

# Reverse Engineering Online Challenge 2022



## Disassembling an Epson EMP-1825 Business Projector



Team: 8059B  
Name: Nicholle  
Anglo-Chinese School (Independent), Singapore

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**There are a total of 39 pages in this submission.**

# **Report**

## **Project overview**

We use projectors extensively in our daily lives and the technology leveraged in making the projector function has continuously intrigued us. Given this opportunity to deconstruct and examine the internals of an electronic device, we did not hesitate to seek permission from our teacher to break down a condemned projector we obtained from the school's media resource team.

## **Deconstruction**

After being successfully granted permission to dismantle the Epson projector, we got to work, starting by documenting the exterior components of the device. Next, we found the user manual online and referred to its instructions to deconstruct the device. Using screwdrivers, we removed the screws fastening the case. We took all necessary precautions including wearing safety goggles throughout the teardown, unplugging all power sources and having a fire extinguisher nearby.

Upon safely removing the cover, we proceeded to investigate the interior components of the device, including its motherboard and daughterboard which we later detached to reveal the optical engine. We researched the different components online using their serial numbers (printed on the individual components) as keywords. By browsing through various datasheets, blogs and product overviews, we obtained more information about the components' specifications and functions. We used a phone camera magnifier to enlarge serial numbers of smaller parts.

## **Findings**

We discovered and researched a variety of different parts including image processors, microcontrollers, integrated circuits, capacitors, transistors, diodes and oscillators.

On the motherboard which controls all major processes in the device, we identified several significant components including the Pixelworks PW190-10L microcontroller, which performs arithmetic, logic, and input/output operations and executes data transmission activities, the B1920L Logic IC, and the STMicroelectronics TDA7430 digitally controlled audio processor. On the daughterboard, we identified multiple chips that pointed to its role of controlling the optical engine - the TI SNx4LVC14A chip controlling the LCD panels in the optical engine, and the TI TMS320 Digital Signal Processor.

The various lenses and mirrors positioned at different angles piqued our curiosity to find out more about the optical engine. We examined the user manual and looked through the diagrams explaining the path of light, and researched on how the screen is projected. We discovered that

a single beam of white light emitted by the lamp is split into 3 different beams of red, blue and green light, which are cast through LCD panels to generate coloured images. The coloured rays are then merged in the prism unit, forming a multi-coloured output.

## Conclusion

From this experience, our team was able to gain vast new insights and perspectives on electronics. We discovered how various components played key roles in coordinating the projector and also learnt about the path of light within its intricate optical engine - the heart of the machine. We were befuddled by the device's complexity and the sheer amount of chips and components required for it to function. This has been a really enriching experience that has enabled us to learn more about the projector's marvellous technology, which continues benefitting us to this day.

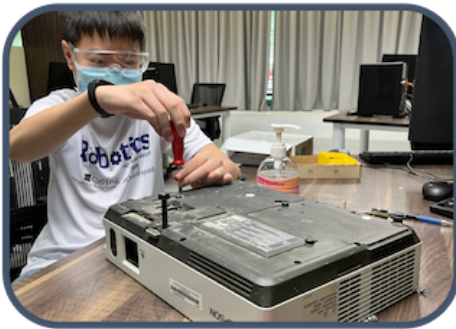
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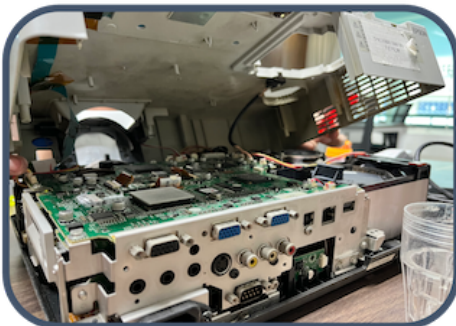
## Complete Deconstruction & Research Process



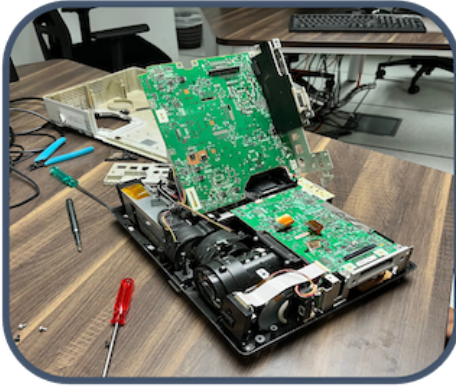
The state of the projector prior to its deconstruction



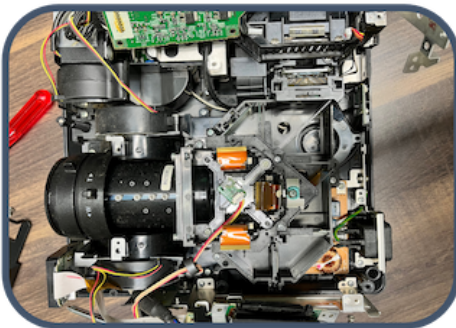
Meticulously unscrewing and removing the cover



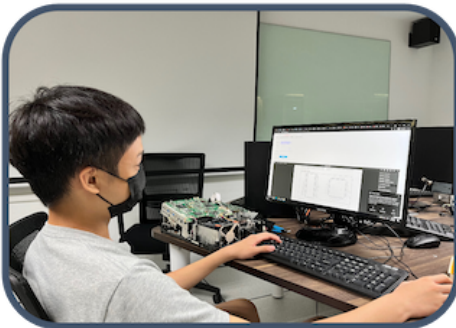
Lifting the cover off and removing the wires connected to the case to reveal the inner workings of the projector



The deconstructed projector's motherboard & daughterboard



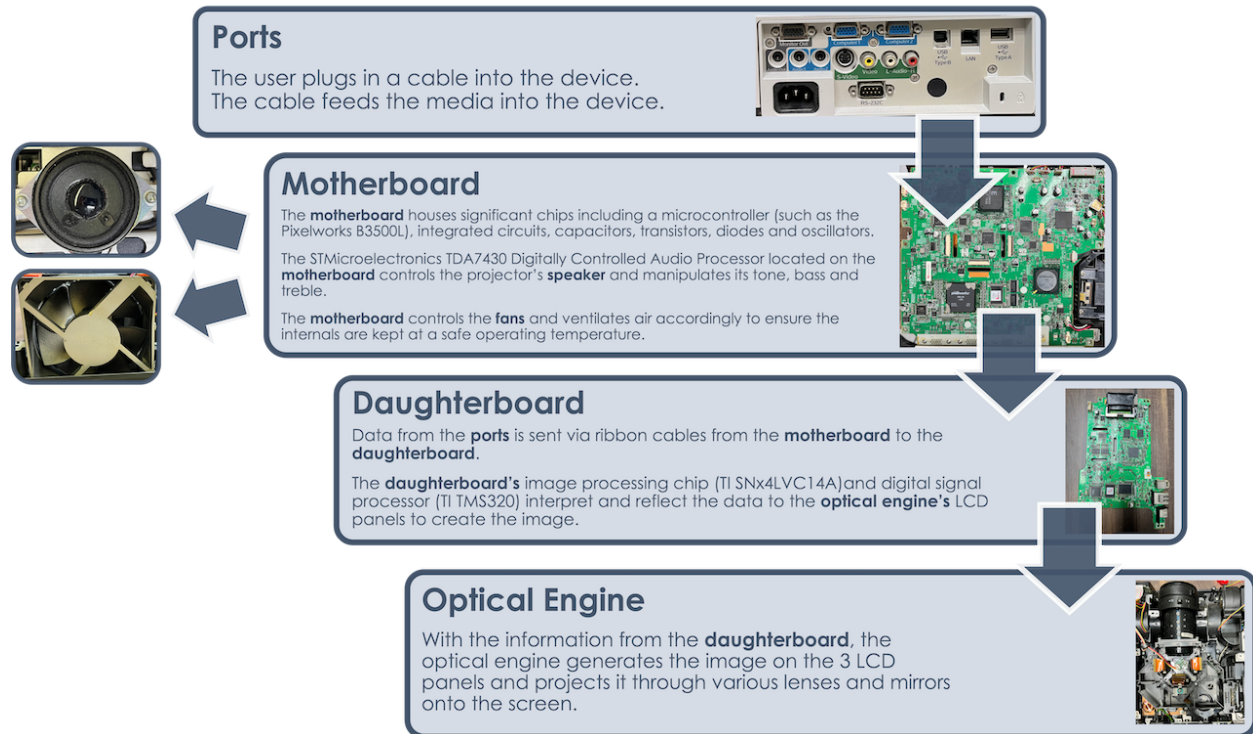
The deconstructed projector's optical engine



