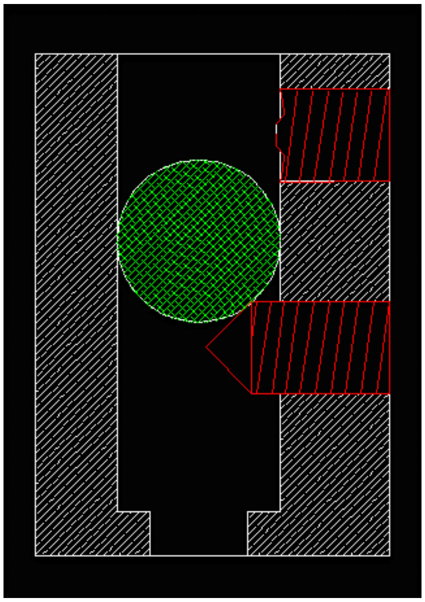
Next ,we will attach the standoffs for the circuit board assembly. Attach the four 8-32 X ¾” long allen set screws. As they are applied only use enough turning pressure with the allen wrench to bottom the screw in the tapped hole so that finger turning will not loosen them. *If they are hard turned into the holes the possibility of them breaking through to the pin side of the heat sink is possible. This would prevent the case interior from being air tight.*

At this point the last item to fasten to the heat sink will be the black Delrin standoff for the Daco shutter assembly. This assembly is shipped assembled so the parts won’t get lost in transit. We will need to carefully dismantle it so that it may be attached to our heat sink.
1. Use an allen wrench and remove the two 6-32 screws on the side of the assembly. You will notice as you remove them that one screw on the top (3/16 hole) is a cup point screw. The screw in the side center is a cone point screw. Make a mental note of this for reassembly in a short time.
2. Next use the allen wrench and push out the screw on the end to push out the nylon ball bearing. Careful! that little ball has gotten away a few times and is hard to find. We now have just the 4-40 allen cap head screw left in the black Delrin standoff.
3. Place the proper allen wrench in the screw head and attach the standoff to the heat sink. The flat on the side will align with the cold finger base.

Now that the standoff is in place, we will reassemble the standoff.
1. Put in the cup point screw until the outside end of the screw (allen wrench hole side) is almost flush with the diameter of the standoff.
2. Now place the ball bearing back into the hole and push it down onto the cone point screw.
3. Replace the top cup point screw until the cup point protrudes a small amount into the hole to keep the ball retained.



Black Delrin standoff attached to the heat sink with nylon ball bearing in place



In the drawing above the ball bearing is green and the set screws are red. The Delrin body is cut in half for this view.

Case Assembly – Step 1

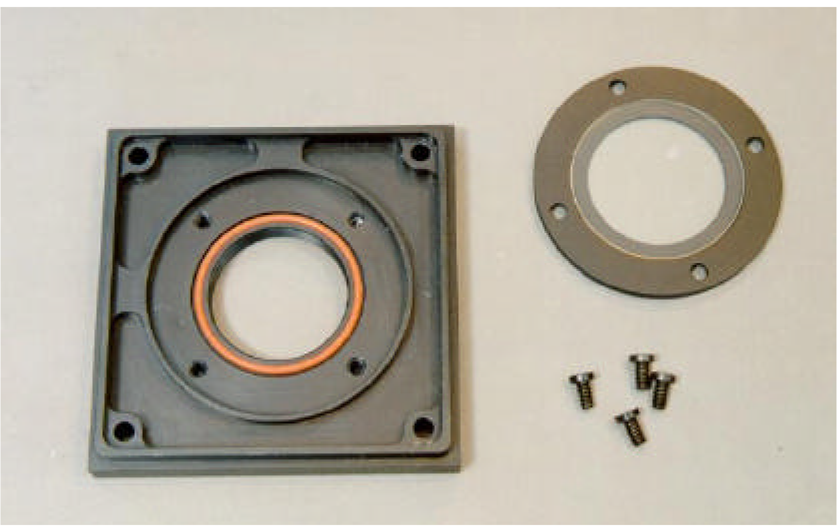
The next task will be to set the shutter height in relation to the CCD and the glass porthole. For assembly of the top cover with the glass port hole, we will need: the glass, (Edmund Scientific 40.2 mm X 2.1 mm thickness, part number K54-050 UV longpass glass); a - 027 silicone, 60 durometer O ring; and four 6-32 X ¼ long low head socket set screws.

1.Lightly stretch the O ring between two fingers. This will allow it to sit in the groove once it is put in place. Once again only a moderate amount will do. It is possible to distort to O ring if it is stretched to far. Once you have completed this task apply a light amount of Parker Super O ring lube to your index and thumb of one hand and work it between the two fingers. Then draw the O ring through your finger tips to lightly coat it. After the O ring is coated gently clean the excess lubricant off with a clean paper towel or lint free cloth. Once this is completed we can set the O ring into its groove on the top cover.

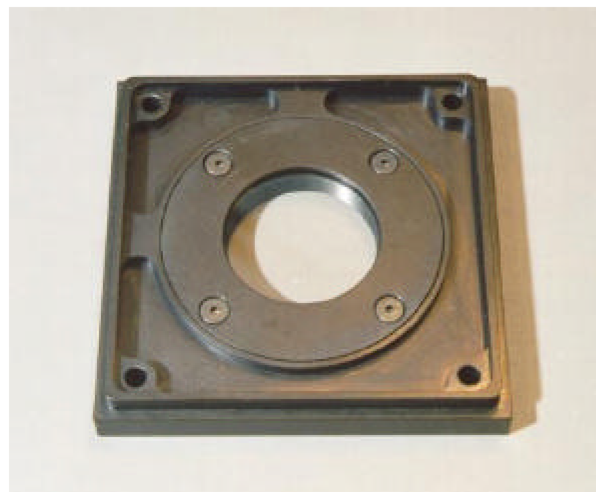
2. Using your two index fingers, start at the 12 o'clock position and drag your fingers symmetrically to the 6 o'clock position. The O ring will retain itself into the machined groove. *It is important not to twist the O ring during this process of insertion. If it will not sit into the groove and insists on popping back out, a little stretching as was previously done will remedy this problem.*

3. Once the O ring is in place, clean your hands well to remove the excess Parker Super O lube, before handling the glass window. Hold the glass window by its edges to place it into the aluminum metal retaining ring. By holding the metal retaining ring in your finger tips with the glass facing up, take the top cover in the other hand and place it over the retaining ring.

4. Once the two parts have been mated, flip the top cover over and place it on a table top. Rotate the retaining ring until the four mounting holes are aligned.
5. Using the four 6-32 X ¼ inch long low head socket set screws and an allen wrench, start threading the screws into their holes until they just make contact with the retaining ring.



Top cover with the O ring installed and the glass set in the retaining ring.



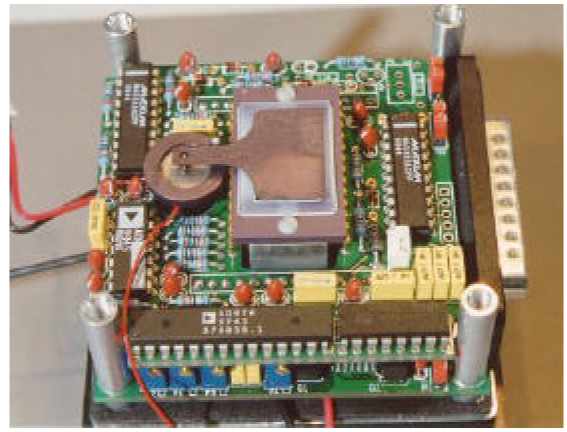
Top cover with with glass retaining ring installed.

Now place the 4 aluminum, ¼ diameter by ¼ inch long circuit board standoffs, on the 8-32 X ¾" long screws mounted on the heat sink. Place the assembled stacked circuit boards onto the 8-32 screws with the standoffs in place.

During the mating of the parts, only one orientation will be possible. This will be for the Delrin standoff and the hole configuration in the boards to allow the shutter mounting. Using the four ¼ diameter by 1 inch long 8-32 threaded standoffs, attach them to the 8-32 threaded set screws to fasten the lower board to the heat sink.

At this time, thermal grease *will not be applied to the CCD to cold finger interface*. We will, however, use the pan head nylon screws to fasten the CCD to the cold finger. Using a jewelers screwdriver, carefully thread the screws into the cold finger, depending on the hole spacing and screw sizing of your CCD detector. The screwdriver slots in the screws are not very deep, therefore extreme care should be taken to not let the tip of the screwdriver drift out of the slot and damage the CCD glass window. Do not over tighten the nylon screws. They will break very easily if too much torque is used once they are seated.

Loosen the top set screw on the Delrin standoff for the mounting tail of the Daco shutter. Using your fingertips grasp the Daco by the diameter on the top of the main body. Place the Daco shutter onto the Delrin standoff. ***[We have found that in some cases a slight twisting motion with inserting pressure will be needed for the two parts to fit together.]*** Care must be taken not to bend the fragile flag arm of the shutter assembly if it comes into contact with the nylon screws or the glass window of the CCD. Using an allen wrench on the lower delrin standoff adjusting screw, turn the screw clockwise to raise the shutter solenoid height until it just clears the nylon screw heads.

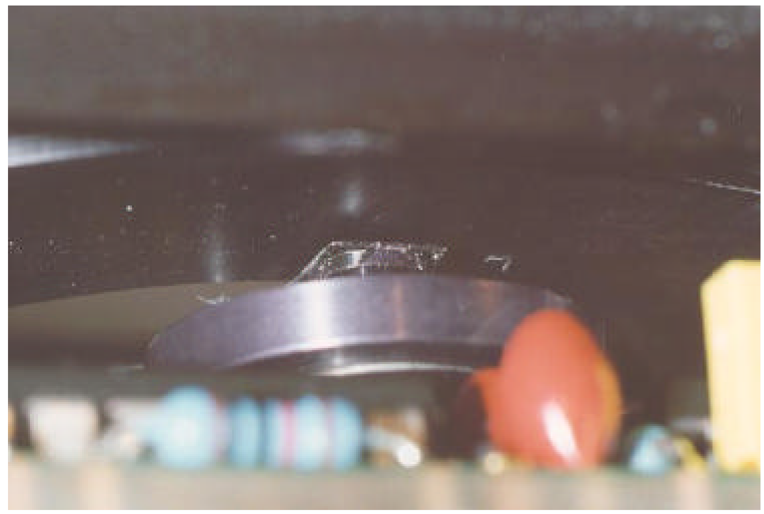


CCD mounted on heat sink with nylon pan head screws. Notice the standoffs mounted for setting the height of the top cover.

Now place the top cover on the four aluminum standoffs. Looking at the assembly from the side we will see a small gap between the CCD and the top cover glass porthole-retaining ring. Using this view, adjust the lower set screw in the delrin standoff to raise the Daco solenoid flag ,as close as possible, to the porthole retaining ring. In doing so, a slight space will still be required so that it will not interfere with its operation.

With the shutter heights properly set, remove the solenoid from the delrin standoff and properly store it in its shipping container until final construction is concluded. At this point in the assembly process, connection of the peltier module to the DB15 power connector will be completed, before final assembly is undertaken.

Carefully remove the pan head nylon screws that are holding the CCD module to the cold finger. Then remove the four, ¼” diameter by 1” aluminum standoffs, retaining the board assembly to the heat sink. Separate the upper board from the lower board as we have previously done, so as not to bend the inter-board connectors pins. Store the upper board with the CCD module still mounted in the **ESD** protective-shipping bag until final circuit board assembly is achieved.



Shutter height adjustment during camera assembly

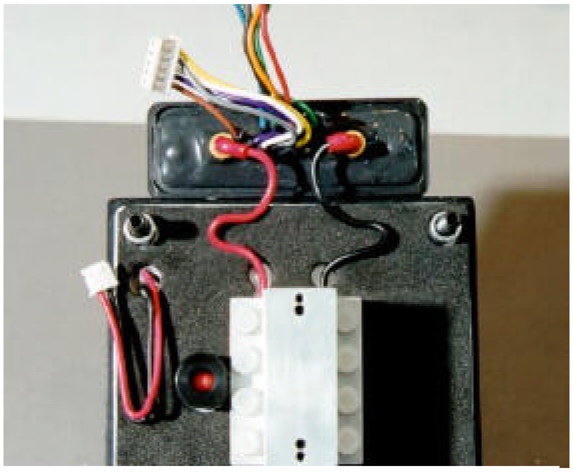
Case Assembly – Step 2

Solder the supply leads of the peltier module to the DB15 sealed power connector using the reference Diagram of the connector. The use of 1/8” I.D. shrink tubing with a length of ¼” will add strength to the interface of the peltier wire leads and the DB15 heavy amperage solder terminals. Before soldering the wires take a minute and study the path that the wires will be routed. The peltier wires will also need to pass through the access cutouts in the lower board to the DB15 high amperage terminals. It is important to use the shortest possible length of wire from the DB15 terminal connection to the lower board cutouts! By bending the striped ends of the wires at a right angle proceed to solder them into the power pins of the DB15 sealed connector. Looking at the back of the connector, the peltier wire on the left will approach its pin at approximately the 4 o’clock position. The wire on the right side will approach at the 8 o’clock orientation respectively. Once the wires are soldered, affix the shrink tubing to aid in stress management. In the picture that follows note the way that the peltier supply leads are formed. This will allow for the excess wire length needed for assembly and disassembly, as well as prevent severe stress at the point of bonding on the peltier. Additional sealing of the power pins will aid in the camera being air tight. We applied a small amount of RTV silicone to the power pins in this localized area.

The sealed DB15 power connector fully assembled with the Molex wire to board connectors and the peltier supply connection

In preparing for the assembly of the case of the camera the first O ring seal for the 80 X 80 mm aluminum tube will be put in place. Before this is done, we will apply Parker Super O ring lube in much the same way as was done with the port hole window O ring seal.

Place one of the 80 X 80 mm square O rings in the machined groove on the heat sink. Do not stretch the O ring during placement. It will make it very difficult to seal the case later in the assembly process if it does not fit properly. We have also found that sealant is not necessary during application of the square O rings. If it is applied it will be next to impossible to properly compress the O rings without them shifting.

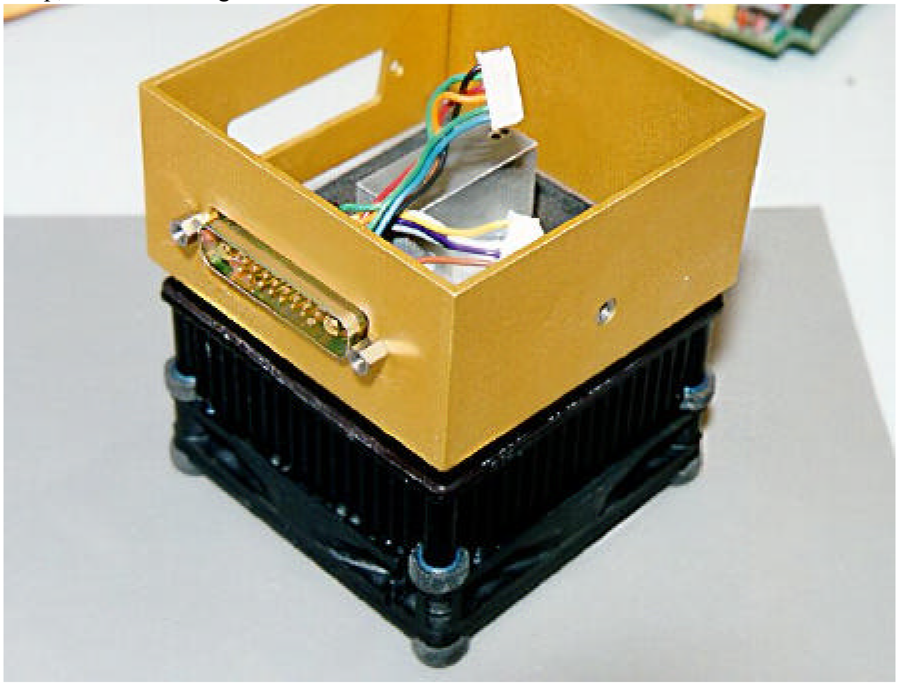


Wires bent for peltier stress and soldered to DB115 power connector with shrink tubing for stress relief.

When this is completed, mount the sealed DB15 power connector to the 80 X 80 aluminum square tubing. Before this is done, using our finger tip, coat the O ring of the DB15 sealed connector. After this is accomplished, we will proceed to mount it to the 80 X 80 square tube. Take into consideration the mounting hole needed in the tubing for the DB25 sealed connector and the orientation of the of the side taper of the cutouts in the square tubing for the correct direction.

A good indication of proper alignment will be the 6-32 threaded access hole in the square tube aligning with the locking set screw for the shutter standoff. Once this is done, place the DB15 power connector into its access hole in the square tube. Using the 4-40 shoulder screws attach the connector to the square tube.

Before final tightening is done, center the connector in the access hole. As you tighten the screws, use an even amount of pressure from side to side until the O ring face is fully seated.
The lower circuit board will now need to be installed into the 80 X 80 square tube.

