Since 1984

Boulder

2110

Preamplifier

Technical Information

The 2110 is a reference level, optimally isolated stereo preamplifier from Boulder's 2100 Series featuring separate chassis enclosures for the left channel, right channel, user interface and four independent power supplies.

Basic Design

The 2110 Balanced Preamplifier is a four-chassis, reference-level preamp and the second generation of 2000 Series preamplifier from Boulder Amplifiers. It is also the successor to one of the company's most successful products, the original 2010 Isolated Balanced Preamplifier, which had an astounding run of 17 years of unchanged preamplifier design.

From its very conception, it was determined that the 2110 retain the basic ergonomics and functionality of its predecessor while undergoing a complete electronic circuit redesign. External physical changes from the original 2010 are subtle, more evolution than revolution, in order to maintain the iconic appearance of the 2010.

All casework is machined and interlocking in order to reduce resonances and microphonic distortions, and the entire chassis is now anodized with no powder-coated portions. The display window has also changed from three modular portions to a single mirrored glass lens spanning the width of the front panel.

Gain stages within the 2110 are the new and proprietary Boulder 993S, a reengineering of the modular and discretely implemented 993 gain stage previously used in Boulder's 2000 Series products until 2013. 993S gain stages are only used in the 2110. The 993S is a surface-mount, circuit board-implemented, fully-discrete, extremely high-current gain stage that provides the best possible distortion figures and exceptionally low noise.

The 2110 is differentially balanced from the inputs to the outputs for optimal common-mode noise rejection via the use of 993S gain stages. The 2110 also incorporates a fully-balanced volume attenuator to eliminate step noise and increase resolution through the volume control.

The separation of all primary functions of the 2110's circuitry and their placement in four separate chassis maintains the quietest possible operation and reduces distortion to unprecedented levels. The left and right audio sections are not connected to the user interface section electrically in any way; instead the audio sections are controlled via a system of optical transmitters and sensors in order to trigger functions within each channel's individual housing.

The 2110's power supply section houses four separate, isolated power supplies in a dedicated chassis. There are supplies for the left channel analog section, right channel analog section, logic and user interface circuitry and standby and power up functions. This fourth supply for standby and power up substantially decreases the 2110's power consumption when not in use.

Boulder was founded in 1984 and is the last high-performance audio manufacturer operating in North America that still performs all of its engineering and manufacturing in-house. This form of production is more costly than outsourcing, though as a result quality control and reliability of the finished products are never compromised.

Boulder

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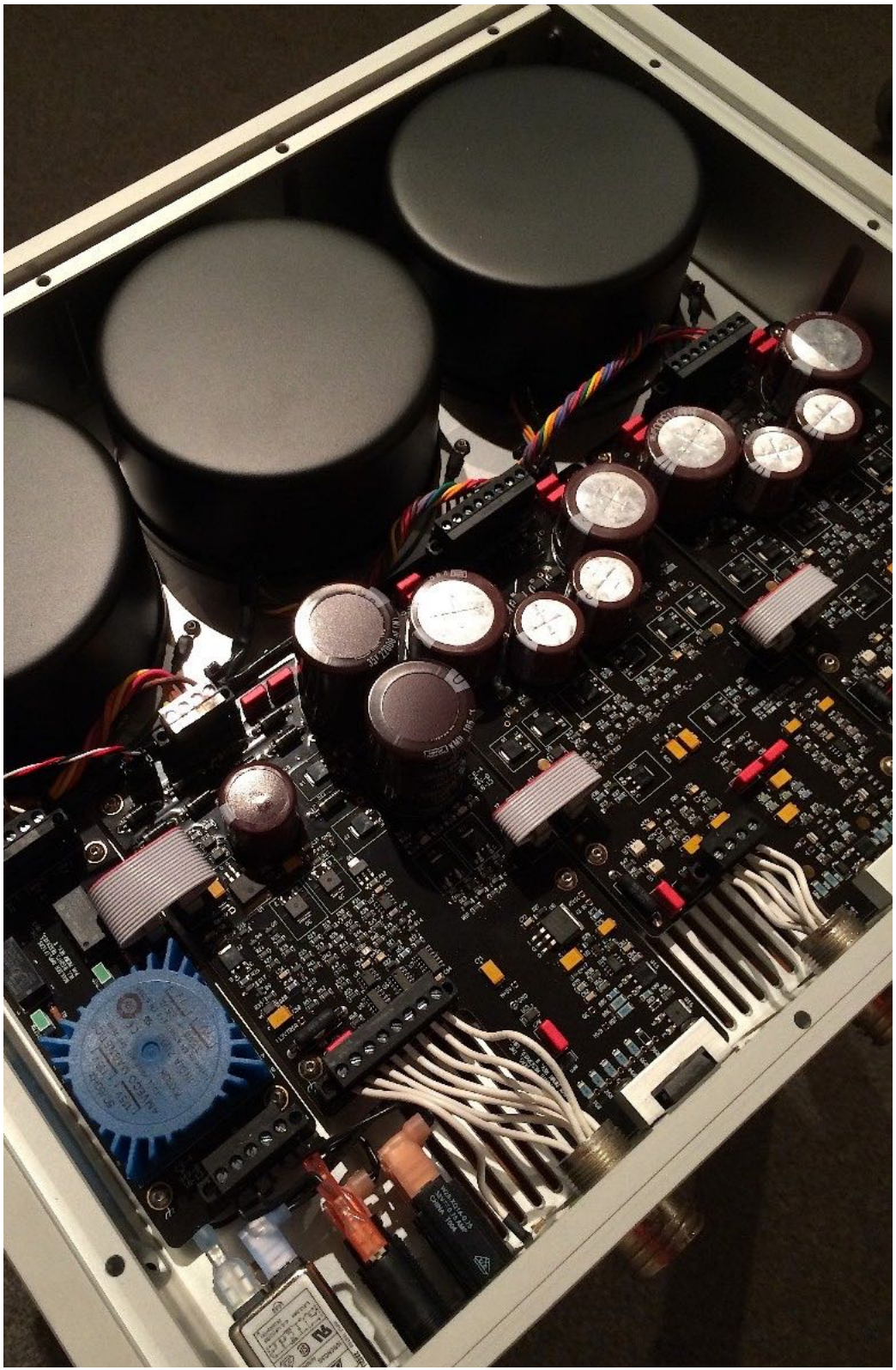