Researching the various components

## Flow of Media

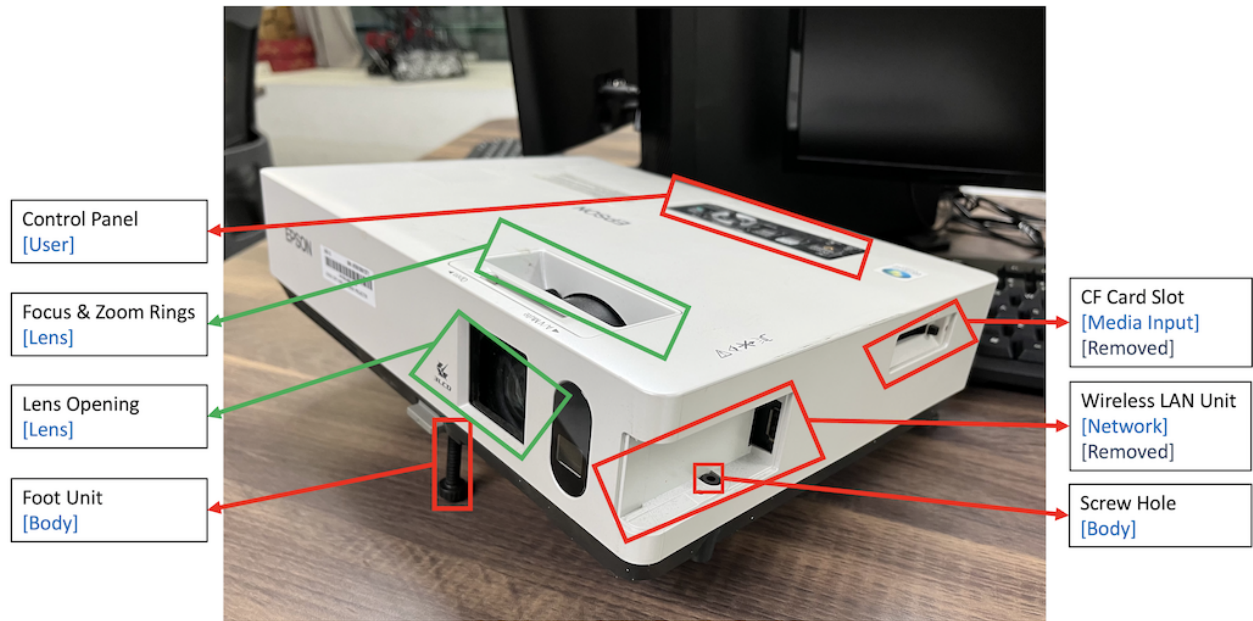
This section details the flow of media within the projector to achieve a projection.