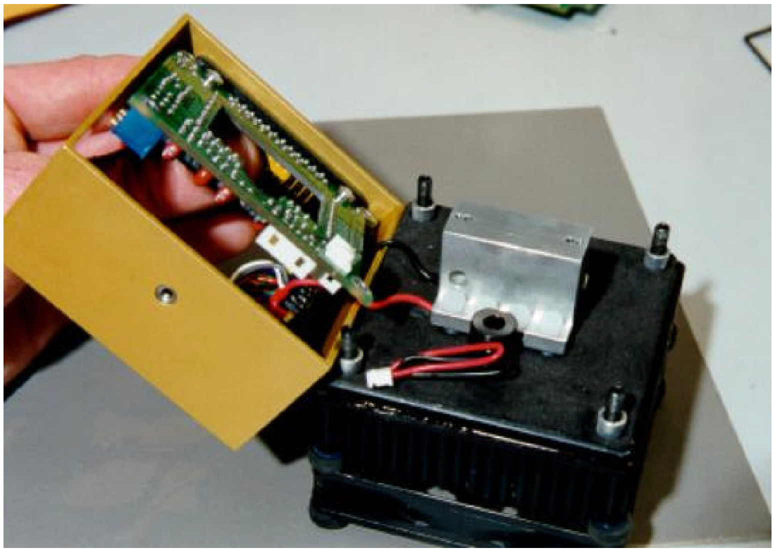


DB15 connector attached to the square tubing

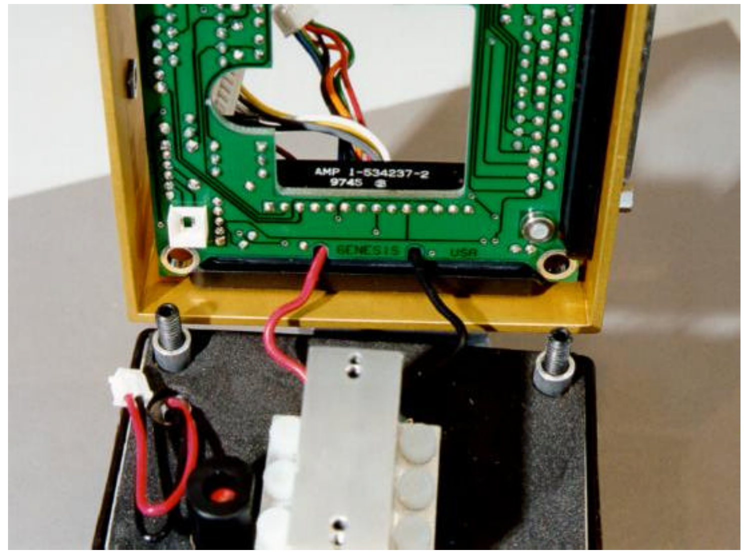
1. First, coat the O ring of the DB25 sealed connector with the Parker Super O ring lube, in the same manner as done previously.

2. Then, holding the board at an angle, approach the access hole from the bottom of the square tube. The DB25 connector will enter the access hole in the tube first, then swing the board into place. Two cutouts are provided on the lower board for the voltage supply wires of the peltier to access the DB15 power connector.

3. Once the board is in place properly use the two 4-40 shoulder screws and secure the DB25 connector. DO NOT tighten the screws of this connector at this time. This connector needs to float in its setting until the case is fully sealed by tightening the top cover and compressing the square O ring seals



Lower board is mounted into the 80 X 80 square tubing



Access cutouts for the peltier supply voltage wires

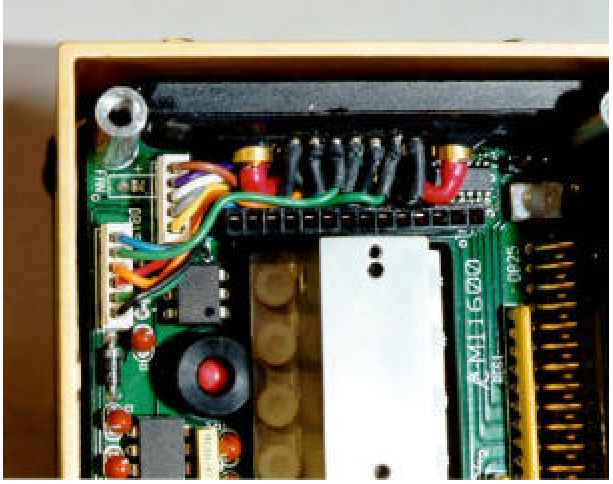
Before we fit together the assemblies, the Molex wire to board connector for the fan connection will need to be attached. We have found the simplest method for managing the extended wire length will be to fold the excess wires towards the black delrin shutter standoff at the point they exit the heat sink. Then double the length of wires back to the Molex connector on the lower board folding a loop in the approximate center of the length.

Case Assembly – Step 3

Preparation can now be made for the mounting of the square tube assembly to the heat sink.
By aligning the board standoff holes in the lower circuit board with the threaded standoffs and 1/4 diameter by 1/4" long spacers on the heat sink, place the tube assembly in position. As the two assemblies' are joined a finishing touch of wire management will be necessary for proper fit. Using the four 1/4 " diameter by 1" long threaded standoffs.
Then thread the screw onto the standoff until the nut makes contact. Using an allen wrench lightly tighten the standoff to the board. Then use a small open-end wrench or fine tipped pliers to loosen the nut. Remove the allen screw and nut assembly and repeat the process on the next standoff.

[It should be noted that excess force used in tightening down the standoffs will make it that much more difficult to remove the lower board standoffs in the future.]

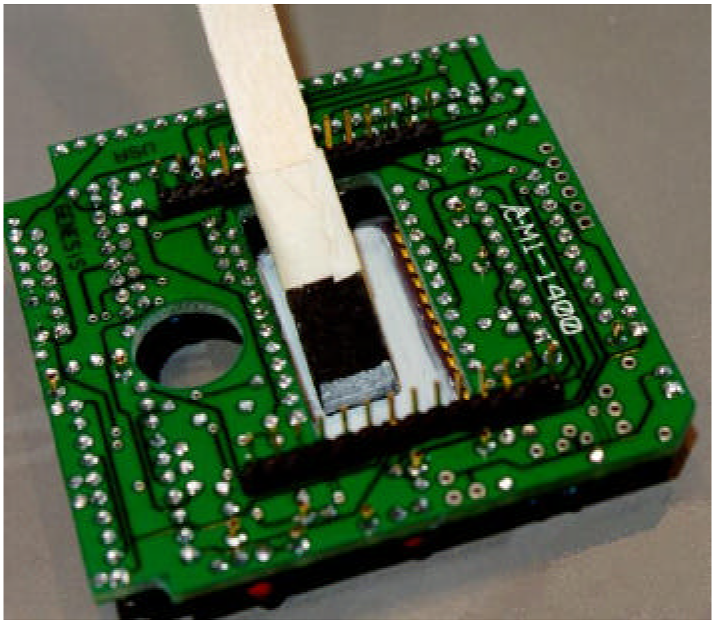
To finish the installation of the lower board the Molex wire to board connectors DB15 and DB15A will need to be connected. Start with DB15 folding the wires into place. A jewelers screwdriver will aid with the manipulation of the wires to their final position. Then proceed to installing the DB15A connector. Space will start to become limited, but with some patience you will be able to neatly tuck them all into place. The final arrangement of the wires is required to be in such a way as not to interfere with the seating of the inter-board connectors during later assembly.



Molex wire to board connectors DB15 and DB15A connected to the lower circuit board. Note the placement of the wires so that there will be no interference with the placement of the upper board into the assembly.

As we prepare to mount the upper board in place with the CCD sensor, thermal grease will must to be applied to the top surface of the cold finger. We have found that a very thin film of thermal grease applied to the cold finger interface surface, as well as the CCD bottom surface will assure us of superior thermal contact. Application to the CCD bottom is difficult because of limited space. We also recommend that the grease does not come into contact with the pins of the sensor.

It is now time for the final placement of the upper board into the camera. With the orientation holes aligned for the shutter placement place the upper board onto the inter-board connectors of the lower board. Press the board assembly down until fully seated onto the lower board. Then press down on the ends of the CCD detector to seat it properly in the thermal grease. The two pan head nylon screws for retaining the CCD detector will now be seated. We remind you that the slots for the jewelers screwdriver are not very deep. Therefore care should be taken to guard the screwdriver tip from damaging the CCD optical window.
Before we attach the Daco shutter to the camera, examine the optical window of the CCD detector. If it needs cleaning we suggest using procedure for accomplishing this task.
The next step is to place the Daco shutter unit into the black delrin standoff.



Application of thermal grease to the CCD sensor bottom surface using our applicator.

1. Before placing the unit on the standoff we will have to engage an allen wrench into the locking set screw on the side of the standoff. Using the access hole in the 80 X 80 metal tubing place the long length of the allen wrench through the hole into the allen screw.

2. Once engaged, we will place the Daco shutter into the camera onto the nylon ball bearing. Orient the flag arm of the shutter so it is square with the CCD sensor window. Lock the set screw to hold the Daco unit in place. We strongly recommend not to use excessive torque to lock the Daco in place. The Delrin standoff will deform and the shutter will not sit square. *Only tighten the screw enough to keep the shutter in place.*

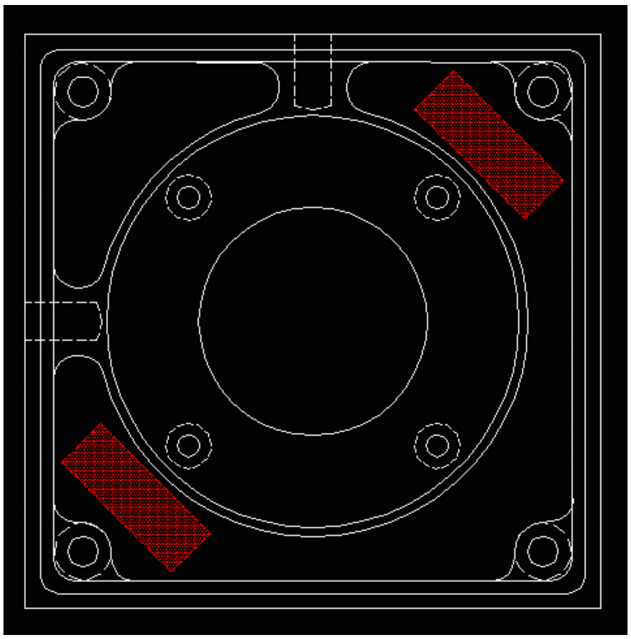
3. The last task to installing the shutter will be to attach the Molex wire to board connector. For simplified wire management we suggest twisting the voltage supply wires into a pair. This will allow routing them to the connector a simple undertaking.
Daco shutter seated in the delrin standoff with the wires twisted and connected to the Molex connector.
In preparing the top cover for assembly we will first examine the porthole glass for dust specs or dirt. If need, be clean the glass, using the same procedure as was used on the CCD sensor glass.

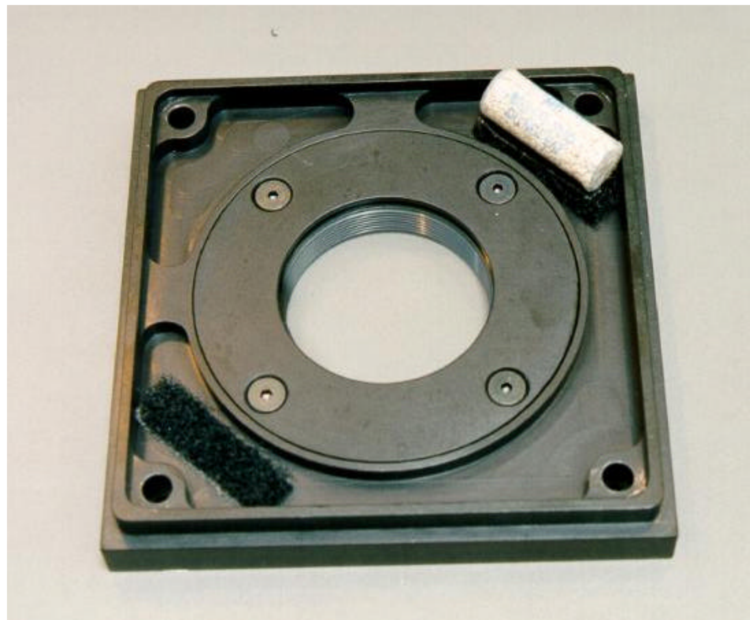
Case Assembly – Step 4

Once we are assured the port hole glass is ready for service, preparations for assembly of the top cover to the camera body will take place. Place the O ring into its machined channel on the top cover.

Preparation will now be made for applying desiccant to the top cover. The simplest and most efficient method of retaining the desiccant cartridges in place will be to use Velcro strips attached to the top cover and desiccant. This material is easily obtainable with adhesive backing for application to a variety of surfaces.
With the desiccant cartridges provided in the Genesis kit only two locations on the top cover are permissible for mounting. Using the drawing below place two 1/4 X 3/4 inch pieces of Velcro on the recessed areas on the top cover. After cutting the Velcro, scratch the surface with your fingernail to shed any loose strands of the material.

Application of the Velcro to the desiccant should not be done until just before the top cover is placed on the camera body. The desiccant cartridges provided in the kit are sealed canisters. They cannot be renewed by heating. Additionally they are a type that will not contaminate the optical surfaces of the camera. From the time that the camera is fully sealed, it will take approximately 12 hours for the moisture remaining in the camera body, to be absorbed.





This view is looking from the bottom of the top cover

Before the top cover is placed on the camera, examine the sides of the cover. Two 1/4-20 threaded holes are provided for mounting the camera on a tripod or OTA tube. We have found the best orientation of the holes will correspond to the DB connectors access in the 80 X 80-mm tube. In this manner the data and voltage supply wiring will always be on the bottom or side of the camera during use, if the threaded holes are used.

The moment of truth

1. We will now do the final sealing of the camera. Open the air tight sealed pack the desiccant was shipped in.

2. Apply the opposite Velcro strip to the desiccant cartridge and place them in the top cover. Place the top cover on the 80 X 80 mm tubing with the proper orientation.

3. Before securing the 8-32 low head socket head screws the four Torlock O ring washers will need an application of Parker Super O ring lube. For this treatment a small dab on your fingertips is sufficient to coat the sealing surfaces of the washers. Place the washers on the screws and insert them into the top cover access holes.

Torlock washers and the 8-32 low head socket allen head set screws.

4. Using an allen wrench, engage the screws until first contact is made with the 1/4 diameter by 1 inch 8-32 board standoffs. The compression of the square O rings will need to be done evenly on all sides. At the same time, during the seating process, a squeezing from the exposed sides of the O ring will be done. By turning the four screws a half turn each in progression the O ring will deform and protrude towards the exposed side.

5. Using your fingertips, press the O ring in against the inner surfaces of the machined grooves on the top cover and heat sink. This process of one half turn of the screws and squeezing will allow the O ring to seal three surfaces, once the screws are fully tightened.

6. At some point during the compression of the O rings, you will not be able to compress the O ring from the sides any longer. Continue to tighten the screws until the top cover compresses the O rings approximately 25 to 30%. If the O rings are compressed more than the recommended amount they will be squeezed out of the machined groove. If this occurs loosen the cover screws, reseat the O ring into its groove and proceed with the compression process again.

7. With the top cover secured and the O rings compressed, we will now finish securing the two 4-40 standoffs of the DB25 sealed connector. These two screws were left partially tightened until the top cover was secured.

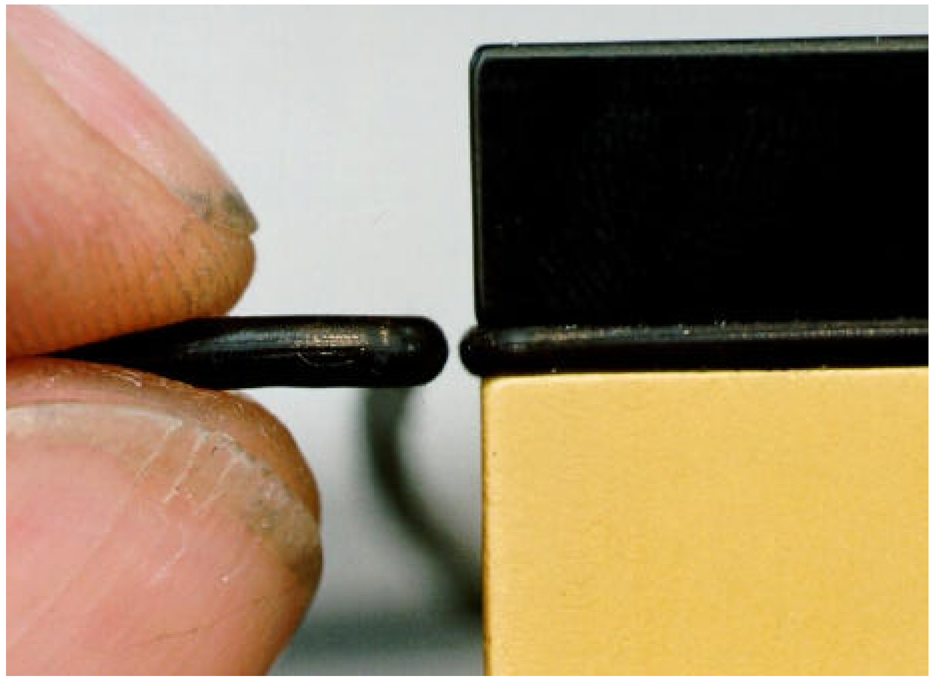
8. Once again we will tighten the standoffs each a little at a time until fully seated.

9. The final hole to seal will be the access hole for the delrin standoff locking screw. In looking at the dome head allen screw you will notice a small O ring. This will also need a treatment of Parker Super O ring lube.

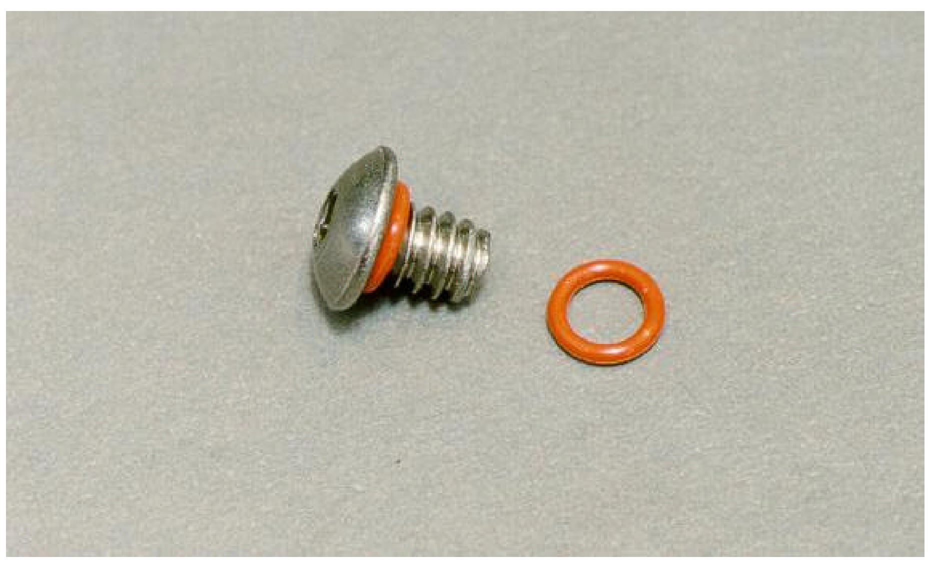
10. Before this screw is applied, some will choose to do additional steps to further dry the internal air of the camera body. Using canned compressed air is an inexpensive solution to achieve this task. Another option is to use nitrogen as an inert gas to fill the sealed camera body.