Power Supply

The 2100 Power Supply casework incorporates four independent power supplies in a separate housing to isolate them from the sensitive analog audio circuitry; a left channel power supply, a right channel power supply, a logic and user interface power supply and a standby power supply. All power supplies are manufactured with surface-mount componentry wherever possible on Boulder's own pick-and-place machinery.

The first stage of regulation is located on each power supply's circuit board. A second regulation stage is located in the main preamplifier section.

All supplies are linear. No switching supplies are used, as switch-mode supplies are a power solution based on economy rather than performance.

Each power supply within the 2100 features a protection scheme that monitors temperature and will shut down the supply in case of overheating. Power will be restored once thermal monitoring determines that the operating temperature of the affected supply has returned to normal. There is also a feedback line from the main preamplifier section that detects any type of excessive draw or short and will shut down the supply in case of a detected fault.

The three supplies are all connected to the preamp via DC cables terminated with military-grade locking connectors.

1. AC Mains

AC mains power to the 2110 is provided via a detachable-cord, 15-amp IEC connector. Incoming AC voltage is filtered for DC contamination prior to feeding each of the four individual supplies within the chassis.

All 2110s are built to operate at 100, 120, 200 and 240 VAC while still adhering to all published specifications.

2. Analog Power Supplies

The large, left and right channel analog supplies each feature a large toroidal transformer, substantial enough to power some small power amplifiers. Individual transformers ensure ideal noise isolation between each channel as well as faster and more efficient operation during periods of high output. The toroidal transformer design was specifically selected for power handling efficiency and low noise radiation. All transformers are manufactured in the United States to Boulder's standards and are potted and high-mass encapsulated in a custom formed enclosure. Transformer hum is not permitted.

Both transformers "float" in a sealed steel case fitted to the size and shape of the analog transformers. Each transformer is isolated from the case so that no contact is made between the transformer and anything that may transmit vibration. The case is magnetically shielded and high-mass encapsulated with a unique mineral, glass and epoxy resin potting compound to eliminate any hum or operational vibration. Each transformer assembly weighs over 8 lbs. (3.6 kg).

To further prevent the transformers

from emitting mechanical noise, a DC filter circuit blocks up to 3VDC on the AC mains. DC is one of the primary causes of transformer hum, thus this circuit is essential in order to maintain silent operation in any environment.

After bridge rectification, four large 1,800µF electrolytic filter capacitors are used to assure a low impedance supply to the analog stage. The use of distributed capacitors provides faster power delivery and recharging, as well as lower harmonic noise during operation, regardless of output power or load. Dynamic and transient response are thus greatly improved.