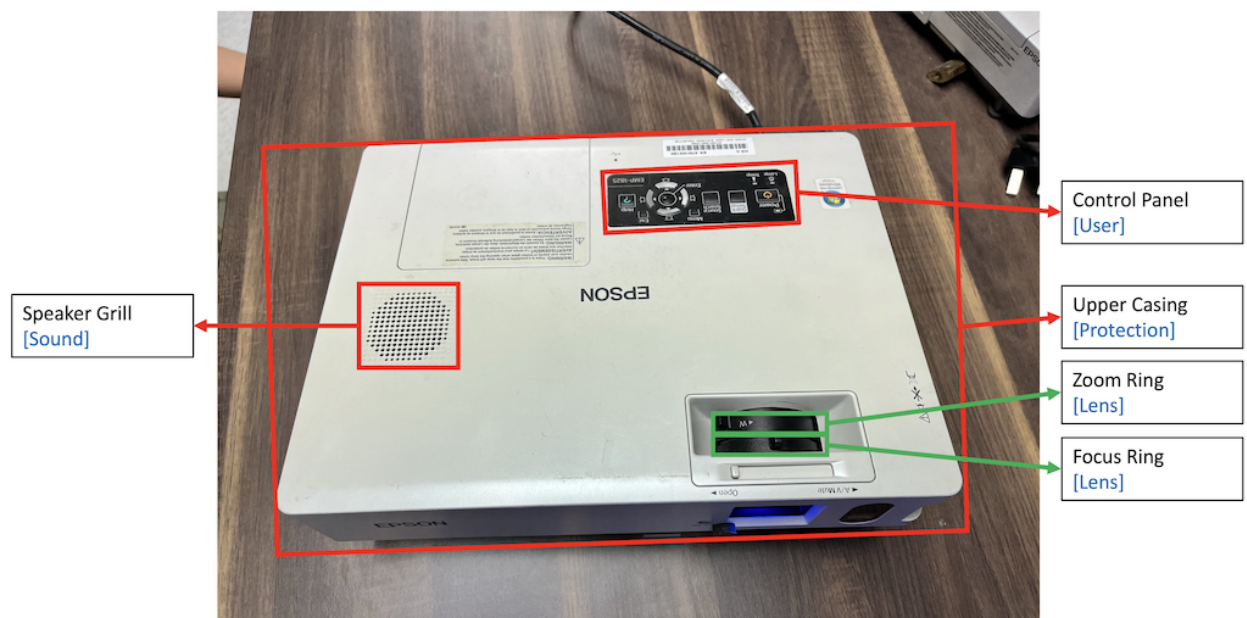
## Labelled Images

### Exterior

#### Front View

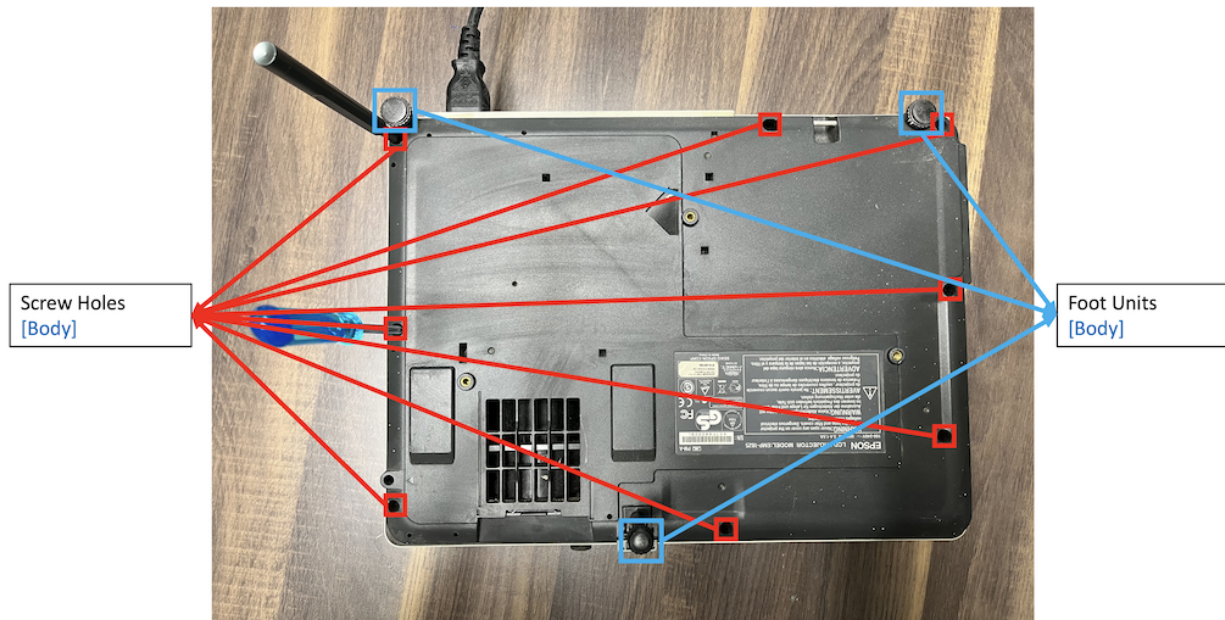


#### Top View

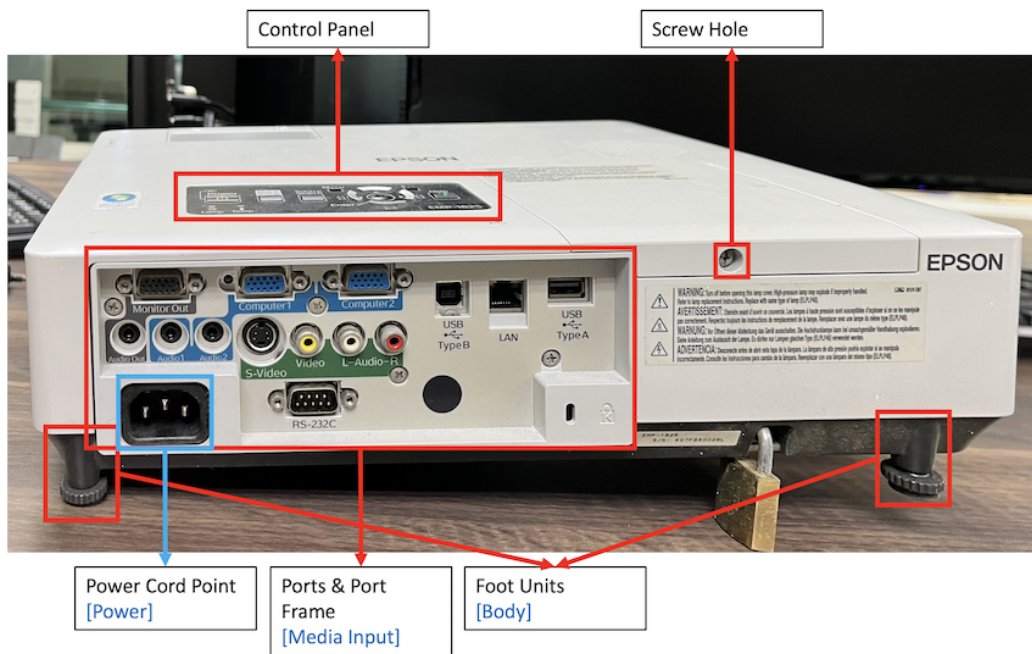




## Bottom View

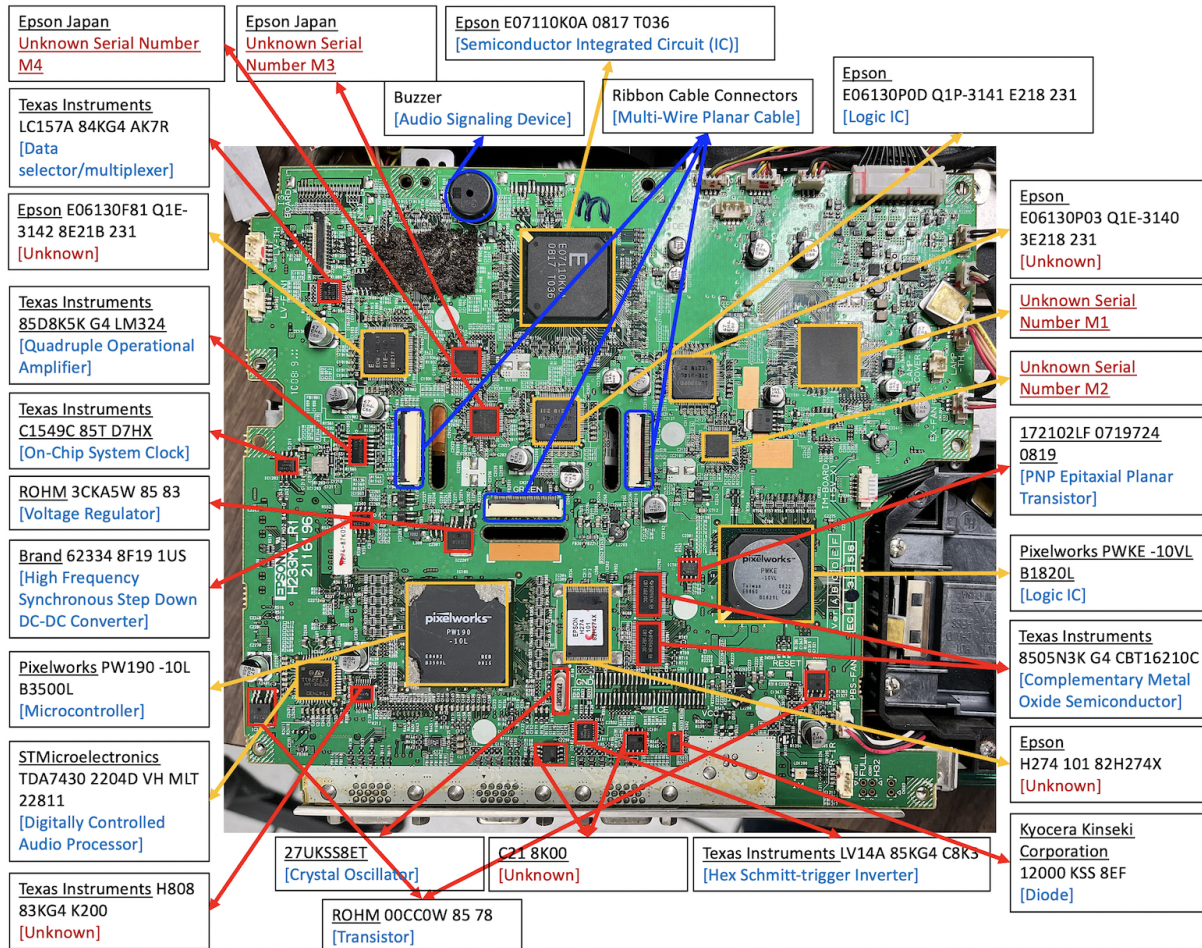