11. With the 6-32 dome head socket set screw in place we advise powering up the camera to test its various functions. Trigger the Daco shutter to assure yourself of its proper operation. Depending on light conditions, capture an image for your first light nostalgia.

We hope that your experience in assembling, testing and using the **Genesis CCD** system is a rewarding experience. We value your comments and suggestions. A **news** List is accessible for sharing information or questions with other builders.



In the photo we can see the original diameter of the O ring and the proper amount of compression from tightening the allen screws on the top cover



6-32 Dome head allen screw with O ring used for sealing the delrin access hole in the 80 X 80 mm tubing.

Apendix A - WorkSheets

KAF-0400 WorkSheet

The Genesis printed circuit boards were designed for The KAF-0401 and KAF-1600 series of CCD sensors. Therefore, to use the KAF-0400, KAF-0400L or the KAF-0400C CCD, we will need to make some changes of the board components for this CCD sensor to operate properly. The list of diodes follows. [Please note: if you are mounting a KAF-0400 CCD, the Mill-Max solderless wire inserts for D8 will need to be removed for the wire diameter of this diode to pass through the hole.]

Part Reference	Voltage
D3	2.0 V
D4	3.9V
D5	3.3V
D6	7.5V
D7	10V
D8	1N4148

The diode D8 with a part number 1N4148 needs to be set opposite polarity than the silk screened outline on the board.

DC Operating Conditions

Symbol	Minimum	Nominal	Maximum
VSUB	0.0V	0.0V	0.0V
VDD	+14.75V	+15.00V	+15.25V
VSS	+0.6V	+0.7V	+1.5V
VRD	+9.75V	+10.00V	+10.25V
VOG	+1.0V	+3.0V	+5.0V
GUARD	+5.0V	+7.0V	+10.0V

Worksheet for testing:

Signals for the support of the CCD when the SET 0 instruction is issued using Pisco for the KAF-0400

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+3.0V		+6.0V	-1.0V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.25V	+14.75V
4	VRD	+10.0V		+10.25V	+9.75V
5	R	+3.0V		+5.0V	0V
6	VSS	+0.7V		+1.5V	+0.6V
7	H1	+6.0V		+8.0V	+4.0V
8	H2	-4.0V		-2.0V	-6.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	0.5V		+1.0V	0V
16	V1	0.5V		+1.0V	0V
17	V2	0.5V		+1.0V	0V
18	V2	0.5V		+1.0V	0V
19	V2	0.5V		+1.0V	0V
20	V2	0.5V		+1.0V	0V
21	V1	0.5V		+1.0V	0V
22	V1	0.5V		+1.0V	0V
23	GUARD	+7.0V		+10.0V	+5.0V
24	GND	/	/	/	/

Signals for the support of the CCD when the SET 255 instruction is issued using Pisco for the KAF-0400

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+3.0V		+5.0V	+1.0V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.25V	+14.75V
4	VRD	+10.0V		+10.25V	+9.75V
5	R	-2.0V		0V	-5.0V
6	VSS	+0.7V		+1.5V	0.6V
7	H1	-4.0V		-2.0V	-6.0V
8	H2	+6.0V		+8.0V	+4.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	-8.0V		-7.5V	-8.5V
16	V1	-8.0V		-7.5V	-8.5V
17	V2	-8.0V		-7.5V	-8.5V
18	V2	-8.0V		-7.5V	-8.5V
19	V2	-8.0V		-7.5V	-8.5V
20	V2	-8.0V		-7.5V	-8.5V
21	V1	-8.0V		-7.5V	-8.5V
22	V1	-8.0V		-7.5V	-8.5V
23	GUARD	+7.0V		+10.0V	5.0V
24	GND	/	/	/	/

KAF-0401 WorkSheet

The list of diodes for the KAF-0401 CCD are as follows. Care should be taken as diodes are placed in the Mill-Max solderless receptacles to comply with the polarity of the components. The silk-screened outline of the board will aid in the proper placement.

Part Reference	Voltage
D3	2.0 V
D4	3.9V
D5	3.9V
D6	9.0V
D7	11V
D8	2.0V

DC Operating Conditions

Symbol	Minimum	Nominal	Maximum
VSUB	0.0V	0.0V	0.0V
VDD	+14.5V	+15.0V	+15.5V
VSS	+1.5V	+2.0V	+2.5V
VRD	+10.5V	+11.0V	+11.5V
VOG	+3.75V	+4.0V	+5.0V
GUARD	+8.0V	+9.0V	+12.0V

Worksheet for testing:

Signals for the support of the CCD when the SET 0 instruction is issued using Pisco for the KAF-0401

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+4.0V		+5.0V	+3.75V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.5V	+14.5V
4	VRD	+11.0V		+11.5V	+10.5V
5	R	+4.0V		+5.0V	+3.5V
6	VSS	+2.0V		+2.5V	+1.5V
7	H1	+6.0V		+6.5V	+5.0V
8	H2	- 4.0V		- 3.5V	- 5.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	+0.5V		+1.0V	0V
16	V1	+0.5V		+1.0V	0V
17	V2	+0.5V		+1.0V	0V
18	V2	+0.5V		+1.0V	0V
19	V2	+0.5V		+1.0V	0V
20	V2	+0.5V		+1.0V	0V
21	V1	+0.5V		+1.0V	0V
22	V1	+0.5V		+1.0V	0V
23	GUARD	+9.0V		+12.0V	+8.0V
24	GND	/	/	/	/

Signals for the support of the CCD when the SET 255 instruction is issued using Pisco for the KAF-0401

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+4.0V		+5.0V	+3.75V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.5V	+14.5V
4	VRD	+11.0V		+11.5V	+10.5V
5	R	-2.0V		-1.75V	-3.0V
6	VSS	+2.0V		+2.5V	+1.5V
7	H1	-4.0V		-3.5V	-5.0V
8	H2	+6.0V		+6.5V	+5.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	-10.0V		-9.5V	-10.5V
16	V1	-10.0V		-9.5V	-10.5V
17	V2	-10.0V		-9.5V	-10.5V
18	V2	-10.0V		-9.5V	-10.5V
19	V2	-10.0V		-9.5V	-10.5V
20	V2	-10.0V		-9.5V	-10.5V
21	V1	-10.0V		-9.5V	-10.5V
22	V1	-10.0V		-9.5V	-10.5V
23	GUARD	9.0V		+12.0V	+8.0V
24	GND	/	/	/	/

KAF-0401E WorkSheet

The list of diodes for the KAF-0401E CCD are as follows. Care should be taken as diodes are placed in the Mill-Max solderless receptacles to comply with the polarity of the components. The silk screened outline of the board will aid in the proper placement.

Part Reference	Voltage
D3	2.0 V
D4	3.9V
D5	3.9V
D6	9.0V
D7	11V
D8	2.0V

DC Operating Conditions

Symbol	Minimum	Nominal	Maximum
VSUB	0.0V	0.0V	0.0V
VDD	+14.5V	+15.0V	+15.5V
VSS	+1.5V	+2.0V	+2.5V
VRD	+10.5V	+11.0V	+11.5V
VOG	+3.75V	+4.0V	+5.0V
GUARD	+8.0V	+9.0V	+12.0V

Worksheet for testing:

Signals for the support of the CCD when the SET 0 instruction is issued using Pisco for the KAF-0401E

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+4.0V		+5.0V	+3.75V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.5V	+14.5V
4	VRD	+11.0V		+11.5V	+10.5V
5	R	+4.0V		+5.0V	+3.5V
6	VSS	+2.0V		+2.5V	+1.5V
7	H1	+6.0V		+6.5V	+5.0V
8	H2	-4.0V		-3.5V	-5.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	+0.5V		+1.0V	0V
16	V1	+0.5V		+1.0V	0V
17	V2	+0.5V		+1.0V	0V
18	V2	+0.5V		+1.0V	0V
19	V2	+0.5V		+1.0V	0V
20	V2	+0.5V		+1.0V	0V
21	V1	+0.5V		+1.0V	0V
22	V1	+0.5V		+1.0V	0V
23	GUARD	+9.0V		+12.0V	+8.0V
24	GND	/	/	/	/

Signals for the support of the CCD when the SET 255 instruction is issued using Pisco for the KAF-0401E

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+4.0V		+5.0V	+3.75V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.5V	+14.5V
4	VRD	+11.0V		+11.5V	+10.5V
5	R	-2.0V		-1.75V	-3.0V
6	VSS	+2.0V		+2.5V	+1.5V
7	H1	-4.0V		-3.5V	-5.0V
8	H2	+6.0V		+6.5V	+5.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	-10.0V		-9.5V	-10.5V
16	V1	-10.0V		-9.5V	-10.5V
17	V2	-10.0V		-9.5V	-10.5V
18	V2	-10.0V		-9.5V	-10.5V
19	V2	-10.0V		-9.5V	-10.5V
20	V2	-10.0V		-9.5V	-10.5V
21	V1	-10.0V		-9.5V	-10.5V
22	V1	-10.0V		-9.5V	-10.5V
23	GUARD	9.0V		+12.0V	+8.0V
24	GND	/	/	/	/

KAF-1600 WorkSheet

The list of diodes for the KAF-1600 CCD are as follows. Care should be taken as diodes are placed in the Mill-Max solderless receptacles to comply with the polarity of the components. The silk screened outline of the board will aid in the proper placement.

Part Reference	Voltage
D3	3.9V
D4	2.0V
D5	3.9V
D6	9.0V
D7	11V
D8	2.0V

DC Operating Conditions

Symbol	Minimum	Nominal	Maximum
VSUB	0.0V	0.0V	0.0V
VDD	+14.5V	+15.0V	+15.5V
VSS	+1.5V	+2.0V	+2.5V
VRD	+10.5V	+11.0V	+11.5V
VOG	+3.75V	+4.0V	+5.0V
GUARD	+8.0V	+9.0V	+12.0V

Worksheet for testing:

Signals for the support of the CCD when the SET 0 instruction is issued using Pisco for the KAF-1600

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+4.0V		+5.0V	+3.75V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.5V	+14.5V
4	VRD	+11.0V		+11.5V	+10.5V
5	R	+2.0V		+5.0V	+3.5V
6	VSS	+2.0V		+2.5V	+1.5V
7	H1	+6.0V		+6.5V	+5.0V
8	H2	-4.0V		-3.5V	-5.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	+0.5V		+1.0V	0V
16	V1	+0.5V		+1.0V	0V
17	V2	+0.5V		+1.0V	0V
18	V2	+0.5V		+1.0V	0V
19	V2	+0.5V		+1.0V	0V
20	V2	+0.5V		+1.0V	0V
21	V1	+0.5V		+1.0V	0V
22	V1	+0.5V		+1.0V	0V
23	GUARD	+9.0V		+12.0V	+8.0V
24	GND	/	/	/	/

Signals for the support of the CCD when the SET 255 instruction is issued using Pisco for the KAF-1600

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+4.0V		+5.0V	+3.75V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.5V	+14.5V
4	VRD	+11.0V		+11.5V	+10.5V
5	R	-4.0V		-1.75V	-3.0V
6	VSS	+2.0V		+2.5V	+1.5V
7	H1	-4.0V		-3.5V	-5.0V
8	H2	+6.0V		+6.5V	+5.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	-8.0V		-7.5V	-8.5V
16	V1	-8.0V		-7.5V	-8.5V
17	V2	-8.0V		-7.5V	-8.5V
18	V2	-8.0V		-7.5V	-8.5V
19	V2	-8.0V		-7.5V	-8.5V
20	V2	-8.0V		-7.5V	-8.5V
21	V1	-8.0V		-7.5V	-8.5V
22	V1	-8.0V		-7.5V	-8.5V
23	GUARD	9.0V		+12.0V	+8.0V
24	GND	/	/	/	/

KAF-1602 WorkSheet

The list of diodes for the KAF-1602 CCD are as follows. Care should be taken as diodes are placed in the Mill-Max solderless receptacles to comply with the polarity of the components. The silk screened outline of the board will aid in the proper placement.

Part Reference	Voltage	Signal
D3	2.0 V	ØR Low
D4	3.9V	ØR High
D5	3.9V	VOG
D6	9.0V	GUARD
D7	11V	VRD
D8	2.0V	VSS

DC Operating Conditions

Symbol	Minimum	Nominal	Maximum
VSUB	0.0V	0.0V	0.0V
VDD	+14.5V	+15.0V	+15.5V
VSS	+1.5V	+2.0V	+2.5V
VRD	+10.5V	+11.0V	+11.5V
VOG	+3.75V	+4.0V	+5.0V
GUARD	+8.0V	+9.0V	+12.0V

Worksheet for testing:

Signals for the support of the CCD when the SET 0 instruction is issued using Pisco for the KAF-0401

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+4.0V		+5.0V	+3.75V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.5V	+14.5V
4	VRD	+11.0V		+11.5V	+10.5V
5	R	+4.0V		+5.0V	+3.5V
6	VSS	+2.0V		+2.5V	+1.5V
7	H1	+6.0V		+6.5V	+5.0V
8	H2	-4.0V		-3.5V	-5.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	+0.5V		+1.0V	0V
16	V1	+0.5V		+1.0V	0V
17	V2	+0.5V		+1.0V	0V
18	V2	+0.5V		+1.0V	0V
19	V2	+0.5V		+1.0V	0V
20	V2	+0.5V		+1.0V	0V
21	V1	+0.5V		+1.0V	0V
22	V1	+0.5V		+1.0V	0V
23	GUARD	+9.0V		+12.0V	+8.0V
24	GND	/	/	/	/

Signals for the support of the CCD when the SET 255 instruction is issued using Pisco for the KAF-0401

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+4.0V		+5.0V	+3.75V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.5V	+14.5V
4	VRD	+11.0V		+11.5V	+10.5V
5	R	-2.0V		-1.75V	-3.0V
6	VSS	+2.0V		+2.5V	+1.5V
7	H1	-4.0V		-3.5V	-5.0V
8	H2	+6.0V		+6.5V	+5.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	-8.0V		-7.5V	-8.5V
16	V1	-8.0V		-7.5V	-8.5V
17	V2	-8.0V		-7.5V	-8.5V
18	V2	-8.0V		-7.5V	-8.5V
19	V2	-8.0V		-7.5V	-8.5V
20	V2	-8.0V		-7.5V	-8.5V
21	V1	-8.0V		-7.5V	-8.5V
22	V1	-8.0V		-7.5V	-8.5V
23	GUARD	9.0V		+12.0V	+8.0V
24	GND	/	/	/	/

KAF-1602E WorkSheet

The list of diodes for the KAF-1602E CCD are as follows. Care should be taken as diodes are placed in the Mill-Max solderless receptacles to comply with the polarity of the components. The silk screened outline of the board will aid in the proper placement.

Part Reference	Voltage
D3	2.0 V
D4	3.9V
D5	3.9V
D6	9.0V
D7	11V
D8	2.0V

DC Operating Conditions

Symbol	Minimum	Nominal	Maximum
VSUB	0.0V	0.0V	0.0V
VDD	+14.5V	+15.0V	+15.5V
VSS	+1.5V	+2.0V	+2.5V
VRD	+10.5V	+11.0V	+11.5V
VOG	+3.75V	+4.0V	+5.0V
GUARD	+8.0V	+9.0V	+12.0V

Worksheet for testing:

Signals for the support of the CCD when the SET 0 instruction is issued using Pisco for the KAF-1602E

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+4.0V		+5.0V	+3.75V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.5V	+14.5V
4	VRD	+11.0V		+11.5V	+10.5V
5	R	+4.0V		+5.0V	+3.5V
6	VSS	+2.0V		+2.5V	+1.5V
7	H1	+6.0V		+6.5V	+5.0V
8	H2	-4.0V		-3.5V	-5.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	+0.5V		+1.0V	0V
16	V1	+0.5V		+1.0V	0V
17	V2	+0.5V		+1.0V	0V
18	V2	+0.5V		+1.0V	0V
19	V2	+0.5V		+1.0V	0V
20	V2	+0.5V		+1.0V	0V
21	V1	+0.5V		+1.0V	0V
22	V1	+0.5V		+1.0V	0V
23	GUARD	+9.0V		+12.0V	+8.0V
24	GND	/	/	/	/

Signals for the support of the CCD when the SET 255 instruction is issued using Pisco for the KAF-1602E

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+4.0V		+5.0V	+3.75V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.5V	+14.5V
4	VRD	+11.0V		+11.5V	+10.5V
5	R	-2.0V		-1.75V	-3.0V
6	VSS	+2.0V		+2.5V	+1.5V
7	H1	-4.0V		-3.5V	-5.0V
8	H2	+6.0V		+6.5V	+5.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	-10.0V		-9.5V	-10.5V
16	V1	-10.0V		-9.5V	-10.5V
17	V2	-10.0V		-9.5V	-10.5V
18	V2	-10.0V		-9.5V	-10.5V
19	V2	-10.0V		-9.5V	-10.5V
20	V2	-10.0V		-9.5V	-10.5V
21	V1	-10.0V		-9.5V	-10.5V
22	V1	-10.0V		-9.5V	-10.5V
23	GUARD	9.0V		+12.0V	+8.0V
24	GND	/	/	/	/

KAF-1602LE WorkSheet

The list of diodes for the KAF-1602LE CCD are as follows. Care should be taken as diodes are placed in the Mill-Max solderless receptacles to comply with the polarity of the components. The silk-screened outline of the board will aid in the proper placement.