3. Logic and User Interface Power Supply

The digital or logic and user interface power supply also includes an initial stage of regulation prior to the preamplifier sections and powers the microprocessor control system, optical control sensors and transmitters and all front panel controls. It is fully independent to prevent any noise from the logic system from having any effect on the analog sections. The microprocessor system controls power-up and standby, Boulder Link, all of the remote functions, input switching, attenuator module operation, the user interface systems and all protection circuitry.

As with the analog section power supplies, the logic and user interface supply utilizes a large, fully potted and encased toroidal transformer and features a thermal detection circuit as well as excessive draw protection circuitry. A trio of filter capacitors totaling 46,200µF reserves enough energy storage to power the large front panel display while still maintaining all of the other microprocessor functions.

4. Standby Power Supply

The standby power supply maintains constant operation, even when the 2110 is placed in standby mode. It is responsible for turning on the analog power supplies and the logic and user interface power supply during use and reducing power consumption when not in use by turning them off. In order to meet European CE regulations, the 2110 will draw less than 1 watt when in standby mode. A small, potted toroidal transformer mounted directly to the standby supply circuit board powers a pair of relays that upon the amplifier being ordered to come out of standby mode will close and trigger the turn-on procedure for the entire preamplifier.

5. 2100 Chassis Casework

All metalwork in the 2100 chassis is machined in-house on Boulder's own CNC machining centers. It is then bead blasted and clear anodized.

Every piece of chassis metal is machined from a solid billet of 6061-T651 aerospace-grade aluminum and cut to tolerances of 0.001" and 0.0005" depending on the application. All metal is interlocking and damped to prevent any resonances from inducing microphonic distortions in the audio circuitry.

The 2100 rests on four damped and resonance controlled feet. These feet are made of nine parts and are constrained layer damped.

Input Section

1. Input Selection and Switching

The input selection is logic controlled. Audio signals are routed from each of the six pairs of inputs (L and R) by sealed, silver contact relays. After input switching, the audio signal is passed to Boulder 993S gain stages.

The input circuit is a true, full-balanced, differential, three-stage, instrumentation-style circuit terminated with 3-pin XLR connectors. This ensures that the audio signal passes from the source to the preamplifier free of distortion and noise by keeping the input impedance as high as possible in comparison to the output impedance of the source. Input impedance is a tested and verified 333k ohms per leg or balanced. This high input impedance ensures a much higher resistance to noise and flat frequency response. The instrumentation-style input design also ensures consistent electrical response regardless of frequency.

Matched impedances or transmission line circuits are not used, as the frequency spectrum of audio does not present reflected waves from the signal receiver and the benefit of resistance to hum is thus preferable.

Pin 2 of the XLR input connector is positive or "hot," and the preamplifier is non-inverting unless the polarity is switched via the remote control or front panel buttons.

All transistors in the input circuit are bipolar. FET-type transistors are not used to carry audio signal because of their lower reliability and much higher distortion levels. Bipolar devices are inherently more reliable and aren't prone to static-related damage. More importantly, the circuit topologies required for FETs are awkward, with high levels of pre-distortion required to drive the outputs.

The 2110 is a direct-coupled design with a servo eliminating up to 50mV of DC voltage offset passed along by the front-end source. The complete left and right analog sections are optically coupled to prevent any ground noise contamination from affecting any aspect of the audio circuit.

Maximum input voltage before clipping is 7 Vrms.

Analog Sections

1. 993S Gain Stage

The 2110 incorporates up to +20 dB of overall line gain. The gain stages in the 2110 are Boulder's proprietary 993S gain stage, a discretely implemented surface-mounted and encapsulated operational amplifier evolved from the 993 gain stage used in the previous generation of Boulder's 2000 Series products. The 993S is a high-current output design that maximizes the benefits and low distortion of discrete design. Six 993S gain stages are used in each channel of the 2110. The 993S operates with +/-24V rails and features exceptional headroom for ideal signal-to-noise ratio. Each 993S provides input buffering and voltage gain with a high slew rate, wide bandwidth, high

current output, low distortion and low output impedance.

The 993Ss in the 2110 are implemented on small, surface-mount circuit boards that are assembled in-house on Boulder's own pick-and-place machines and board ovens. Surface-mount technology allows for smaller PCB real estate (which decreases PCB capacitance) as well as elimination of lead inductance and optimized ground planing. After the circuit board assemblies pass initial testing, the boards are mounted in a Boulder machined housing and potted with a proprietary mineral and epoxy compound to control microphonic resonances and evenly distribute and stabilize heat generated by the circuitry. The entire 993S assemblies (three each for positive and negative halves of the waveform per channel) are then retested prior to installation and trimmed using an automated, computerized process that evaluates up to 10,000 different resistor value combinations to match each 993S to a predetermined engineering specification. During operation they are plugged into the left and right channel analog section's main circuit board to provide input buffering and gain for the incoming audio signal as well as buffering for the preamplifier's output.