## Back View



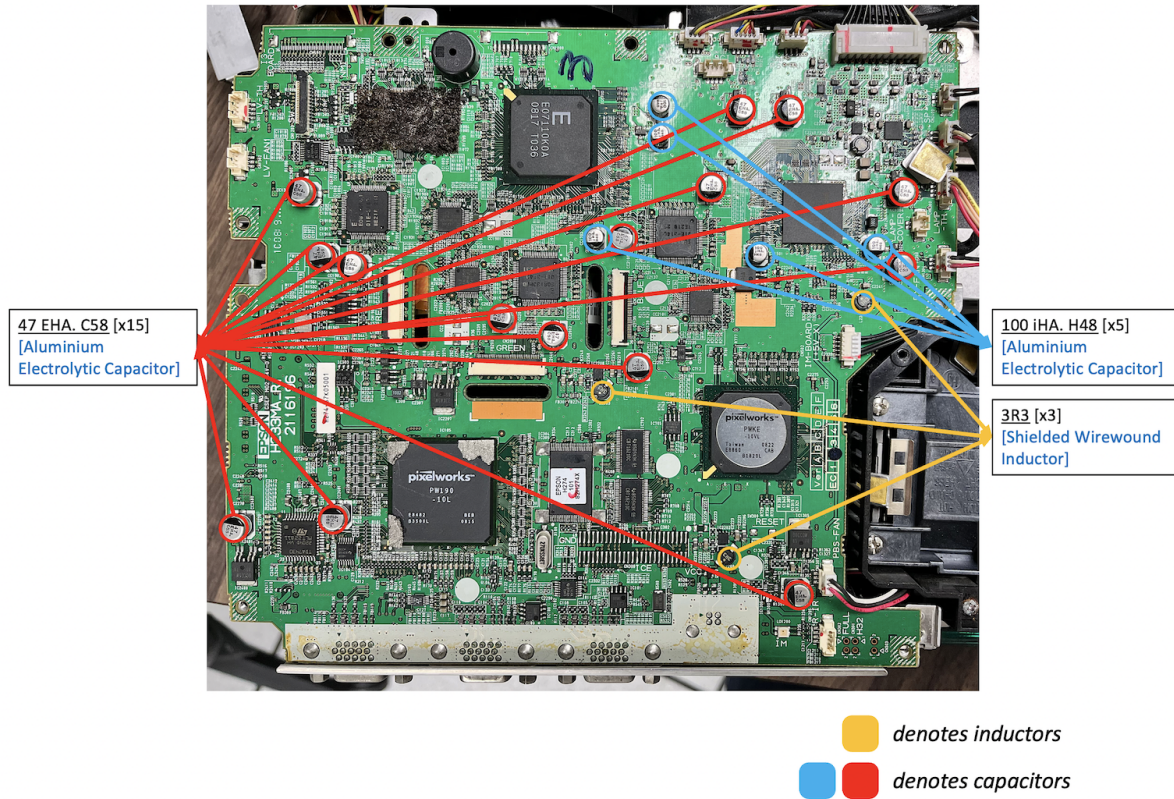
## Interior

### Motherboard

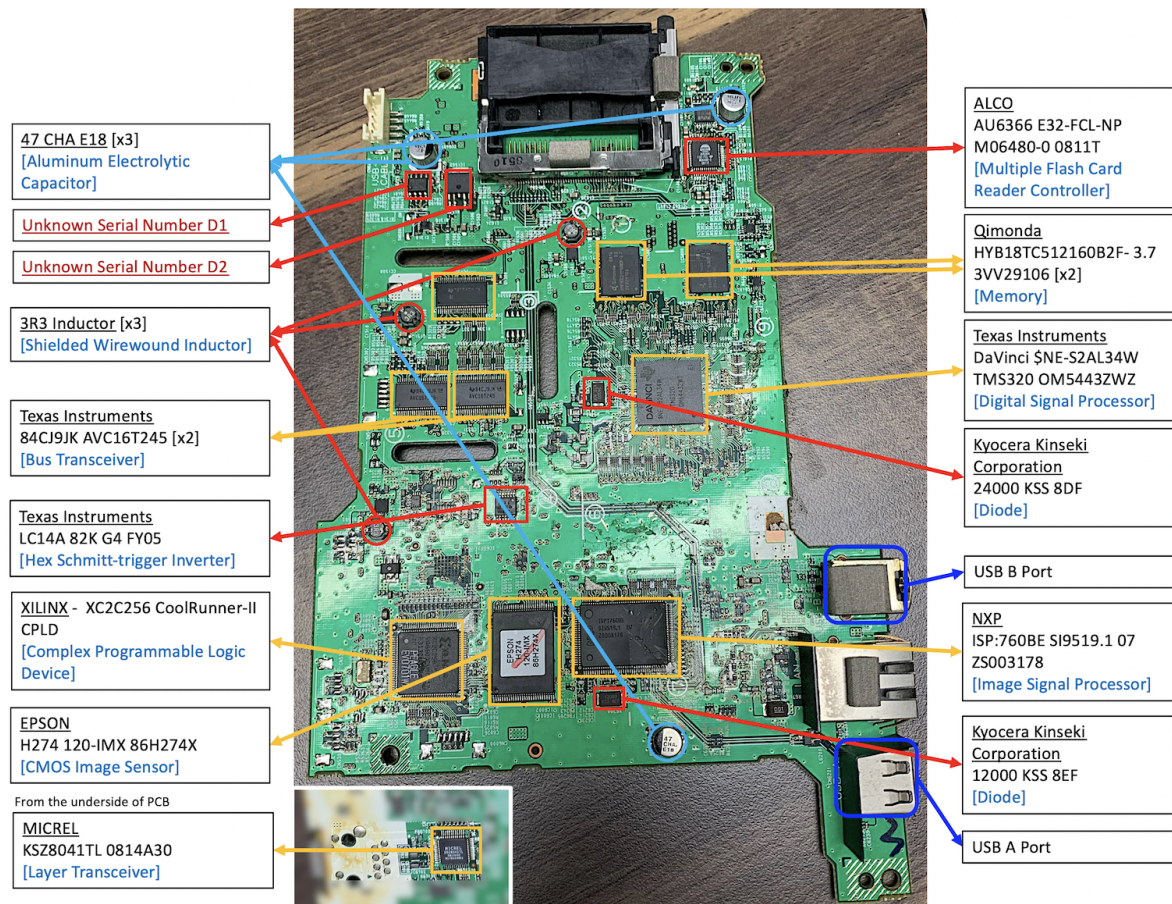


- denotes significant chips
- denotes common components
- denotes miscellaneous parts