Part Reference	Voltage
D3	2.0 V
D4	3.9V
D5	3.9V
D6	9.0V
D7	11V
D8	2.0V

DC Operating Conditions

Symbol	Minimum	Nominal	Maximum
VSUB	0.0V	0.0V	0.0V
VDD	+14.5V	+15.0V	+15.5V
VSS	+1.5V	+2.0V	+2.5V
VRD	+10.5V	+11.0V	+11.5V
VOG	+3.75V	+4.0V	+5.0V
GUARD	+8.0V	+9.0V	+12.0V

Worksheet for testing:

Signals for the support of the CCD when the SET 0 instruction is issued using Pisco for the KAF-1602LE

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+4.0V		+5.0V	+3.75V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.5V	+14.5V
4	VRD	+11.0V		+11.5V	+10.5V
5	R	+4.0V		+5.0V	+3.5V
6	VSS	+2.0V		+2.5V	+1.5V
7	H1	+6.0V		+6.5V	+5.0V
8	H2	-4.0V		-3.5V	-5.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	+0.5V		+1.0V	0V
16	V1	+0.5V		+1.0V	0V
17	V2	+0.5V		+1.0V	0V
18	V2	+0.5V		+1.0V	0V
19	V2	+0.5V		+1.0V	0V
20	V2	+0.5V		+1.0V	0V
21	V1	+0.5V		+1.0V	0V
22	V1	+0.5V		+1.0V	0V
23	GUARD	+9.0V		+12.0V	+8.0V
24	GND	/	/	/	/

Signals for the support of the CCD when the SET 255 instruction is issued using Pisco for the KAF-1602LE

CCD Pin #	Signal	Normal Voltage	Measured Voltage	Maximum Voltage not to pass	Minimum Voltage not to pass
1	VOG	+4.0V		+5.0V	+3.75V
2	VOUT	Video Signal	Video Signal	/	/
3	VDD	+15.0V		+15.5V	+14.5V
4	VRD	+11.0V		+11.5V	+10.5V
5	R	-2.0V		-1.75V	-3.0V
6	VSS	+2.0V		+2.5V	+1.5V
7	H1	-4.0V		-3.5V	-5.0V
8	H2	+6.0V		+6.5V	+5.0V
9	GND	/	/	/	/
10	GND	/	/	/	/
11	GND	/	/	/	/
12	GND	/	/	/	/
13	GND	/	/	/	/
14	VSUB	0V	0V	/	/
15	V1	-8.0V		-7.5V	-8.5V
16	V1	-8.0V		-7.5V	-8.5V
17	V2	-8.0V		-7.5V	-8.5V
18	V2	-8.0V		-7.5V	-8.5V
19	V2	-8.0V		-7.5V	-8.5V
20	V2	-8.0V		-7.5V	-8.5V
21	V1	-8.0V		-7.5V	-8.5V
22	V1	-8.0V		-7.5V	-8.5V
23	GUARD	9.0V		+12.0V	+8.0V
24	GND	/	/	/	/

Apendix B – Parts List

Parts list for the Genesis CCD camera

Resistors

Resistors are metal film 1% tolerance

Part Reference Number	Board (L =Lower) (U =Upper)	Component Value	Part Number	Manufacturer
RES 1	L	9 X 4.7k	4610X-101-472	Bourns
RES 2	L	5 X 4.7k	4606X-101-472	Bourns
R1	L	1k	1/4 W	Xicon
R5	L	3.3k	1/4 W	Xicon
R6	U	1.5k	1/4 W	Xicon
R7	U	1.5k	1/4 W	Xicon
R8	U	220	1/4 W	Xicon
R9	U	220	1/4 W	Xicon
R10	U	220	1/4 W	Xicon
R11	U	220	1/4 W	Xicon
R12	U	1.5k	1/4 W	Xicon
R13	U	2.2k	1/4 W	Xicon
R14	U	1.5k	1/4 W	Xicon
R15	U	4.7k	1/4 W	Xicon
R16	U	2.2k	1/4 W	Xicon
R17	U	4.7k	1/4 W	Xicon
R18	U	1k	1/4 W	Xicon
R19	U	10k	1/4 W	Xicon
R20	U	9.1k	1/4 W	Xicon
R21	U	10	1/4 W	Xicon
R22	U	10	1/4 W	Xicon
R23	U	1k	1/4 W	Xicon
R24	U	1k	1/4 W	Xicon
R25	U	220	1/4 W	Xicon
R26	U	68k	1/4 W	Xicon

Capacitors

Capacitors are (Panasonic) Tantalum 25 Volt 10% tolerance with .100 (2.54 mm) lead spacing. (AVX) are Metallized Polyester Film with .200 (5 mm) spacing 63Volt 10% tolerance

Part Reference Number	Board (L =Lower) (U =Upper)	Component Value	Part Number	Manufacturer
C1	L	10uF	ECS-F1EE106K	Panasonic
C2	L	10uF	ECS-F1EE106K	Panasonic
C3	L	4.7uF	ECS-F1EE475K	Panasonic
C4	L	4.7uF	ECS-F1EE475K	Panasonic
C5	L	100nF	BF014D0104J	AVX
C6	L	100nF	BF014D0104J	AVX
C7	L	100nF	BF014D0104J	AVX
C8	L	100nF	BF014D0104J	AVX
C9	L	4.7uF	ECS-F1EE475K	Panasonic
C10	L	4.7uF	ECS-F1EE475K	Panasonic
C11	L	4.7uF	ECS-F1EE475K	Panasonic
C12	L	4.7uF	ECS-F1EE475K	Panasonic
C13	U	4.7uF	ECS-F1EE475K	Panasonic
C14	U	4.7uF	ECS-F1EE475K	Panasonic
C15	U	4.7uF	ECS-F1EE475K	Panasonic
C16	U	4.7uF	ECS-F1EE475K	Panasonic
C17	U	4.7uF	ECS-F1EE475K	Panasonic
C18	U	4.7uF	ECS-F1EE475K	Panasonic
C19	U	4.7uF	ECS-F1EE475K	Panasonic
C20	U	3.3uF	ECS-F1EE335K	Panasonic
C21	U	100nF	BF014D0104J	AVX
C22	U	4.7uF	ECS-F1EE475K	Panasonic
C23	U	4.7uF	ECS-F1EE475K	Panasonic
C24	U	4.7uF	ECS-F1EE475K	Panasonic
C25	U	2.2nF	BF014D0222J	AVX
C26	U	4.7uF	ECS-F1EE475K	Panasonic
C27	U	4.7uF	ECS-F1EE475K	Panasonic
C28	U	4.7uF	ECS-F1EE475K	Panasonic
C29	U	4.7uF	ECS-F1EE475K	Panasonic
C30	U	4.7uF	ECS-F1EE475K	Panasonic
C31	U	1nF	BF014D0102J	AVX
C32	U	1nF	BF014D0102J	AVX
C33	U	1nF	BF014D0102J	AVX
C34	U	1nF	BF014D0102J	AVX
C35	U	100nF	BF014D0104J	AVX

Diodes

Part Reference Number	Board (L =Lower) (U =Upper)	Component Value	Part Number	Manufacturer
D1	L	1N5819	1.0 Amp 40V Schottky	Numerous
D2	L	1N5819	1.0 Amp 40V Schottky	Numerous
D3	U	2.0Volts	500 mW	Special order
D4	U	3.9Volts	BZX55C 500mW	Rohm
D5	U	3.9Volts	BZX55C 500mW	Rohm
D6	U	9.0Volts	BZX55C 500mW	Rohm
D7	U	11Volts	BZX55C 500mW	Rohm
D8	U	2.0Volts	500 mW	Special order
D9	U	1N5819	1 Amp 40V Schottky	Numerous

Potentiometers are 25 multiturn

Part Reference Number	Board (L =Lower) (U =Upper)	Component Value	Part Number	Manufacturer
P1	L	100k	3296X-104	Bourns
P2	L	100k	3296X-104	Bourns
P3	L	100k	3296X-104	Bourns
P4	L	100k	3296X-104	Bourns
P5	U	1k	3296X-102	Bourns

Integrated Circuits

Part Reference Number	Board (L =Lower) (U =Upper)	Component Value	Manufacturer
Q1	L	LM78L05 (TO 92)	ST Microelectronics
Q2	L	LM78L05 (TO 92)	ST Microelectronics
Q3	U	LM317LZ (TO-92)	ST Microelectronics
U1	L	M74HCT14 (CMS)	Supplied
U2	L	M74HCT14 (CMS)	Supplied
U3	L	LM348N (DIP 14)	ST Microelectronics
U4	U	MAX333ACPP or MAX333AEPP (DIP 20)	Maxium
U5	U	MAX333ACPP or MAX333AEPP (DIP 20)	Maxium
U6	U	AD713JN (DIP 14)	Analog Devices
U7	U	AD976AN 100Kps or AD976AAN 200Kps (DIP 28)	Analog Devices
U8	U	74HCT157 (DIP 16)	ST Microelectronics
U9	U	KAF-0401 (DIP 24)	Kodak
U10	L	AQV-210E (DIP 6)	Aromat/NAIS

Supports and Connectors

Part Reference Number	Board (L =Lower) (U =Upper)	Description	Part Number	Manufacturer
CL1	L	Interconnects Single Row	1-534237-2	AMP
CL2	L	Interconnects Single Row	1-534237-2	AMP
CU1	U	Single Row Pin Header	890-39-036-10-800 (Cut)	Mill-Max
CU2	U	Single Row Pin Header	890-39-036-10-800 (Cut)	Mill-Max
JP1	U	Single Row Pin Header	890-39-036-10-800 (Cut)	Mill-Max
GND	L	Single Row Pin Header	890-39-036-10-800 (Cut)	Mill-Max
TB1	L	Single Row Pin Header	890-39-036-10-800 (Cut)	Mill-Max
TB2	U	Single Row Pin Header	890-39-036-10-800 (Cut)	Mill-Max
TB3	U	Single Row Pin Header	890-39-036-10-800 (Cut)	Mill-Max
DB15	L	Board to wire connector	532530510	Molex
DB15A	L	Board to wire connector	532530610	Molex
FAN	L	Board to wire connector	532540210	Molex
S1	U	Board to wire connector	532530210	Molex
U3	L	DIP 14 Socket Carriers	614-93-314-31-012	Mill-Max
U4	U	DIP 20 Socket Carriers	614-93-320-31-012	Mill-Max
U5	U	DIP 20 Socket Carriers	614-93-320-31-012	Mill-Max
U6	U	DIP 14 Socket Carriers	614-93-314-31-012	Mill-Max
U7	U	DIP 28 Socket Carriers	614-93-328-31-012	Mill-Max
U8	U	DIP 16 Socket Carriers	614-93-316-31-012	Mill-Max
U10	L	DIP 6 Socket Carriers	614-93-306-31-012	Mill-Max
Jumper (Qty 4)	L + U	.025 Square pin jumpers	999-39-210-02-000	Mill-Max
Power Connector (DB15S)	L	Waterproof Connector	Special Order	Genesis
DB25 PC data connector (DB 25S)	L	Waterproof Connector	Special order	Genesis
Molex wire harness	L	5 pin wire to board harness	Custom made	Molex
Molex wire harness	L	6 pin wire to board harness	Custom made	Molex

Camera Case and Hardware

Component	Quantity	Material	Clarification	Supplier
Heat Sink	1	Aluminum / Black Anodize	Base of Camera	Genesis
Set screws	4	Steel 4-40 X 1/2" long	Heat sink fan standoff hardware	Genesis
Fan Standoffs	4	Aluminum / Black Anodize	1/4 dia. w /4-40 thread I.D.	Genesis
Pan head screws	4	Nylon 4-40 X 1 3/8" long	Fan mounting hardware	Genesis
Washers	8	Nylon 5/16 dia. X .032 thick	Fan mounting hardware	Genesis
Sorbothane shock mounts	8	Sorbothane	Fan vibration isolators	Genesis
Cold Finger	1	Aluminum	CCD drain / Peliter contact	Genesis
Thermal grease	1	Various	Peliter interface material	Various
Peltier	1	Part# CP 1.0-63-08L	30 X 15 X 4 mm	Melcor
Socket head set screw	8	Nylon 6-32 X 1/2" long	Cold Finger mounting hardware	Genesis
Pan head screws	2	Nylon 2-56 X 1/4 0r 1-64 X 1/4	CCD mounting to cold finger	Genesis
Central Body Tubing	1	Aluminum / Gold Anodize	80 X 80 mm tubing w/ 2mm wall thickness	Genesis
Set screws	4	Steel 8-32 X 3/4" long	Board stand off screws	Genesis
Board Standoffs	4	Aluminum 1/4 dia. X 1/4" long	8-32 lower board standoff	Genesis
Board Standoffs	4	Aluminum 1/4dia. X 1" long w/ 8-32 I.D. thread	8-32 upper board standoff	Genesis
Top Cover	1	Aluminum / Black Anodize	Top camera cover	Genesis
Glass Retaining Ring	1	Aluminum / Black Anodize	Glass Retainer	Genesis
Port hole glass	1	Part # K54-050	40.2 mm X 2.1 mm thick UV longpass glass	Edmund Scientific
Low head socket set screws	4	Steel 6-32 X 1/4" long	Glass retaining ring screws	Genesis
T-Ring Adapter	1	Aluminum / Black Anodize	2 3/8" Diameter Ring w/ 42 mm X .75 I.D. thread	Genesis
Cap head socket set screws	4	Steel 6-32 X 5/16" long	Retaining ring screws	Genesis
Optical Tube	1	Aluminum / Black Anodize	1 1/4 Diameter threaded tube	Genesis
Low head socket set screws	4	Steel 8-32 X 1/2" long	Top cover screws	Genesis
O Ring seals	2	Silicone 60 durometer	80 X 80 mm square (custom)	Genesis
O ring seals	4	Silicone / Steel	8-32 cover seals	Genesis
Hex head DB screws	4	Stainless Steel	4-40 Standoff screws	Genesis
DB25 IDC connector (Female)	1	Various	External mating IDC cable connector	Genesis
DB25 IDC connector (Male)	1	Various	External mating IDC cable connector	Genesis
DB15S Power Connector	1	Custom Part	External mating connector	Genesis
Fillister slotted screw	2	Nylon 4-40 X 1/4"	DB25 hold down	Genesis
Delrin Standoff	1	Delrin / Black 7/16 dia.	Shutter Standoff	Genesis
Ball Bearing	1	Nylon 3/16 dia.	Shutter height adjuster	Genesis
Cap head socket set screw	1	4-40 X 1/4"	Shutter standoff hold down	Genesis
Socket set screw	1	6-32 X 1/8" cup point	Daco lock screw for Standoff	Genesis
Socket set screw	1	6-32 X 3/16" cone point	Ball bearing adjusting screw	Genesis
Fan	1	FBA08T12H / Hydro-Wave	Muffin fan / modified for Sorbothane w/ Molex connector	Panasonic/Genesis
Fan guard	1	80 X 80 X 3.05 (Modified)	Black plastic fan guard modified for Sorbothane	Qualtek/Genesis
O ring	2	Silicone 60 durometer	80 X 80 case seal	Genesis
O ring	1	-027 Silicone 60 durometer	Glass port hole seal	Genesis
Dome head socket cap screw	1	6-32 X 3/16" with O ring (black)	Sealing case access hole	Genesis

Special order

IDC Hood	2	Black plastic IDC hood with thumb lock screws	Special Order	Genesis
Cable Hood	2	Black plastic round cable entry hood with thumb screws	Special Order	Genesis
Daco Shutter	1	3/8" Diameter case 60° Swing	For KAF-0401 series	Genesis
Daco Shutter	1	7/16" Diameter case 70° Swing	For KAF-1600 series	Genesis

Price Schedule

The pricing schedule of the Genesis CCD camera has been broken down into many options. If you cannot find a materials package to fit your need, please contact us. Custom kits may be an option.