2. Feedback Theory and Use

Correct and appropriate levels of feedback are used for achieving ideal operating parameters, including gain determination, constant group delay across the entire bandwidth (maximally linear phase response) and bandwidth limiting.

A hallmark of Boulder designs is a thorough *understanding* and *proper use* of feedback. Decades ago, the use of feedback developed a poor reputation as designers asked the then new, integrated operational amplifiers to do something they weren't capable of due to their slow speed. Early monolithic op-amp designs were not fast enough to keep up with feedback loops in wide-bandwidth applications, resulting in horrible distortions. Less enlightened designers who didn't know how to solve the problem simply tried to remove the feedback, which also resulted in further compromised sound and again increased distortion. This philosophy still exists in a number of hobbyist workshops today.

In 1984 the Boulder' 500 showed the audio community, perhaps for the first time, that the proper use of feedback in combination with proper discrete operational amplifier design results in vastly improved sound and measurably lowered distortion. The gain of the output stage could thus be reduced and its bandwidth increased. The resulting design had lower distortion than any single-stage design.

3. Balanced Volume Attenuator

The 2110 features Boulder's first fully-balanced volume attenuator. All previous generations of Boulder preamplifiers used the volume attenuator as a summing device within the overall balanced circuit design. The new the volume attenuator in the 2110 is true differentially balanced to

eliminate any trace of step noise when the volume control is actuated as well as maximize resolution of the audio signal passing through it.

Volume attenuation in the 2110 is via an optically activated, microprocessor controlled and CMOS switched resistor ladder network. Each step in the volume control is the result of a set of precision discrete resistors arranged in series to adjust the volume level.

A range of 100 dB via 0.1 dB, 0.5 dB or 1.0 dB steps of volume adjustment is available, from infinite attenuation (no output) to 0.0 dB (maximum output), with 0.5 dB steps set as the factory default. The different steps of resolution in the volume control are contained in their own sealed and potted volume attenuator modules. The left and right channels each have their own attenuators. Operation of the volume control remains linear and avoids the wiper noise and impedance shifts present in traditional volume pots as well as the non-linearity of FET (transimpedance) volume controls.

At maximum output, the 2110 will produce +20 dB of voltage gain (balanced) above line level and a maximum output level of 28 Vrms.