## Daughterboard

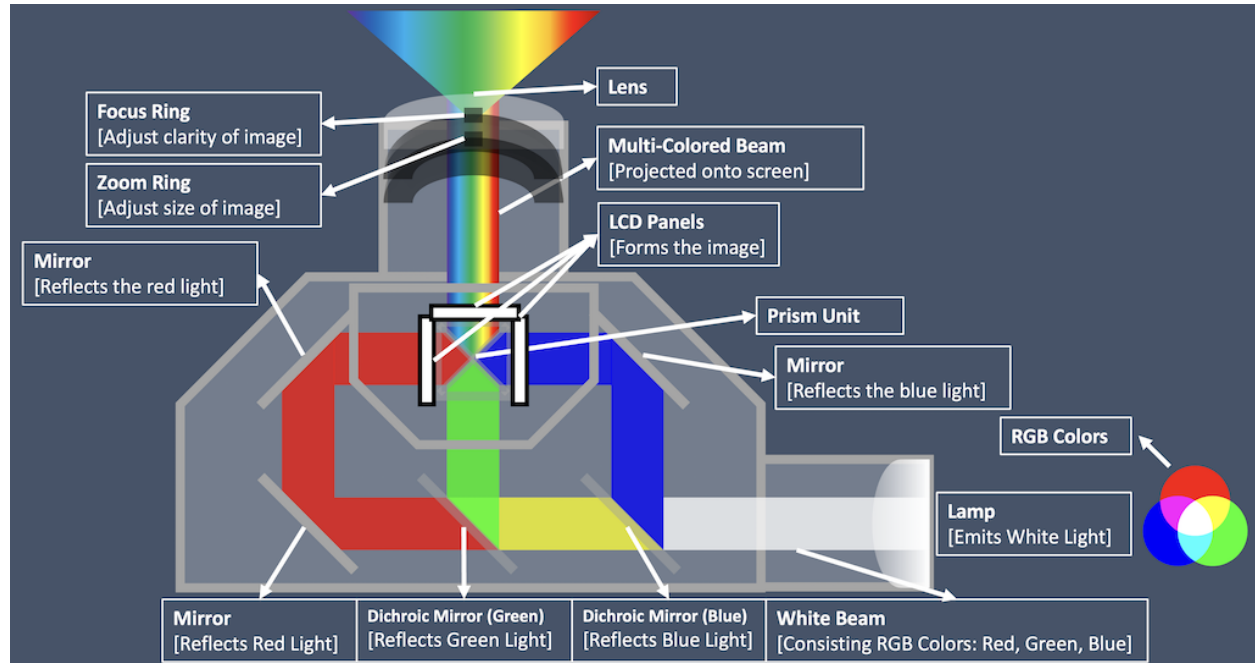


- denotes significant chips
- denotes common components
- denotes miscellaneous parts



# Optical Engine

## Flow of Light





## List of Components






Component	Part Description
Dichroic Mirrors	Disperses the polarised light into the R/G/B spectrums
Prism Unit	Integrates the R/G/B light
LCD Panels	The R, G, B light passes through 3 LCD panels which generates the picture. They create the Red, Green, Blue parts of the projection, allowing for vibrant colour representation.
Zoom Ring	Adjusts size of image projected
Focus Knob	Adjusts sharpness of image projected





## List of Components



### External

*This subsection includes all components visible from the exterior.*

No.	Component [Name/Picture]	Part Type	Part Description [Function/Comments]
1	<b>Upper Case</b>  [Bottom view]  [Top view]	Plastic Casing	Shields the interior components from the external environment and damage. Safely prevents any electrical hazards.

2	<b><u>Air Filter Assy</u></b> 	Plastic Frame	The air filter assembly
3	<b><u>Ports Frame</u></b> 	Plastic Frame	The frame that encases the various video and audio input ports, including VGA, USB, LAN and the power plug.
4	<b><u>Ports</u></b> 	Ports	The multiple input ports that allow media to be transmitted to the projector.
5	<b><u>Control Panel</u></b> 	User Control	Allows the user to control the media being fed into the projector, i.e. switching input sources and adjusting volume.
6	<b><u>Screws</u></b> 	Screws	Different kinds of screws which tightly secure the casing and components of the projector.

7	<b><u>Foot Units</u></b> 	Rubber Foot (Underside)	<p>Feet which prevent the projector from sliding. They fit on the bottom of the projector and are fitted with rubber feet.</p> <p>They are secured by a screw-like system consisting of screw grooves on the side.</p>
8	<b><u>Zoom Ring</u></b> 	Rotating Knob	Adjusts size of image projected
9	<b><u>Focus Ring</u></b> 	Rotating Knob	Adjusts sharpness of image projected
10	<b><u>Wireless LAN Unit</u></b> <b>[Removed]</b> 	Network & Connectivity	Enables the usage of the projector over a wireless network. The user can project information seamlessly without the need for cables.

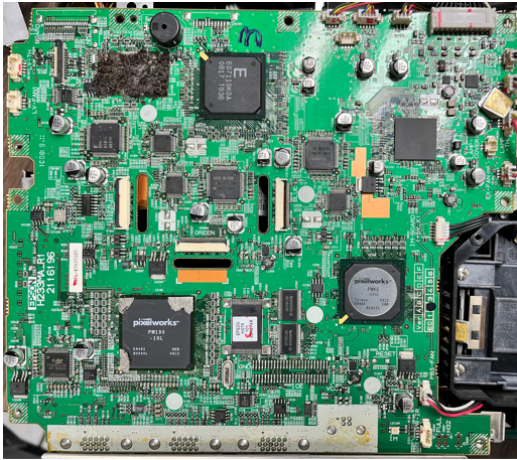
11	<b>CF Card Slot</b> 	Data Storage	A slot that accommodates the use of a CompactFlash Card, which is a type of flash memory mass storage technology that is mostly utilised in mobile electronic devices.
12	<b>Speaker Grill</b> 	Sound	Protects the driver element and speaker internals from external conditions while allowing for loud and clear emission of sound.