- **Upper and Lower circuit boards with Mill-Max CCD standoff pins and diode solderless pins mounted. SMD chips will be mounted on the lower board.**
  $79.00 US

- **Upper and Lower circuit boards with Mill-Max CCD standoff pins and diode solderless pins mounted. SMD chips will be mounted on the lower board. Sealed DB-15 power and DB25 connectors with mating DB-15 external connector.**
  $140.75 US

- **Upper and Lower circuit boards with Mill-Max CCD standoff pins and diode solderless pins mounted. SMD chips will be mounted on the lower board. Sealed DB-15 power and DB25 connectors with mating DB-15 external connector. Complete discrete electronic components package for board assembly. The A/D converter will be AD976A. (No CCD)**
  $260.70 US

- **Upper and Lower circuit boards with Mill-Max CCD standoff pins and diode solderless pins mounted. SMD chips will be mounted on the lower board. Sealed DB-15 power and DB25 connectors with mating DB-15 external connector. Complete discrete electronic components package for board assembly. The A/D converter will be AD976AAN. (No CCD)**
  $276.96 US

- **Full Camera kit supplied with all components necessary to produce one Genesis CCD camera using a AD976A A/D (100 Ksps.) converter. (No CCD, power supply, Daco shutter)**
  $758.25 US

- **Full Camera kit supplied with all components necessary to produce one Genesis CCD camera using a AD976AAN A/D (200 Ksps.) converter. (No CCD, power supply or Daco shutter)**
  $773.26 US

- **Assembled and tested Genesis CCD camera with Daco large shutter, sensor selected customer specifications. (Power supply and CCD sensor are additional to listed pricing).**
  $1035.00 US

- **Linear power supply providing +-15VDC and 5VDC @ 3 Amps 1 mV P-P Rms.**
  $65.00 US

- **Daco Shutter (small) $82.00 US**
- **Daco Shutter (large) $87.00 US**

Apendix C – Inter Board Pin Out

Connectors CU1 - CL1

PIN#	UPPER BOARD CU1	FUNCTION	LOWER BOARD CL1
1	U5-2, U5-9	+0.5V V-CLK-HI-SRC	U3-1, C9+
2	U5-4, U5-7	-8.0V V-CLK-LOW-SRC	U3-7,C11-
3	U4-5,U5-5,U6-10,R22,C24-,R7	-15V	DB15A-1, D2,C2-, P2 ,P4, U3-11
4	TB3-6 TB2-1 U5-16,U5-14 U4-16 R6,14,15,16,17,21	+15V	DB15A-3, D1,C1, P1, P3, U3-4
5	U4-2, U4- 7	+6.0V H-CLK-HI-SRC	U3-8, C10+
6	U4-11	P5 Clamp-CLK-CTRL	U1-6<U1-5, DB25-6 (d4)
7	U4-1,U4-10	P3 H1+ H2-CLK-CTRL	U1-12<U1-13 DB25-4 (d2)
8	U4-20	P4 CCD-Reset-CLK-CTRL	U1-4<U1-3 DB 25-5 (d3)
9	U5,10	P2, V2-CLK-CTRL	U1-10<U1-11 DB 25-3 (d1)
10	U5,11	P9, V0/VDD-CTRL Enable	DB15-3,U1-2<U1-1 DB25-1 (Strobe)
11	U5-1	P1, V1-CLK-CTRL	U1-8<U1-9, DB25-2 (d0)
12	TB3-3	Thermal Sensor	R5, (DB15-2)
13	TB3-2	Thermal Sensor	DB15-1
14	TB3-1	P10 Shutter-CTRL	DB15A-6, R1-(U10-1), U2-8<U2-9, DB25-14 (autofeed)

Connectors CU2 - CL2

PIN#	UPPER BOARD (CU2)	FUNCTION	LOWER BOARD (CL2)
1	U4-4, U4-9	-4.0V H-CLK-LO-SRC	U4-14, C12-
2	U7-27,C29+,C35+,R26	+5Volts-Analog	Q1-2 out,,C3+,
3	Analog Ground Plane	Ground- Analog	Analog Ground Plane
4	U7-24	P6 A2D-Convert-CTRL	U2-6<U2-5, DB25-7 (d5)
5	D9, S1-1 (-Black)	Shutter-Actuate (Low Active)	U10-6
6	D9,S1-2 (Red+)	+12Volts-Shutter/Fan	Fan, DB15A-4
7	U7-23	P7 A2D-BYTE-CTRL	U2-4<U2-3 DB25-8 (d6)
8	TB3-5,U7-28,C28+,U8-16,C30+	+5Volts-Digital	Q2-2out,C4+,TB1-3,RES2-1,U1-14,U2-14
9	Upper Ground Digital Plane	Ground-Digital	Lower Digital Ground Plane
10	U8-1	P8 MUX-NIBBLE-CTRL	U2-2<U2-1 DB25-9 (d7)
11	U8-4,C34	MUX-01Y (output LSB)	DB25-13 (selectED!)
12	U8-7,C33	MUX-02Y (output 2nd LSB)	DB25-12 (nopaper)
13	U8-12,C31	MUX-04Y (output 4th LSB MSB)	DB25-11 (busy)
14	U8-9,C32	MUX-03Y (output 3rd LSB)	DB25-10 (ack)

DB15 Molex Connector

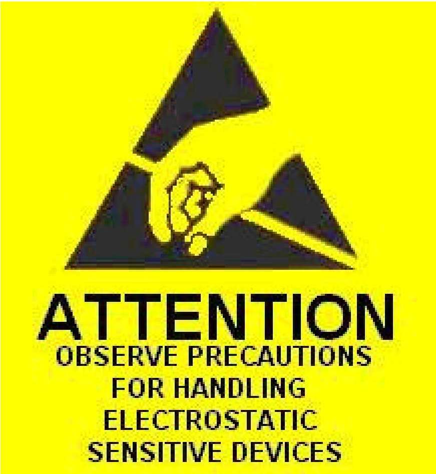
PIN #	FUNCTION	COLOR CODE
1 to DB15-7 (Audine-DB-15-14)	Thermal Sensor CL1/CU1-12 (TB3-2)	Brown
2 to DB15-8 (Audine-DB-15-15)	Thermal Sensor ,R5, CL1/CU1-13TB3-3	Purple
3 to DB15-9 (Audine-DB-15-12)	AUX1/VDD-CONTROL,CL1/CU1-12 (U5-11) U1-2<U1-1,P9, DB25-10 (strobe)	White
4 to DB15-10 (Audine-DB-15-10)	AUX2: U2-10<U2-11 (init)	Grey
5 to DB15-11(Audine-DB-15-9)	AUX3: U2-12<U2-13, DB25-17 (select)	Yellow

DB15A Molex Connector

PIN #	FUNCTION	COLOR CODE
1 to DB15-1 (Audine-DB-15-3)	-15Volts	Black
2 to DB15-2 (Audine-DB-15-2/13)	Ground Logic (+-15V)	Green
3 to DB15-3 (Audine-DB-15-1)	+15V	Red
4 to DB15-4 (Audine-DB-15-8)	+12V (Fan/Shutter)	Orange
5 to DB15-5 (Audine-DB-15-6/7)	12V Ground (Fan/Shutter)	Green
6 to DB15-6 (Audine-DB-15-11)	Shutter Control,U2-8<U2-9,R1,CL1-14, DB25-14 (autofeed), TB3-1(optional hookup on upper board)	Blue

Apendix D – Constrcution Tips

Electrostatic Safety



The fundamental aspect of matter which permits the flow of electricity is the existence of free electrons in that matter. The electrical resistance of a material is defined by how many electrons exist in the material. Metals, for example, have many free electrons so it is relatively easy to generate a current flow from them. Insulators, on the other hand, have relatively few free electrons, so current flow is, therefore, lower. The characteristics of insulators is that they do not allow the redistribution of electrical charge across their entire surface. This keeps a local electrical charge from building up. This is static electricity, and it leads to electrostatic discharge (**ESD**) that damages electronic devices.

The amount of moisture in the air is the humidity, and it can determine the amount of electrical charge an object can hold. The air resistance can control this charge, and will "bleed off" electrostatic charge. This explains why **ESD** will happen more in the wintertime when humidity is low and air resistance is high. The threshold of feeling electrostatic charge is around 4,000 volts. Any potential below 4,000 volts cannot be felt, but is still dangerous to electronic equipment. If the static spark is heard, then it is in the range of 5,000 to 50,000 volts. It is quite possible for the human body to have an electrostatic charge of 35,000 volts!

There are times when electronic components are affected by **ESD** (soft faults). These faults do not appear immediately because the damage is on a molecular level. Over time, 60 days to 9 months, the component fails. Statistics indicate that 90 present of all **ESD** may be of this type. It is difficult to detect because it will take 60 days to 9 months for failure to occur, the only other way it will appear in the component is in reduced performance until failure. Electronic components can be identified by class according to electrostatic discharge capability. Class-1 is the most sensitive, CCDs, Mosfets, Jfets, and A/D converters. Class-2 is less sensitive, its range is in the 1,000 to 4,000 volt area. Lastly, Class-3 with the least sensitivity has a range of 4,000 to 15,000 volts.

The key to a good program for controlling **ESD** is found in creating an environment that is protected against generating static electricity. The environment must consider things such as floors, workbenches, materials, equipment, and operating procedures. At the very least, one must equip themselves with an electrostatic wrist strap, portable protective work mat, and protection for the parts being placed into the unit. An elaborate facility may include a grounded workbench made of **ESD** protective materials, humidity controls, and air ionizers in addition to the above. In the lists below, the terms "hard ground" and "soft ground" will be used. The term hard ground means that the item is connected to ground through copper or aluminum wiring, while the term soft ground means that it is through a resistance.

Work Area

The work area should be controlled access, which means that people should be kept out unless they understand the procedure of **ESD** and handling. The surrounding work area (approx. 5 feet) should be avoided.

- No tapes (3M magic, masking) except where installed and removed under controlled ionization.
- No vinyl-covered notebooks or instruction folders.
- No telephones, unless designed for the area.
- No plastic note holders, penholders, and calendar holders.
- No plastic cased vacuum cleaners or heat guns.
- No unapproved soldering irons.
- No unapproved solder suckers.

Floors are very important in protecting against **ESD** damage. Only use conductive, static dissipative floors, anti-static carpeting, conductive vinyl, or terrazzo floor tiles that are used with conductive adhesive. Use conductive wax on floors, or leave them un-waxed. Static charge builds up on normal wax. Painted or sealed concrete floors should be covered with grounded **ESD** floors mats, or treat them with a topical anti-static compound if no floor mats are available. Use of a grounded floor is not terribly useful if the individual is not soft grounded. It helps to use conductive shoes or heel grounders. Conductive work stools or chairs should also be used.

Work Benches

Workbenches should be set on conductive flooring or mat with a protective wrist strap on the bench that grounds the worker. It should have a resistance that limits current flow to 5 mA, the threshold of perception of voltages that will be worked on at the bench. So, for 240 volts, this means that the resistance should be higher (240/0.005 = 48,000 ohms).

The Bench top material should be a conductive material. Glass and Formica are not suitable materials. A wood or metal table top with an anti-static mat would be more suitable.

There are two types of **ESD** wrist straps: carbon impregnated plastic and insulated metal conductor. The carbon-impregnated type distributes the resistance over its entire length, so it should be insulated against touching hard grounds. The insulated metal conductor type contains a built-in resistor. The strap should include an alligator clip or snap or another form of quick disconnect.

Equipment

The equipment used on the **ESD** workbench should be designed for the purpose. **Solder** equipment should be 3 wire types with grounded tips. The resistance of the tip to hard ground should be 20 ohms or less, so that the voltage buildup will be less than 15 volts. Solder suckers used should be **ESD** types, which means at least they will have conductive tips. All exposed metal surfaces on metal equipment should be hard grounded. However, the test equipment should not be set directly on the workbenches conductive surfaces, for fear of rendering the surface and the person using the equipment at hard ground potential. Ground fault interrupters (GFI) should be used on all outlets on the workbench.

Clothing

People handling **ESD** sensitive electronic products should be properly attired when doing so. They should be wearing long-sleeve smocks or close fitting shirts. Never use smocks or gloves made of common ordinary plastic, as it is not **ESD** safe. A good precaution is to use static control towelettes in the clothes dryer to help control static buildup. I have myself worn a cotton T-shirt under a sweat shirt, was **ESD** protected with wrist strap, using proper precautions; only to find out, when it was ready to retire that evening in the dark, to watch the “fireworks” show when I disrobed. Oh well, we will see what happens in about 2 to 9 months!

ESD Protective Materials

Protective materials should be used to protect electronic products containing **ESD** sensitive components. Chips should not be removed from their foam carriers or tubes until they are ready for use. It is only once the component is mounted on its circuit board is greatly minimized. The finished, printed circuit boards should be stored in **ESD** protective bags, wrappings or boxes until use.

Conclusion

ESD protection is not a very difficult thing to do, and is so very important in electronics. It is a limited and low impact concept, so should be done whenever electronic gear is being handled and serviced.
The **ESD** icon will be used throughout the web site to draw attention and awareness in handling sensitive electronic components.

Tools

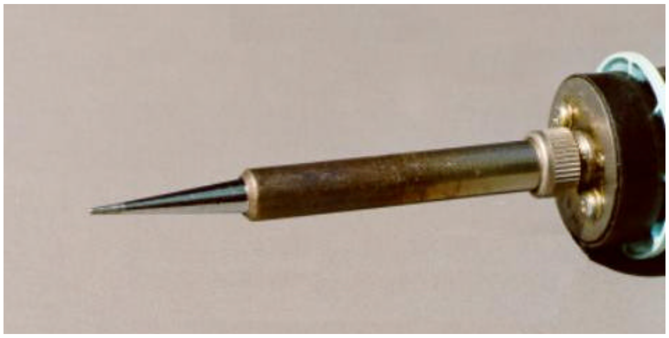
For constructing the Genesis camera we recommend using the tools listed for effortless assembly and quality construction. For most electronic assembly these tools are indispensable.

- A quality soldering iron preferably with a manual temperature setting control or a pencil type 40 watt iron with a fine tip.
- A Wire Solder of the type SN63PB37 with a diameter of .031 is recommended for the assembly of the PC boards. This will assure proper contact joints and allows a proper amount to be dispensed in the desired location. We feel it is a good choice for the whole assembly of the camera electronics.
- Solder Braid with a width of .030 made of braided copper that will aid in the removal of solder if a component is improperly placed on the PC Boards. A solder sucker (vacuum) with an **ESD** safe tip may also be used.
- Speedy bend lead formers are an inexpensive tool we recommend, that will greatly improve the finished look of your camera. It will provide uniform bends to the component leads and allow the parts to sit properly on the PC boards.
- Wire strippers that can accommodate hookup wire sizes as small as 28 AWG
- Wire cutters (nippers) with very narrow cutting head for working in close spaces.
  Allen hex key wrench set with the size range of .050 through 5/32. These sets come in a molded plastic holder and are also available with ball ends. Used in assembly of camera housing and maintenance of unit.
- Precision screwdriver set for setting multi-turn potentiometers and also to aid in the assembly of the camera. Both flat tip and Phillips tip will be needed.
- Magnify glass for identifying some of the PC board silk screen legends and for those of us with aged vision to aid in the verification of assembly tasks.

A digital Multimeter equipped with test leads will be necessary to allow you to test for voltages as well as capacitance and resistance. A sophisticated unit of this type can be quite expensive. The possibility of purchasing a used unit on the Internet is a cost-effective way of acquiring this piece of indispensable equipment. **Ebay** is constantly a good source of units of this caliber. An oscilloscope is also a piece of test equipment that by far would be the most expensive device used in building the Genesis. On the **Audine** web site there are instructions for testing the clock signals with an oscilloscope. It is noted that if instructions are followed for the assembly and testing of the camera on this web site, a digital Multimeter will be all that is necessary for the construction.

The power supplied for the camera needs to be a stable source of +/- 15 DC Volts @ .4 Amps. One can be constructed by the builder to provide the voltages necessary to operate the device. It has been found to purchase a commercial linear power supply has the best potential benefits. A switching type can also be used, but it is advisable to filter out unwanted current ripple that these supplies produce. Again, **Ebay** has been a good source for acquiring units of this type at a reasonable cost. A supply of 5 Volts DC @ 3 Amps is needed for **Peltier** operation. This is discussed on a page devoted to this application. And last a supply of 12 Volts DC @ .05 Amps is needed for the cooling fan operation and shutter supply voltage.

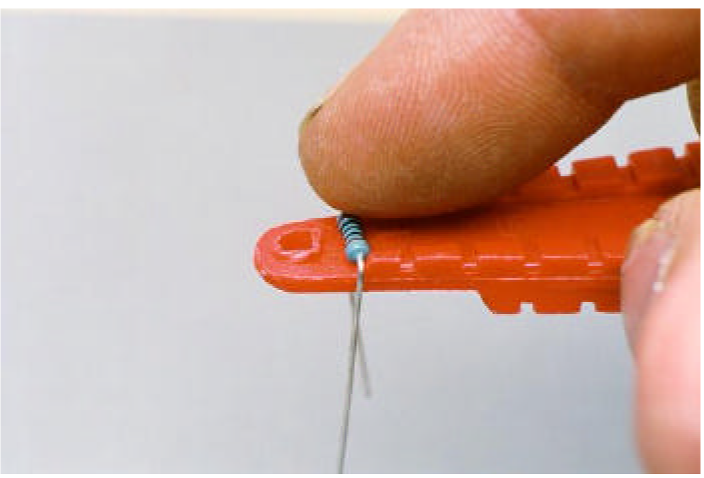
Good lighting is indispensable in the assembly of the camera. It will aid you in the proper placement and assembly of the components. The fine work is sometimes very trying on the eyes. For most, assembly will be done during the evenings, so this will be a necessity



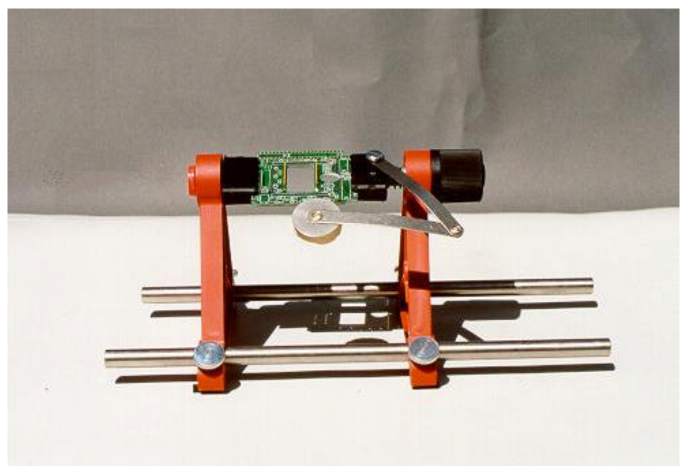
We recommend a soldering iron with a fine tip as is illustrated in the picture.

A solder vice or other holding apparatus will be used in the assembly of the PC boards, and wiring of the DB connectors. A commercial unit as pictured can be used, or a simple small swivel vice is also adequate. For a cost-effective solution a small piece of wood with heavy copper wires inserted into it, with alligator clips on the ends will suffice.

Last, a PC computer will be needed for testing, and for the operation of the Genesis camera. A notebook type will be ideal for its portability in the testing of the camera as well as use in the field. A desktop personal computer will be equally effective. A PC of the Pentium class, with a low CPU rating will be perfectly suitable for use with the Genesis. At least 50 MB of hard drive space, as an estimate, will be necessary for installing software for both the testing and operation of the camera, as well as storage of your first images. Windows 95/98 must be the operating system on the PC.



A commercial soldering stand will make assembly straightforward.



Speedy bend lead formers are an inexpensive tool that will produce a uniform professional touch to your board assembly.

Soldering

Good practice in soldering components to circuit boards takes some patience and a planned approach.
From reviewing the page on, holding the components in place will require different forms of technique to make the soldering process simplified. Tapes are not a suitable material to hold components in place, unless they have been designated as **ESD** safe. Normally bending the leads of loose components, as they exit from the holes, is sufficient to hold them in place until soldering them permanently into the circuit boards is done.

If the component is larger, using your finger and tacking one lead to hold it in place will suffice. Be careful, parts do heat quickly! We have also found that using alligator clips and heavy gauge wire mounted in a wooden base is an excellent way of holding the boards. Commercial board holders are also an effective and efficient tool for this assembly process.

The solder, we have found that performs universally for all soldering operations of assembly is: SN62PB36, or for best results use SN62PB36AG02 which has silver content and produces stronger, cleaner joints.

We have found two tools to also be indispensable in soldering assembly work. In the event that a component is installed in the wrong place, or backwards it will be essential to remove it. An **ESD** safe, solder sucker will remove the bulk of the solder from the joints.

In the event that a more delicate or precise application is needed, copper wire braid will do the job nicely. To use the braid we would place it over the area of the component to be removed. Then, place the soldering iron on top of the braid. In a very short time you will observe the braid saturate with the solder to be removed. If the component is not free, repeat the same process with a fresh area of braid, cutting the saturated ends as you proceed. This requires a bit of patience to release the component from the PC board.

As you progress in installing components, cutting the excess leads from the components will be necessary. Using the fine wire snips, cut the leads flush with the solder joint at the pads. It is advised that the cut leads not be allowed to clutter your work area. In the future testing of the camera, the debris could prove to be disastrous, by shorting out contacts on the boards under voltage.

Good lighting is essential for assembly work. It will aid in the identification of components, as well as combating eye fatigue. For some of the components a magnifying glass will surely make reading the small markings very simple.

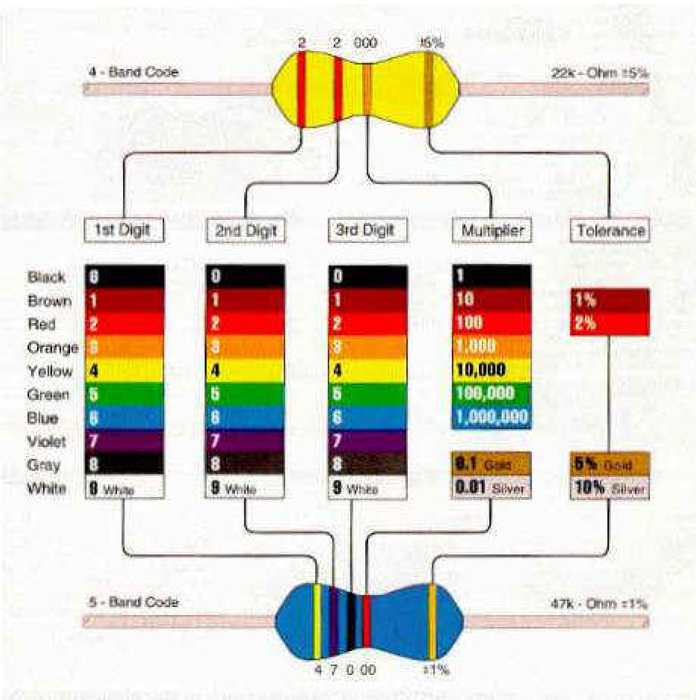
With careful attention to what has been outlined in this page, you are sure to accomplish quality work in your completed camera.

Recognizing Components

Lets take a moment to study the distinctive components, and gain a clear understanding of characteristics of these parts that are applied in the Genesis camera. Each type of component has markings that need to be deciphered, or for some polarities, must be observed for proper installation. In reviewing the different types we will be assured of a smooth assembly process.

Resistors

Many different values of resistors are used in the assembly of the Genesis. Therefore it is helpful to know how to identify the color coding values of the components. It is possible to check the values of this component using a digital mulitimeter set in the ohms setting. But for quick reference reading the color bands is just as effective. Below is a picture explaining the classification of the codes and how to read them. Resistors have no polarity.



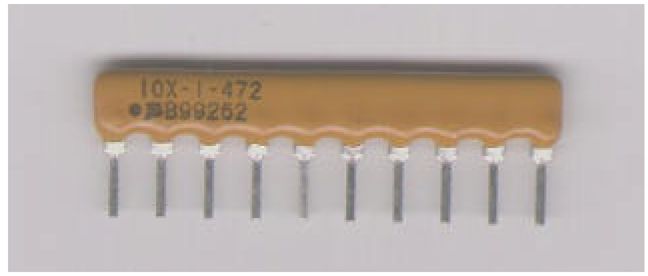


Figure A

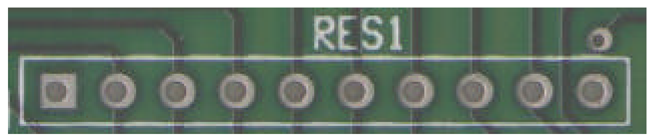


Figure B

Resistor networks do have polarity. Pin 1 of the network is identified by the small round black dot in the printed identification on the module as seen in (Fig A) on the left-hand side. The identification of pin 1 on the printed circuit boards is recognized by the square solder pad as seen in (Fig B).

Capacitors

Tantalum capacitors have polarity and this must be observed during installation. In looking at the photo (Fig A) we can see some markings that identify the component. The top number represents the value of 10µF for the component value. The second value has this component rated at 25 Volts. The vertical line denotes the positive leg of the capacitor. This positive lead is always longer to help with its identification. In the second photo (Fig B) we can see the silk screen outline on the printed circuit board. The side that has the white marking depicted around the mounting hole would be for the positive lead of the capacitor.

Metallized Polyester film capacitors have no polarity in their installation. The markings in (Fig C) show this component to have a value of 2.2 nF with a 63 volt rating. In the second photo (Fig D) the silk screen outline on the printed circuit boards.

Figure A

Figure B

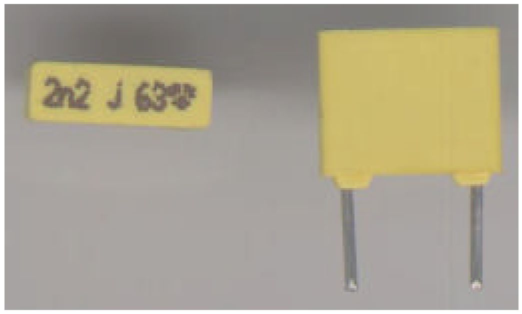


Figure C

Figure D

microfarads (µF)		nanofarads (nF)		picofarads (pF)
0.000001µF	=	0.001nF	=	1pF
0.00001µF	=	0.01nF	=	10pF
0.0001µF	=	0.1nF	=	100pF
0.001µF	=	1nF	=	1000pF
0.01µF	=	10nF	=	10,000pF
0.1µF	=	100nF	=	100,000pF
1µF	=	1000nF	=	1,000,000pF
10µF	=	10,000nF	=	10,000,000pF
100µF	=	100,000nF	=	100,000,000pF

Capacitance Conversion Chart

Diodes

The Genesis uses two different styles of diodes in the camera assembly. Diodes do have polarity and are identified by the circular printed band on one end of the body of the component. The plastic case style DO-204AL has the circular ring and component identification marked on the body of the part. The glass D0-41 type only has the circular ring printed on it. Great care must be used in handling the glass parts. It is very difficult to measure the values of these components if they are mixed up in the assembly process. They will be identified in the packaging clearly when purchased from Genesis. In the photos below we can see the two different components in (Fig A). In (Fig. B), we see the silk screen markings on the printed circuit boards. The heavy line on the right side of the circuit board outline corresponds to the ring on the diode.

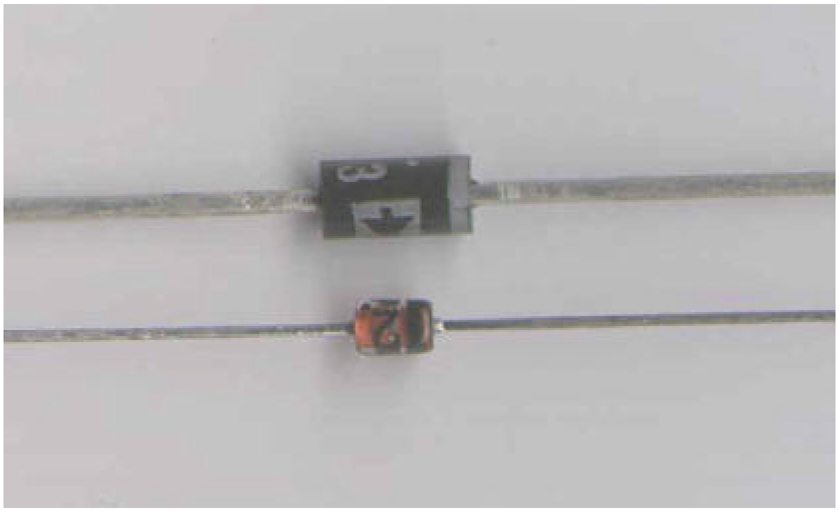


Fig A.

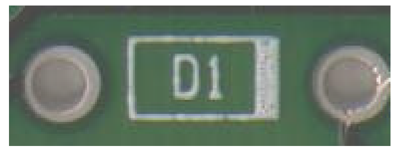


Fig B

Integrated Circuits

Integrated circuits come in many different package styles. Care must be taken when handling IC modules to ensure **ESD** does not damage them. Of the two types used in the Genesis, most are DIP style packages. Two IC modules of the SOIC type come pre-mounted on the lower printed circuit board (Fig B). In the pictures below we see two different DIP packages. The first thing we notice is the difficulty in reading the legend on the top module. Great care must be taken to insure proper placement of the modules in their identifiable places on the PC boards. It is advised to use good lighting and a magnify glass to be sure of the legend markings.

Pin 1 can be identified in different ways. Below we see two typical styles of identification in (Fig A). The top IC shows a dot on the lower left corner. In the second IC we see a half moon notch on the left side center. In both cases, pin 1 would be the lower left hand pin. In the picture (Fig B) the SOIC component is identified by the angle that runs along the length of the bottom edge. The small leg on the lower left hand corner is pin 1. The picture of the PC board in (Fig C) shows the silk screen outline depicting the left hand notch for orientation, with the square solder pad identifying pin 1. In all cases, where you visualize a square solder pad during construction, this will denote pin 1 of the component.

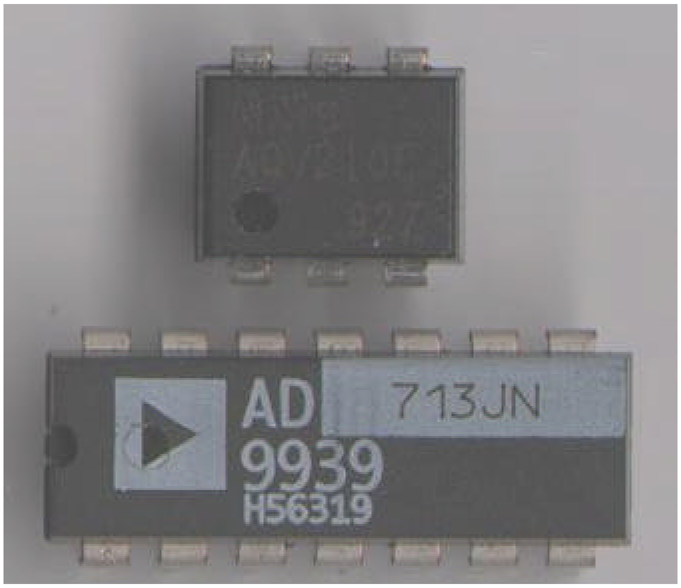


Fig A.

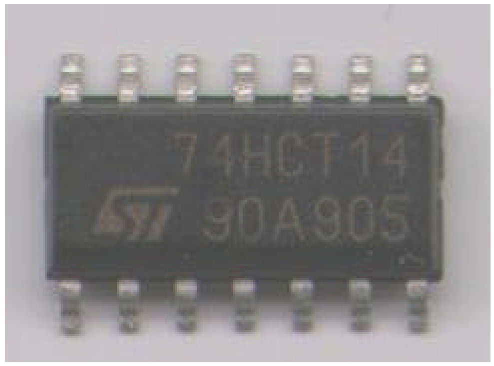


Fig B.

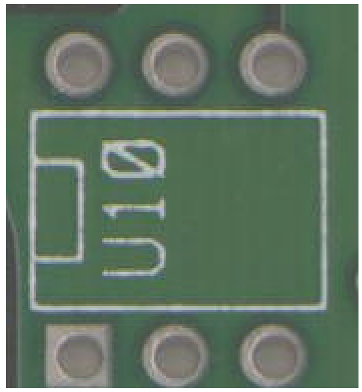
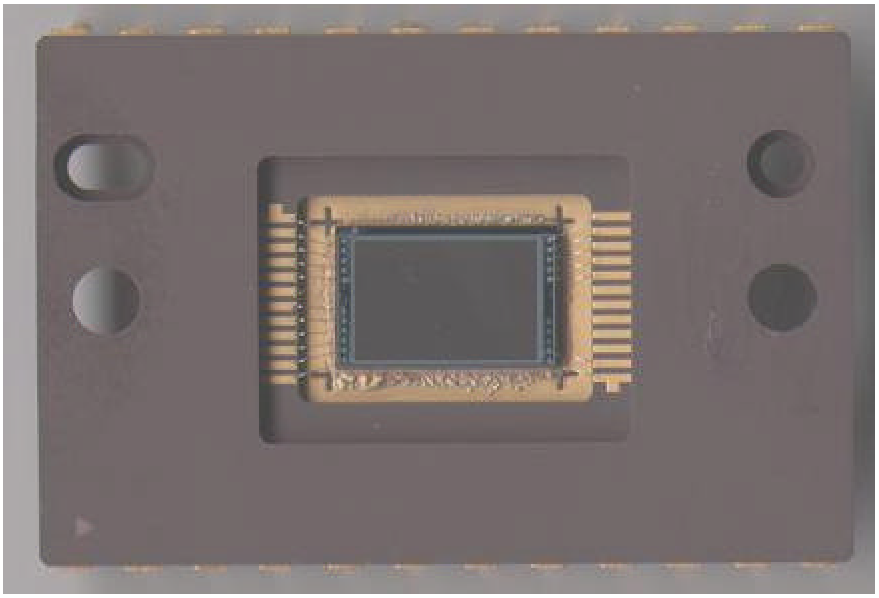


Fig C.

CCD

In the picture below, a Kodak KAF-0401 without the protective glass cover is shown. Great attention to detail must be observed for **ESD** handling procedures, particularly when handling the CCD sensor. In the photo please observe a small triangle etched into the ceramic surface of the CCD case. This identifies the pin on the lower left corner as number 1. The PC boards will have a square pad for pin 1 that will be difficult to detect because of the Molex mounting pins preset into the boards. A triangle mark is silk screened onto the PC boards to make identification of pin 1 straightforward.