## Internal



*This subsection includes all internal components.*


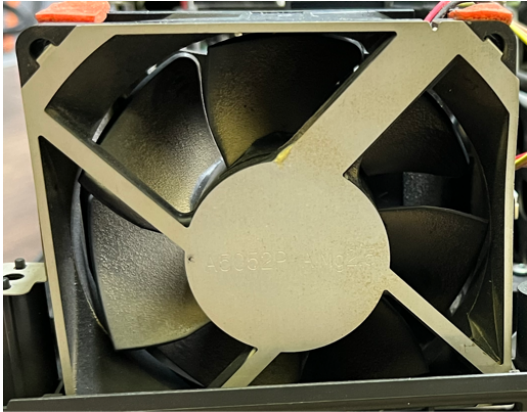
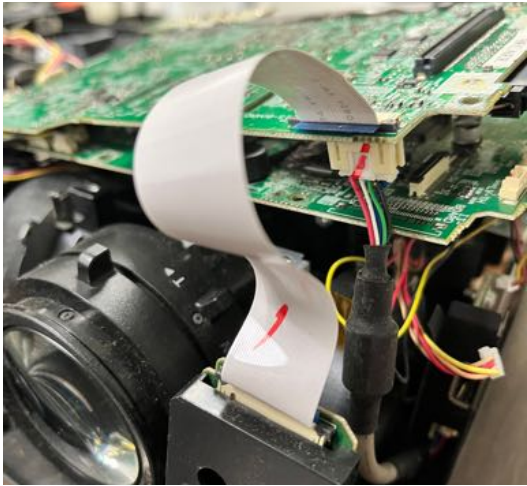
### Major Components

*This subsection includes all significant internal components.*

No.	Component [Name/Picture]	Part Type	Part Description [Function/Comments]
1	<b><u>Motherboard</u></b> 	Printed Circuit Board	<p><i>A printed circuit board structurally supports and electrically links electrical or electronic components through the use of conductive tracks, pads, and other features carved from one or more sheet layers of copper bonded onto and/or between sheet layers of a non-conductive substrate.</i></p> <p>The motherboard is connected to various media input ports on its side. It digitally processes input data from external sources and generates drive signals. It controls the external I/O interface as well as manipulating the lamp. It monitors sensors' input and regulates internal temperature with the fans. In addition, it transmits data (via ribbon cables) to the daughterboard which controls the optical engine.</p>








2	<b><u>Daughterboard (Top &amp; Bottom)</u></b> 	Printed Circuit Board	<p>The daughterboard is the second significant PCB in the projector. It has various chips related to image and visual processes, pointing to the fact that it controls the optical engine. The daughterboard works closely with the motherboard to receive data about the media to be projected. The information from the motherboard is processed by various chips and the image is cast on the LCD panels of the optical engine.</p>
3	<b><u>Optical Engine</u></b> 	Optical Engine	<p>The optical engine serves as the heart of the projector, where fundamental light processes occur to generate the multicoloured image seen on the projected display.</p>




4		Speaker	Plays sound by converting electrical energy into mechanical energy in the form of sound waves that the user hears.
5		Fan	Keeps the device at a safe operating temperature and prevents the internals from overheating.
6		Multi-Wire Planar Cable	A ribbon cable connector or Multi-Wire Planar Cable connects the motherboard to the other internals of the projector.








## Motherboard Components



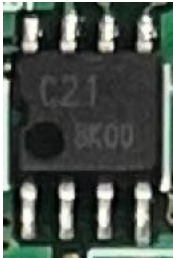
No.	Component [Name/Picture]	Part Type	Part Description [Function/Comments]
1	<b>Pixelworks</b> <b>PW190-10L</b> <b>B3500L</b> 	Microcontroller	<p>The microcontroller is an important component of the circuit board. It controls embedded functions of the projector including memory, peripherals and most importantly a processor.</p> <p>As a microcontroller, it interprets and responds to a variety of commands that control the microcontroller's operation. This entails basic arithmetic, logic, and input/output (I/O) operations. It also executes data transmission activities, which send commands to other components, such as audio and visual output.</p>
2	<b>Pixelworks</b> <b>PWKE -10VL B1820L</b> 	Logic IC	<p>It is one of the major chips found on the circuit board. It sends signals/information to other components of the projector by translating continuously variable physical quantities such as spatial position and voltage.</p> <p>A Logic Integrated Circuit (IC) is a semiconductor device that produces a digital output signal by performing a simple logical operation on one or more digital input signals (represented by 1 and 0 or H and L).</p>

	<b><u>Epson</u></b> <b><i>E07110K0A 0817 T036</i></b> 	Semiconductor IC	<p>A Semiconductor is a small piece of semiconducting material, commonly made of silicon, that performs the same function as a bigger circuit made up of discrete components.</p> <p>A semiconductor material's electrical conductivity lies between that of a conductor, such as metallic copper, and that of an insulator, such as glass. As the temperature rises, its resistivity decreases; metals, on the other hand, respond in the opposite manner.</p>
4	<b><u>Epson</u></b> <b><i>H274 101 82H274X</i></b> 	Unknown	<p>Epson did not publish any datasheets on this component online due to intellectual property rights.</p>
5	<b><u>STMicroelectronics</u></b> <b><i>TDA7430 2204D VH</i></b> <b><i>MLT 22811</i></b> 	Digitally Controlled Audio Processor	<p>Controls the audio coming out of the projector's speaker for tone, bass and treble balance.</p> <p>They reproduce surround sound by using programmable phase shifters to send a signal to the amplifier, which allows the amplifier to tune the outgoing audio.</p> <p>This chip is also used in car radio and Hi-Fi systems.</p>





6	<b>Epson</b> <b>E06130F81 Q1E-3142</b> <b>8E21B 231</b> 	Unknown	Epson did not publish any datasheets on this component online due to intellectual property rights.
7	<b>Epson</b> <b>E06130P0D Q1P-3141</b> <b>E218 231</b> 	Logic IC	<p>It sends signals/information to other components of the projector by translating continuously variable physical quantities such as spatial position and voltage.</p> <p>A Logic Integrated Circuit (IC) is a semiconductor device that produces a digital output signal by performing a simple logical operation on one or more digital input signals (represented by 1 and 0 or H and L).</p>
8	<b>Epson</b> <b>E06130P03 Q1E-3140</b> <b>3E218 231</b> 	Unknown	Epson did not publish any datasheets on this component online due to intellectual property rights.




9	<b><u>Texas Instruments</u></b> <b><i>H808 83KG4 K200</i></b> 	Unknown	We were unable to find any information about this part.
10	<b><u>Texas Instruments</u></b> <b><i>SNx4LV14A</i></b> <b><i>(LV14A 85KG4 C8K3)</i></b> 	Hex Schmitt-trigger Inverter	<p>The SNx4LV14A devices contain 6 independent inverters. These devices perform the boolean function <math>Y = A</math>.</p> <p>In general, a Hex Schmitt-trigger Inverter converts physical input signals into digital output signals to be fed into chips.</p> <p>It can convert any type of input signal into a digital output signal, allowing it to function with both digital and analog inputs. An inverting Schmitt trigger has the advantage of being a hysteresis device, which means that whatever signal is outputted at the time has an effect on any future output. This means that there is not a proportional or constant output for any one input state. In a Schmitt trigger, there is a wide range of input signals that can result in one of two different output states.</p>

11	<b><u>Texas Instruments</u></b> <b><u>SN74LVC157A</u></b> <b><u>(LC157A 84KG4 AK7R)</u></b> 	Data selector/multiplexer	<p>It allows multiple channels of data to be placed in a logical order on a time-shared output bus in the projector.</p> <p>A device that can receive multiple input signals and output a single output signal in a recoverable manner for each input signal. It is also an integrated system that usually contains a certain number of data inputs and a single output.</p>
12	<b><u>Unknown Serial</u></b> <b><u>Number M1</u></b> 	Unknown	<p>Due to the deterioration of the projector throughout its lifespan, the serial number on these chips had faded and could not be interpreted.</p>
13	<b><u>Unknown Serial</u></b> <b><u>Number M2</u></b> 	Unknown	