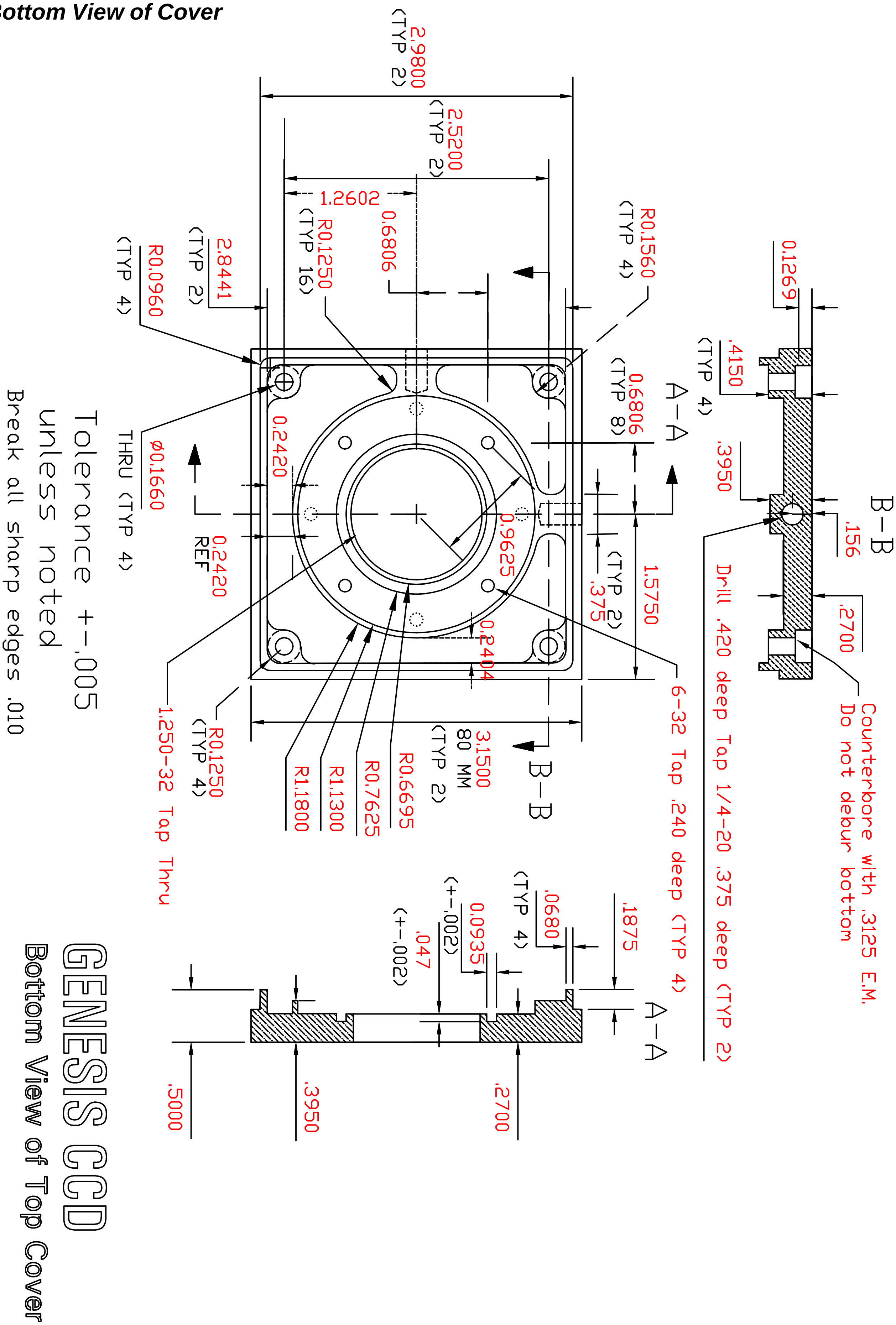


Unlisted components

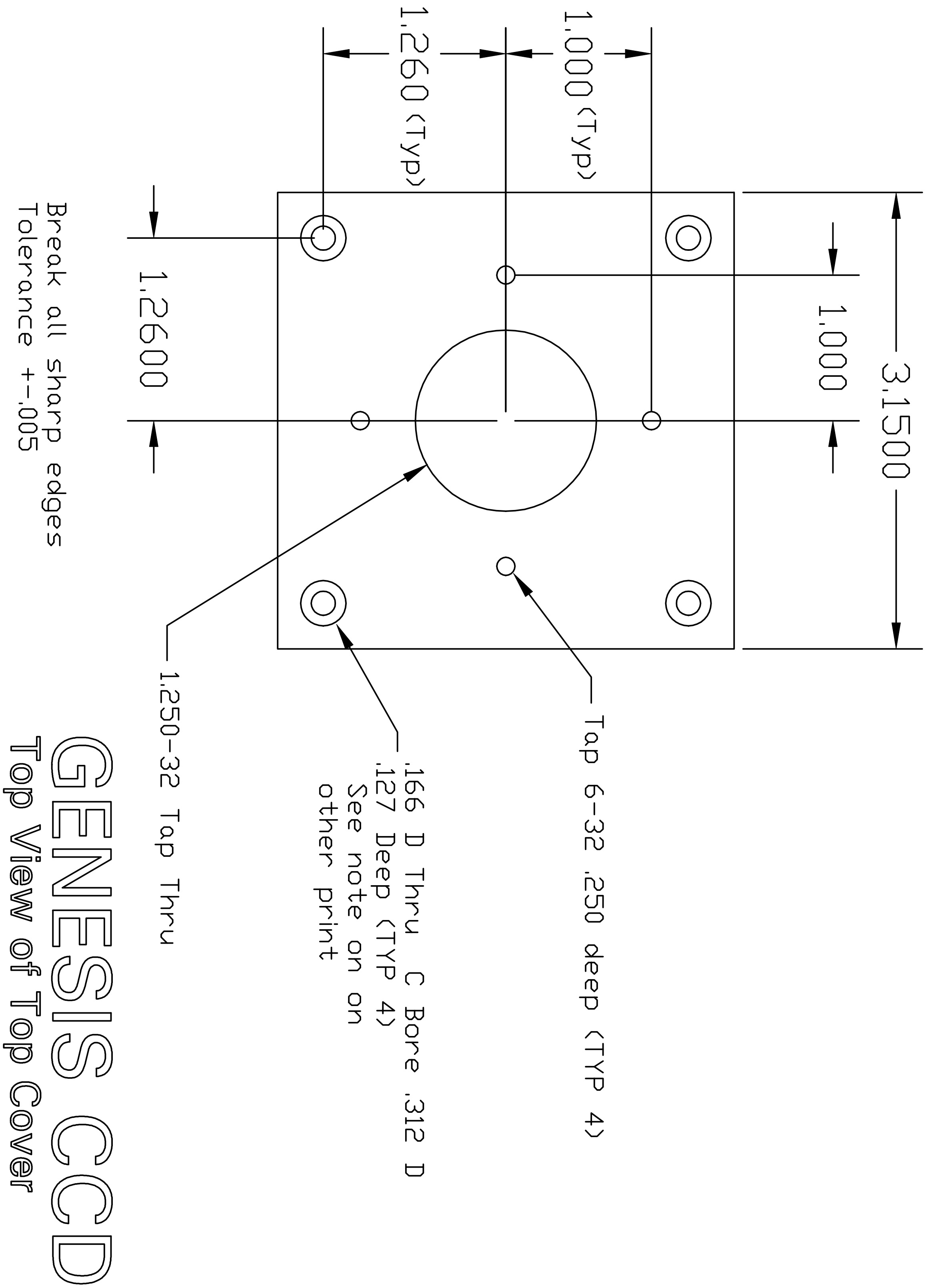
Some of the components used in the assembly of the Genesis have not been listed. Their placement will be aided by the assembly instructions and the silk screen outlines on the PC boards.

Appendix E - The Mechanical Files

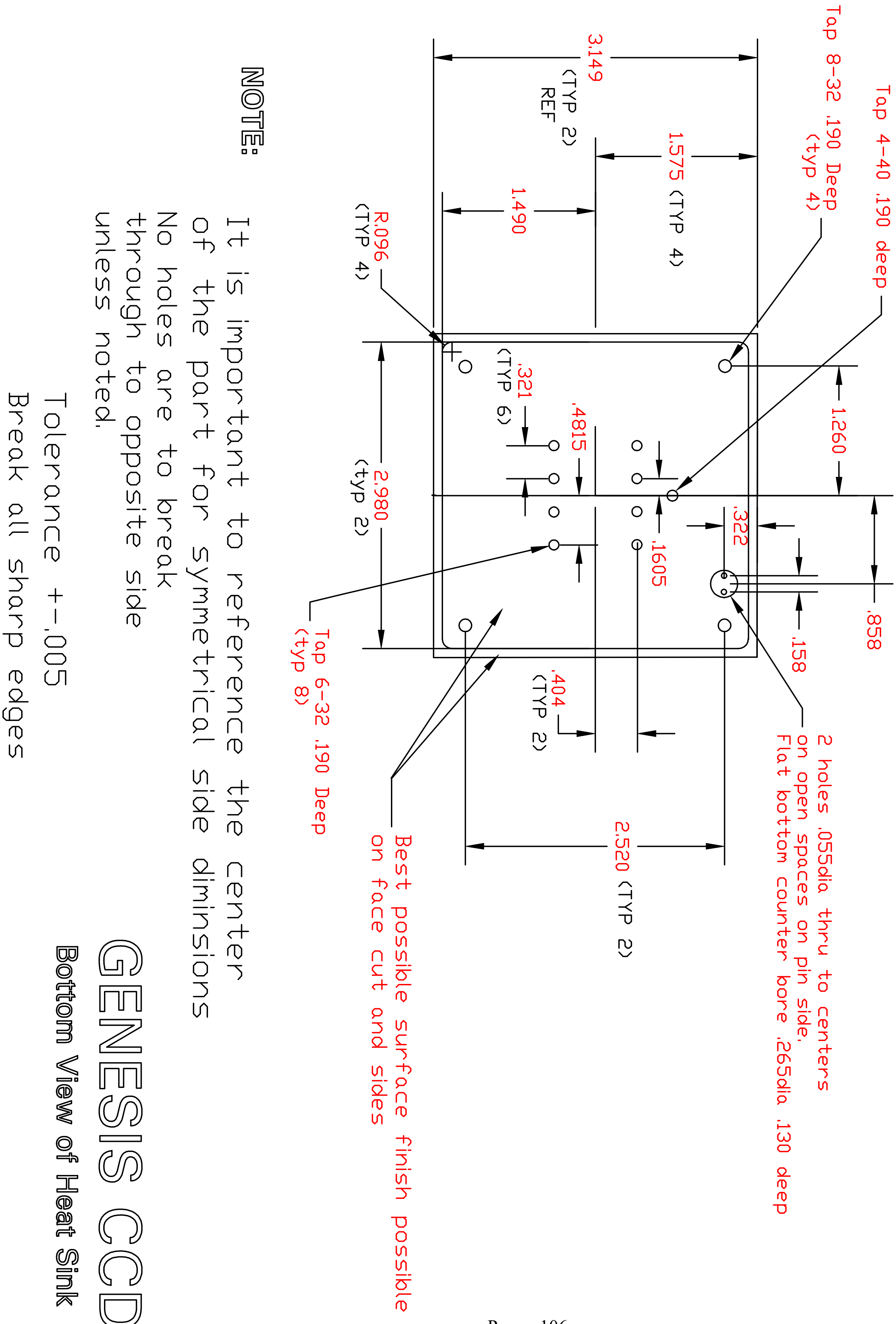
Bottom View of Cover



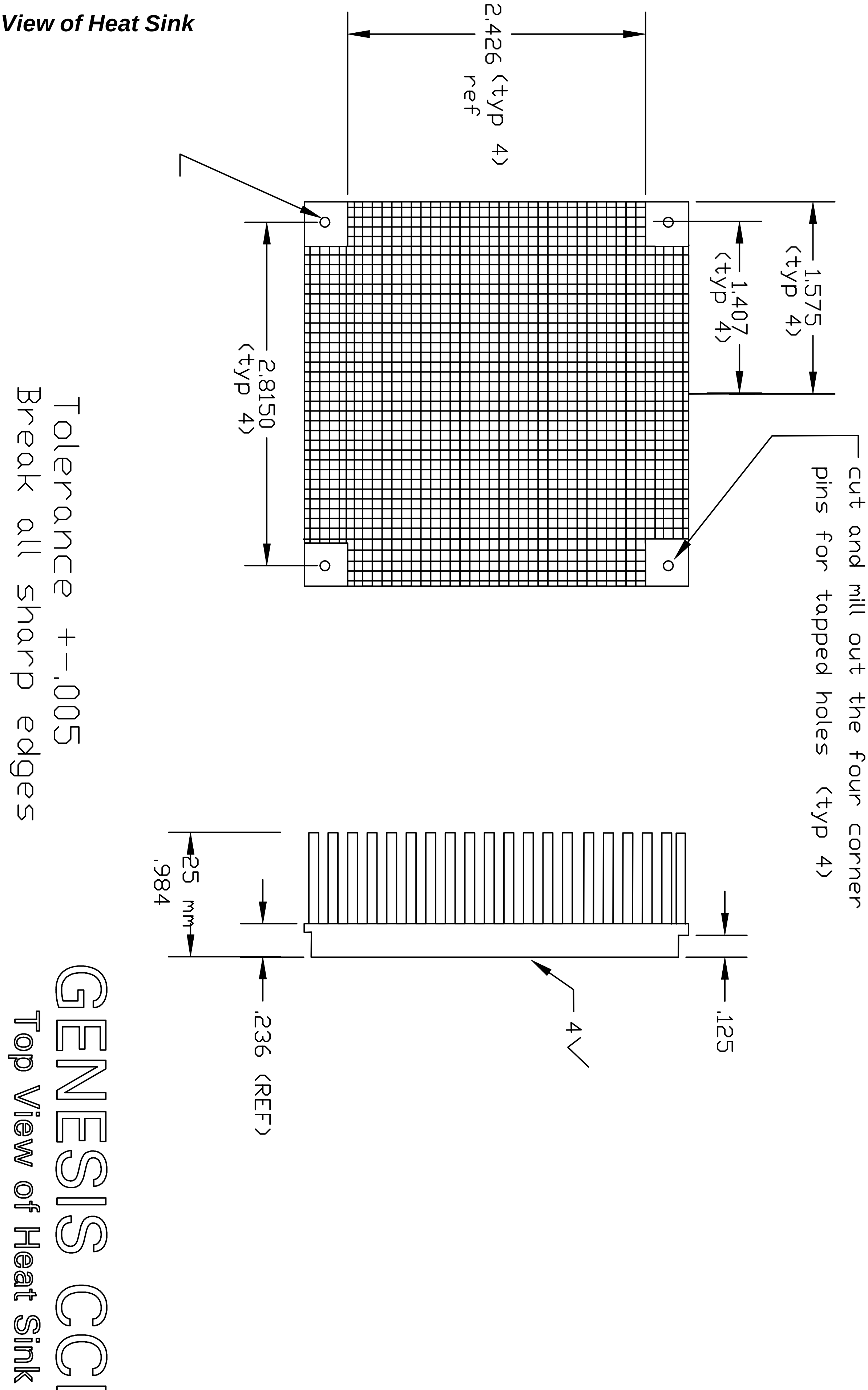
Top View of Cover



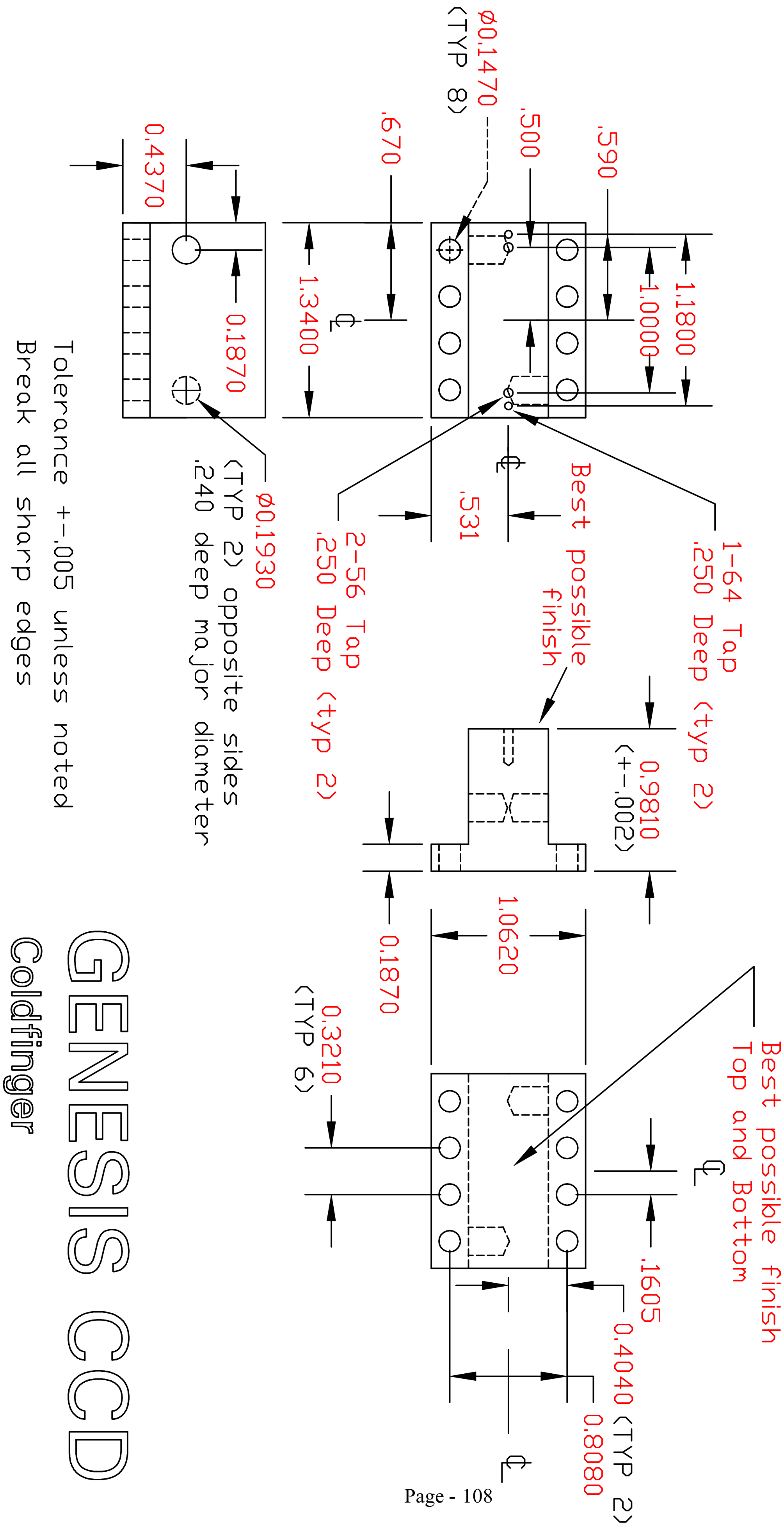
Bottom View of Heat Sink



Top View of Heat Sink

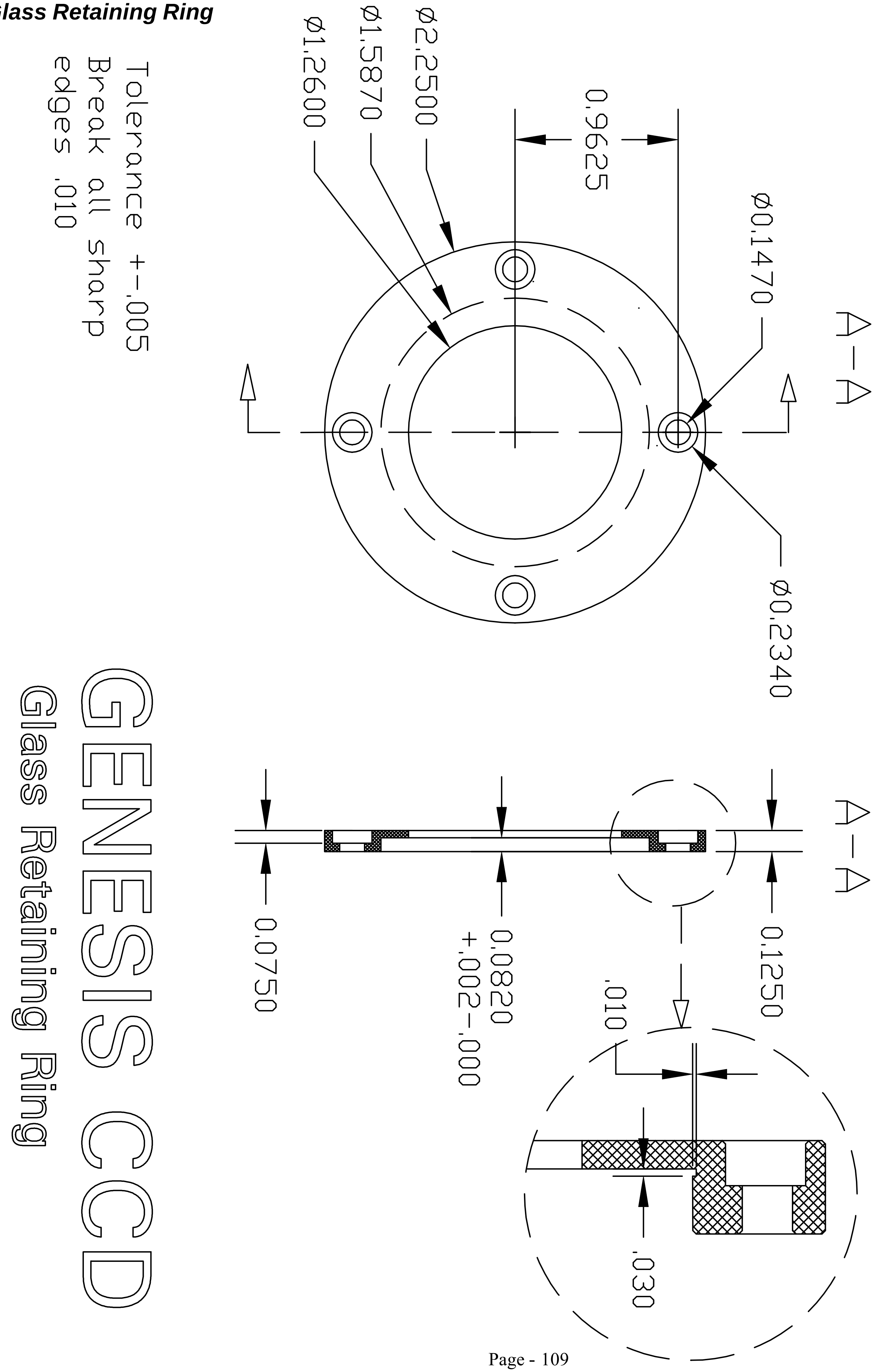


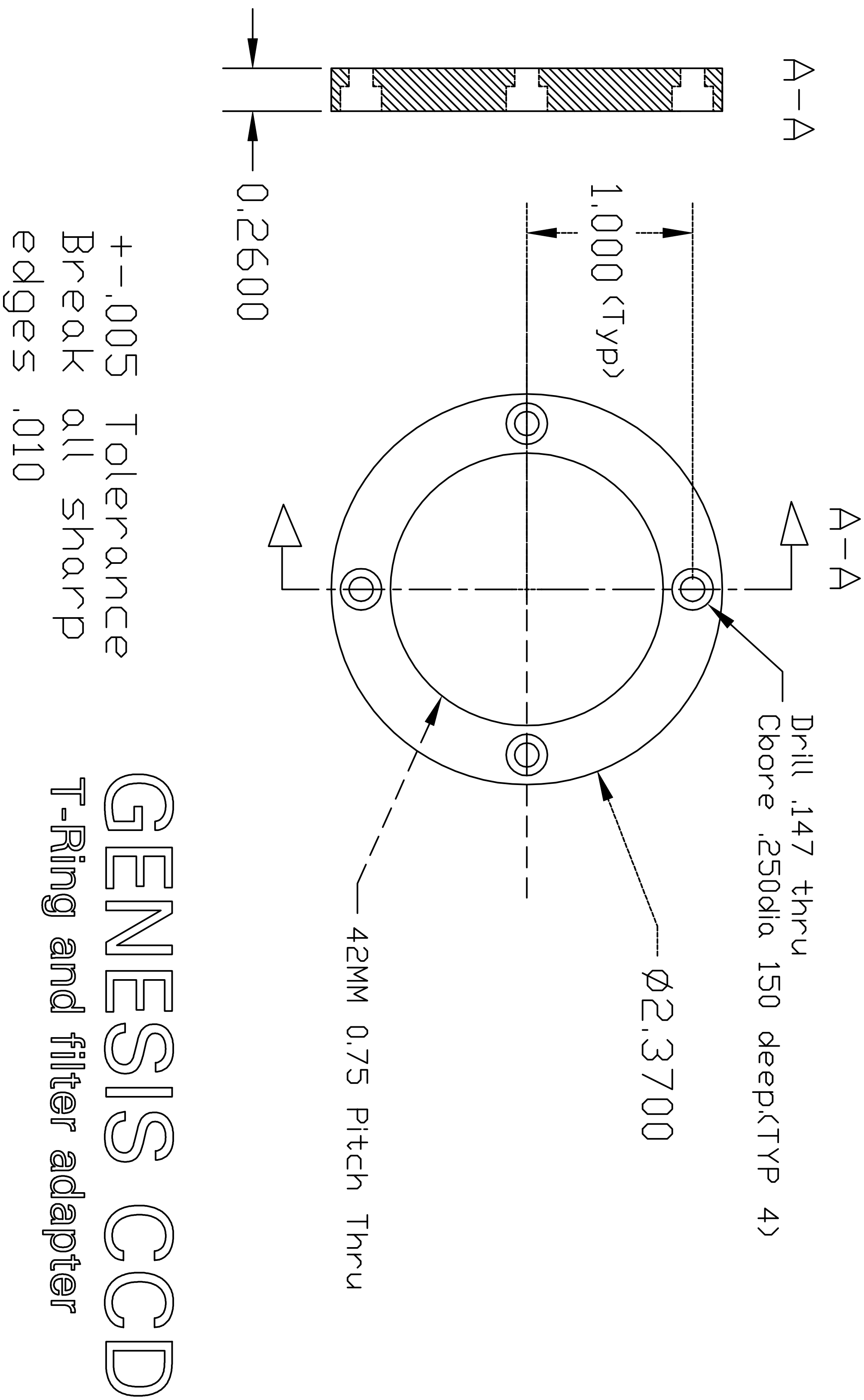
Cold Finger



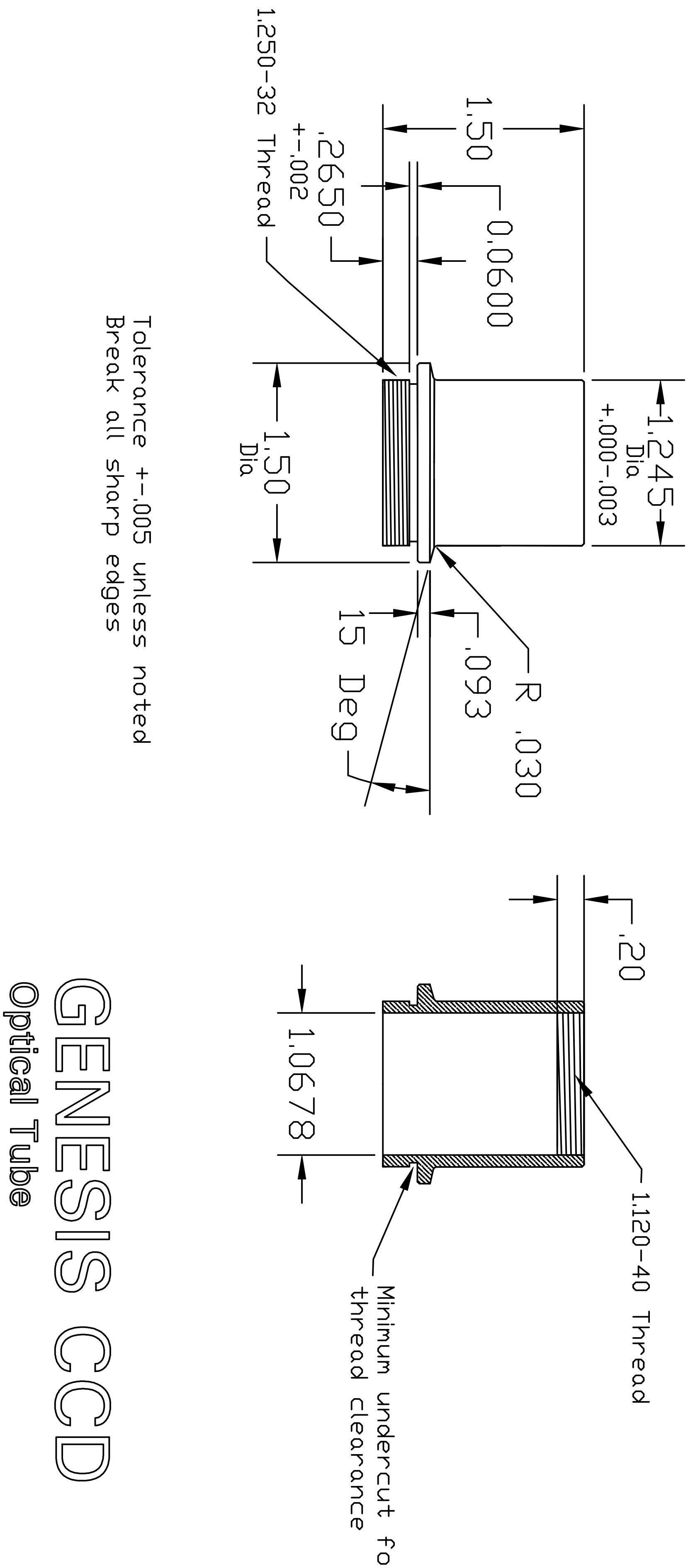
Ø0.1470
(TYP 8)
.500
.590
.670
0.4370
1.1800
1.0000
1.3400
0.1870
Ø0.1930
(TYP 2) opposite sides
.240 deep major diameter
Tolerance +-.005 unless noted
Break all sharp edges
.531
2-56 Tap
.250 Deep (typ 2)
Best possible
finish
1-64 Tap
.250 Deep (typ 2)
0.9810
(+-.002)
1.0620
0.1870
0.3210
(TYP 6)
Best possible finish
Top and Bottom
.1605
0.4040 (TYP 2)
0.8080
GENESIS CCD
Coldfinger

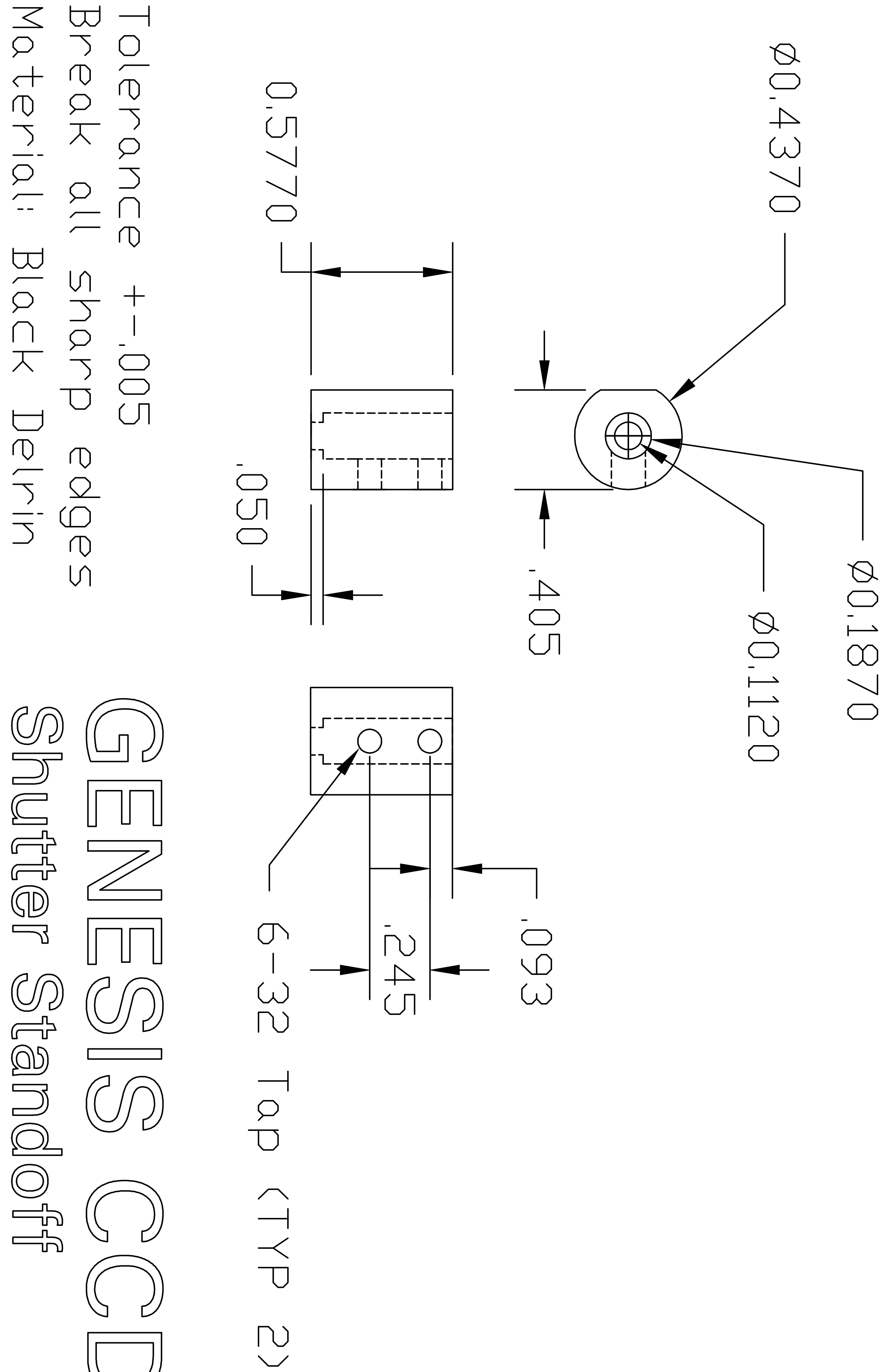
Glass Retaining Ring



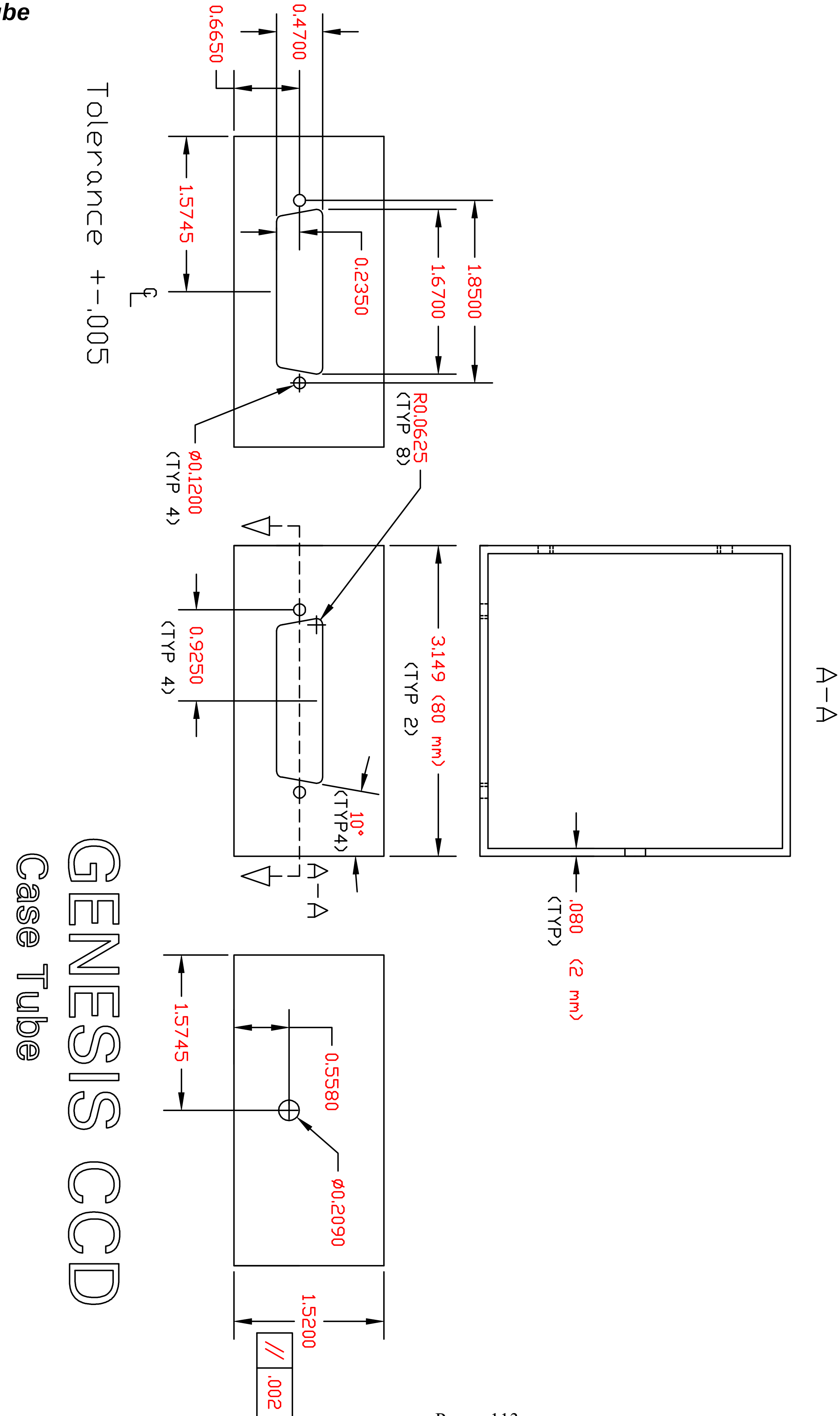

A-A
0.2600
1.000 <Typ>
A-A
+-.005 Tolerance
Break all sharp
edges .010
Drill .147 thru
Cbore .250dia 150 deep.<TYP 4>
Ø2.3700
42MM 0.75 Pitch Thru
GENESIS CCD
T-Ring and filter adapter

Optical Tube




Ø0.4370
Ø0.1870
Ø0.1120
.405
0.5770
.050
.093
.245
6-32 Tap (TYP 2)
Tolerance +-.005
Break all sharp edges
Material: Black Delrin
GENESIS CCD
Shutter Standoff

Case Tube



GENESIS CCD
Case Tube
Tolerance +-.005
0.6650
0.4700
1.5745
0.2350
1.6700
1.8500
R0.0625
(TYP 8)
ø0.1200
(TYP 4)
0.9250
(TYP 4)
3.149 (80 mm)
(TYP 2)
10°
(TYP4)
A-A
.080 (2 mm)
(TYP)
1.5745
0.5580
ø0.2090
1.5200
// .002

Index

Q

R

S

T

V

W