14	<b>ROHM</b> <b>00CC0W 85 78</b> <b>[x2]</b> 	Transistor	<p>It amplifies and switches electrical signals and power to transmit to the other components in the circuit board.</p> <p>A transistor contains three layers of silicon. The behaviour of electric charges in the silicon lets the transistor act as a valve, controlling the flow of electricity through it. Transistors also switch signals on and off at high speeds, allowing billions of data communication between chips per second to coordinate the visual and audio processes.</p>
15	<b>27UKSS8ET</b> 	Crystal Oscillator	<p>It creates an electrical signal with a given frequency to track time inside the projector.</p> <p>A crystal oscillator is an electronic oscillator circuit that generates an electrical signal with a constant frequency by utilising the mechanical resonance of a vibrating crystal of piezoelectric material to keep time.</p>
16	<b>C21 8K 00 [x2]</b> 	Unknown	<p>We were unable to locate any information about this part.</p>





17	<b>Kyocera Kinseki Corporation</b> <b>12000 KSS 8EF</b> 	Diode	<p>A diode is a semiconductor device that operates essentially as a one-way current switch. It lets current flow freely in one direction, but severely prevents current from flowing in the opposite direction.</p>
18	<b>Texas Instruments</b> <b>CBT16210C</b> <b>(8505N3K G4)</b> <b>[x2]</b> 	Complementary Metal Oxide Semiconductor	<p>8505N3K is a high-speed, low-resistance CMOS (Complementary metal-oxide-semiconductor) switch that is used to relay a signal bus. These bus switch ICs, also known as bilateral switches or analog switches, perform the same basic functions as mechanical relays but without the moving parts and with substantially superior performance.</p>
19	<b>172102LF 0719724 0819</b> 	PNP Epitaxial Planar Transistor	<p>A transistor contains three layers of silicon. The behaviour of electric charges in the silicon lets the transistor act as a valve, controlling the flow of electricity through it. Transistors also switch signals on and off at high speeds, allowing billions of data communication between chips per second to coordinate the visual and audio processes.</p>
20	<b>Epson Japan</b> <b>Unknown Serial Number M3</b> 	Unknown	<p>Due to the deterioration of the projector throughout its lifespan, the serial number on these chips had faded and could not be interpreted.</p>



21	<b>Epson Japan</b> <u>Unknown Serial</u> <u>Number M4</u> 	Unknown	
22	<b>Texas Instruments</b> <b>85D8K5K G4 LM324</b> 	Quadruple Operational Amplifier	<p>A Quadruple Operational Amplifier that is applicable for use with TVs: LCD and Digital. This device is made up of four independent high-gain frequency-compensated operational amplifiers that are specifically designed to operate from a single or split supply over a wide range of voltages. In single-supply applications, quadruple operational amplifiers have several distinct advantages over standard operational amplifier types: the quad amplifier can operate at supply voltages ranging from 3.0 V to 32 V.</p>
23	<b>Texas Instruments</b> <b>C1549C 85T D7HX</b> 	On-Chip System Clock	<p>The TLC1549C is a 10-bit, switched-capacitor, successive-approximation analog-to-digital converter. As an on-chip system clock, it issues a steady high-frequency signal that synchronises all the internal components, allowing them to work together.</p>







24	<b>3CKA5W 85 83</b> 	Voltage Regulator	<p>A voltage regulator is a device designed to maintain a fixed voltage level automatically. A voltage regulator may use a simple feed-forward design or may include negative feedback. It may use an electromechanical mechanism or electronic components.</p>
25	<b>62334 8F16 1US</b> 	High Frequency Synchronous Step Down DC-DC Converter	<p>The TPS6223X device family is a high frequency synchronous step down DC-DC converter designed specifically for battery powered portable applications. It can handle up to 500mA of output current and allows for the use of tiny, low-cost chip inductors and capacitors. As a Step Down DC-DC Converter, it steps down voltage (while drawing less average current) from its input (supply) to its output (load).</p>
26	<b>3R3 Inductor [x3]</b> 	3.3 Micro Farhat Shielded Wirewound Inductor	<p>As passive circuit components, wire wound surface mount inductors require an external power source. They have a core made of a magnetic metal such as iron, with wire wound around it. When an electrical current travels through the coiled wire, which has strong insulation to make the inductors appropriate for use with bigger currents, energy is stored in a magnetic field.</p> <p>As a 3.3 micro farhat inductor, it suppresses current spikes and also filters voltage after being sent through a buck converter.</p>


27	<b>100 iHA. H48 [x15]</b> 	Electrolytic Aluminium Capacitor	An electrolytic capacitor is a polarised capacitor with an anode or positive plate constructed of a metal that anodises to generate an insulating oxide layer. This oxide layer serves as the dielectric of the capacitor. The surface of this oxide layer is coated with a solid, liquid, or gel electrolyte, which serves as the cathode or negative plate of the capacitor. Electrolytic capacitors offer a substantially larger
28	<b>47 EHA. C58 [x5]</b> 	Electrolytic Aluminium Capacitor	capacitance-voltage (CV) product per unit volume than ceramic or film capacitors due to their relatively thin dielectric oxide layer and expanded anode surface, allowing them to have huge capacitance values.




## Daughterboard Components

No.	Component [Name/Picture]	Part Type	Part Description [Function/Comments]
1	<b><u>MICREL</u></b> <b><i>KSZ8041TL</i></b> <b><i>0814A30</i></b>  [Located on underside of the PCB]	Layer Transceiver	The KSZ8041 is a single supply physical Layer Transceiver, which provides interfaces to transmit and receive data. A unique mixed signal design extends signalling distance while reducing power consumption.
2	<b><u>Texas Instruments</u></b> <b><i>84CJ9JK</i></b> <b><i>AVC16T245</i></b> <b><i>[x2]</i></b> 	Bus Transceiver	84CJ9JK Bus transceivers are tri-state bi-directional devices which allow the flow of data between two points making them compatible with bus-oriented systems or the bi-directional (input or output) control of interface circuitry.


3	<p><b><u>Texas Instruments</u></b>  <b>SNx4LVC14A</b>  <b>(LC14A 82KG4 FY05)</b></p> 	<p>Hex Schmitt-trigger  Inverter</p>	<p>The SNx4LVC14A chip is designed for LCD screens. It controls the LCD panels in the optical engine.</p> <p>In general, a Hex Schmitt-trigger Inverter converts physical input signals into digital output signals to be fed into chips.</p> <p>It can convert any type of input signal into a digital output signal, allowing it to function with both digital and analog inputs. An inverting Schmitt trigger has the advantage of being a hysteresis device, which means that whatever signal is outputted at the time has an effect on any future output. This means that there is not a proportional or constant output for any one input state. In a Schmitt trigger, there is a wide range of input signals that can result in one of two different output states.</p>
4	<p><b>3R3 Inductor [x3]</b></p> 	<p>3.3 Micro Farhat  Shielded Wirewound  Inductor</p>	<p>As passive circuit components, wire wound surface mount inductors require an external power source. They have a core made of a magnetic metal such as iron, with wire wound around it. When an electrical current travels through the coiled wire, which has strong insulation to make the inductors appropriate for use with bigger currents, energy is stored in a magnetic field.</p> <p>As a 3.3 micro farhat inductor, it suppresses current spikes and also filters voltage after being sent through a buck converter.</p>

5	<p><b><u>Texas Instruments</u></b>  <b>DAVINCI</b>  <b>\$NE-S2AL34W</b>  <b>TMS320</b>  <b>DM6443ZWZ</b></p> 	<p>Digital Signal Processor (DSP)</p>	<p>TMS320, a digital signal processor (DSP), is a specialised microprocessor chip with an architecture optimised for digital signal processing operations. DSPs are fabricated on MOS integrated circuit chips.</p> <p>The TMS320 digital signal processor is from the DaVinci family of system-on-a-chip processors from Texas Instruments which is largely utilised in embedded video and vision applications. A DSP core based on the TMS320 C6000 VLIW DSP series and an ARM CPU core are combined in many of the processors in the family.</p>
6	<p><b><u>EPSON</u></b>  <b>H274</b>  <b>120-IMX</b>  <b>86H274X</b></p> 	<p>Complementary Metal Oxide Semiconductor (CMOS) Image Sensor</p>	<p><a href="#">The Complementary Metal Oxide Semiconductor (CMOS) sensor helps to detect and convey information to the other parts of the projector which can be used to make an image.</a></p> <p>In a CMOS sensor, the charge from the photosensitive pixel is converted to a voltage at the pixel site and the signal is multiplexed by row and column to multiple on chip digital-to-analog converters (DACs). Each site is essentially a photodiode and three transistors, performing the functions of resetting or activating the pixel, amplification and charge conversion, and selection or multiplexing.</p>


7	<b>47 CHA E18 [x2]</b> 	Aluminium Electrolytic Capacitor	<p>A capacitor is a device that stores electrical energy in an electric field. It is a two-terminal passive electronic component. Capacitance is the effect of a capacitor.</p> <p>An electrolytic capacitor is a polarised capacitor with an anode or positive plate constructed of a metal that anodises to generate an insulating oxide layer. This oxide layer serves as the dielectric of the capacitor. The surface of this oxide layer is coated with a solid, liquid, or gel electrolyte, which serves as the cathode or negative plate of the capacitor. Electrolytic capacitors offer a substantially larger capacitance-voltage (CV) product per unit volume than ceramic or film capacitors due to their relatively thin dielectric oxide layer and expanded anode surface, allowing them to have huge capacitance values.</p>
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8	<b><u>NXP Semiconductors</u></b> <b><i>ISP:760BE SI9519.1 07</i></b> <b><i>ZS003178</i></b> 	Image Signal Processor (ISP)	<p>760BE is an Image Signal Processor, which is a type of media processor or specialised digital signal processor used for image processing. ISP functionality typically exists in any camera-based system. ISPs usually perform a variety of image enhancements in addition to their primary function of converting a raw image sensor's one-colour-component-per-pixel output into the RGB or YUV images that are more commonly used elsewhere in the system.</p> <p>To improve system integration on embedded devices, a system-on-a-chip architecture including multi-core processing is often used.</p>
9	<b><u>Kyocera Kinseki Corporation</u></b> <b><i>24000 KSS 8DF</i></b> 	Diode	<p><a href="#">A diode is a semiconductor device that operates essentially as a one-way current switch.</a> It lets current flow freely in one direction, but severely prevents current from flowing in the opposite direction.</p>
10	<b><u>Kyocera Kinseki Corporation</u></b> <b><i>12000 KSS 8EF</i></b> 	Diode	<p><a href="#">A diode is a semiconductor device that operates essentially as a one-way current switch.</a> It lets current flow freely in one direction, but severely prevents current from flowing in the opposite direction.</p>

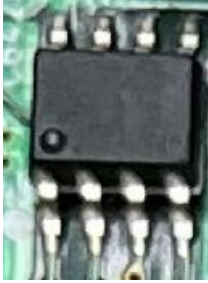



11	<p><b>XILINX XC2C256</b> <b>CoolRunner-II CPLD</b></p> 	Complex Programmable Logic Device (CPLD)	<p>The XC2C256 Complex Programmable Logic Device (CPLD) is a programmable logic device. CPLDs are commonly used for loading the configuration data of a field programmable gate array from non-volatile memory.</p> <p>The device has complexity between that of PALs and FPGAs, as well as architectural features from both. The CPLD's main building block is a macrocell, which contains logic that implements disjunctive normal form expressions as well as more specialised logic operations.</p> <p>The 256-macrocell CoolRunner™-II device is designed for both high performance and low power applications. This allows high-end communication equipment to save power while also providing high speed to battery-operated devices. Overall system reliability is improved as a result of the low power stand-by and dynamic operation.</p>
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12	<p><b>ALCOR MICRO, Corp</b> <b>AU6366 E32-FCL-NP</b> <b>M06480-0 0811T</b></p> 	<p>USB2.0 Single LUN Multiple Flash Card Reader Controller</p>	<p>The AU6366 reads and processes the data inputted from the CF Card Slot (which is connected to the daughterboard).</p> <p>The AU6366 is a single chip integrated USB 2.0 multimedia card reader controller that allows a PC/DVD/Printer to read/write different types of flash media cards. Flash media cards such as CF, SMC, XD, SD, MMC, and Memory Stick are widely used to store digital photos and compressed music in digital cameras, cell phones, PDAs, and MP3 players.</p> <p>The AU6366's performance is maximised by utilising the most recent and fastest card specifications available in the industry.</p> <p>The AU6366 is constructed with a shared pin architecture.</p>
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13	<p><b>Qimonda</b> <b>HYB18TC512160B2F-</b> <b>3.7 3VV29106 [x2]</b></p> 	Memory	<p>The HYB18TC512160B2F integrated circuit that holds programs and data temporarily or permanently.</p> <p>The 512-Mb DDR2 Dynamic Random-Access Memory (DRAM) is a high-speed Double-Data-Rate-Two CMOS DRAM device containing 536,870,912 bits and internally configured as a quad-bank DRAM.</p> <p>Dynamic random-access memory (dynamic RAM or DRAM) is a type of random-access semiconductor memory that stores each bit of data in a memory cell, which is typically made up of a tiny capacitor and a transistor, both of which are typically based on metal-oxide-semiconductor (MOS) technology. When a capacitor is used in a design, it can be charged or discharged; these two states are used to represent the two values of a bit, which are conventionally referred to as 0 and 1. The electric charge on the capacitors slowly leaks away, and if nothing is done, the data on the chip will be lost. To prevent this, DRAM requires an external memory refresh circuit that rewrites the data in the capacitors on a regular basis, restoring them to their original charge. As such, DRAM is considered a volatile memory.</p>
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14	<b><u>Unknown Serial Number D1</u></b> 	Unknown	Due to the deterioration of the projector throughout its lifespan, the serial number on these chips had faded and could not be interpreted.
15	<b><u>Unknown Serial Number D2</u></b> 	Unknown	

**Note: All diagrams and images were original from 8059B.**

**End of Submission**