Output Section

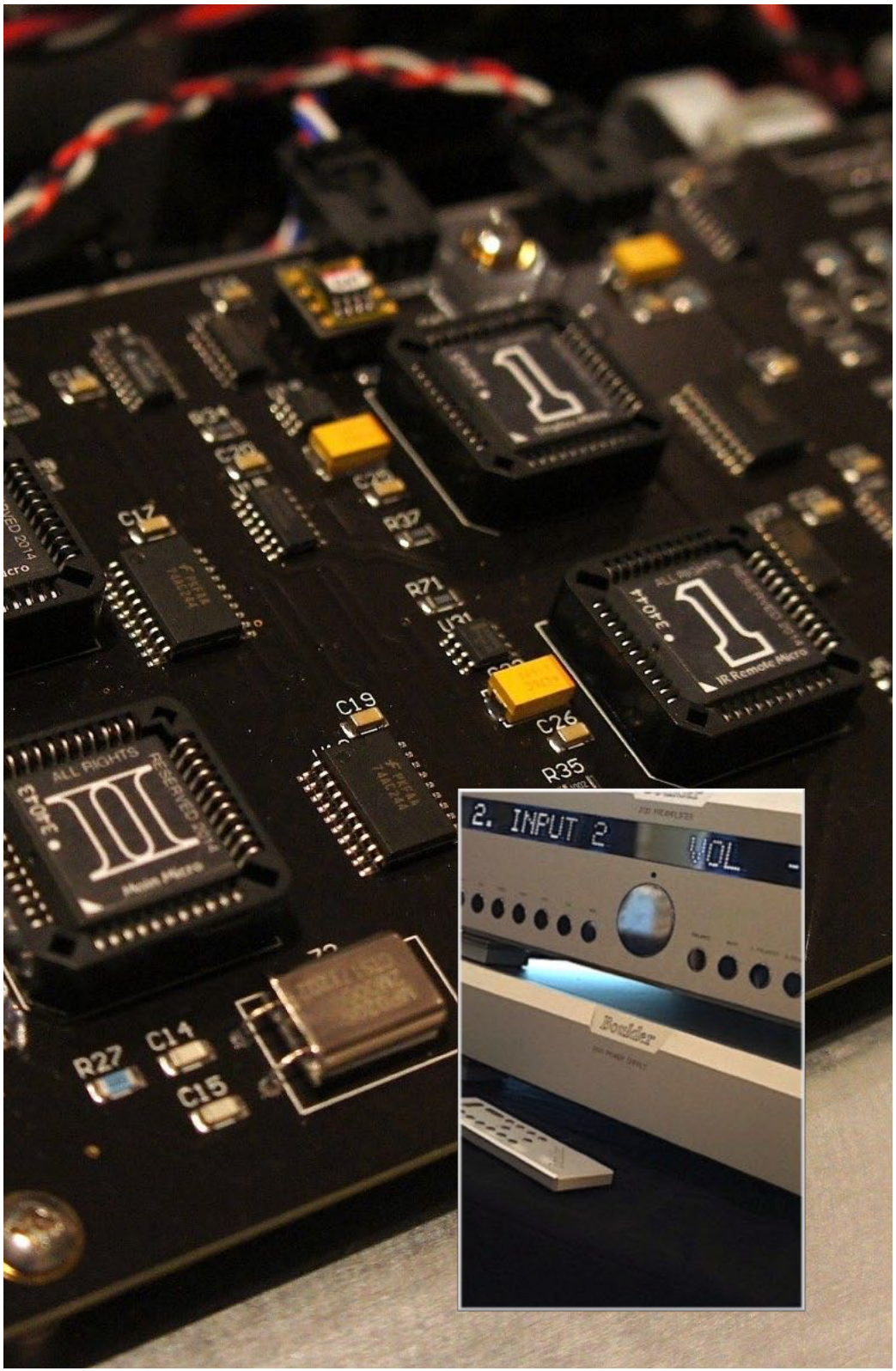
1. Main Outputs

Three pairs of balanced main line outputs are provided and connected in parallel. Thus, no individual pair of the main outs has a sonic advantage over the other. The 2110 output section is buffered by 993S gain stages. The extremely high current output available in the 2110 enables it to drive any length of cable without the inductive and loading effects of the cable having an impact on the electrical characteristics of the 2110's output section. Frequency response, group delay, and absolute minimal distortion levels remain unchanged regardless of the length or characteristics of the cable.

2. Auxiliary Outputs

One pair of auxiliary outputs on balanced XLR connections is also present. These output pairs can be used for recording or secondary line-level feeds. The auxiliary outputs are not affected by the volume control and are connected directly to the output buffering of the 99S3 gain stage prior to the attenuation circuit. Gain for the auxiliary out circuit is -1 dB.

At maximum output, the 2110 will produce +20 dB of voltage gain (balanced) and a maximum output level of 28 Vrms.



Microprocessor, Programming and User Interface

1. Monitoring and Protection

The 2110 user interface is comprised of dual dot matrix LED displays and a set of microprocessor controlled front panel functions. All of these functions are also available on the hand-held IR remote control.

The 2110's display is provided by a pair of 7/8" tall, 12 character, alpha-numeric, dot matrix LED displays. The LEDs are white to increase visibility in a darkened room. The left display normally indicates the selected input and the right display normally indicates the volume setting. All inputs can be programmed to name the input in caps, lower case, Katakana, and/or symbols.

The chassis-width display window is custom, hand-ground, mirror-coated Pyrex glass (not acrylic, plexiglas, or plastic to prevent warping, scratching and poor legibility). Mirror finishing is done to Boulder specifications to retain optimal legibility with no halo effects or blurring while still remaining mirror finished when the unit is in Standby mode. The display can be programmed for eight different levels of intensity as well as a setting to turn the display off entirely. When a button on the front panel or IR remote control is pressed, the display will illuminate for a period of five seconds before returning to the Display Off mode.

Functions for Standby, Display Brightness Adjustment, Programming Features, Mute (programmable fixed attenuation), and Left and Right Channel Polarity (0° and 180°) are available, along with buttons for the direct selection of each of the six inputs, auxiliary output and the volume control disc.

All actions and user interface functions are controlled by an advanced microprocessor section. This circuit board is located in a separate enclosure beneath the left and right analog section cases. Four microprocessors and three F-RAMs control the operation of the volume attenuator modules, display functions, mechanical input selection, all user interface controls, turn-on/turn-off procedures and protection circuits associated with each power supply. F-RAM or Ferroelectric RAM is a non-volatile random-access memory that uses a ferroelectric layer. F-RAM is a new, alternative, non-volatile random-access memory technology that offers the same functionality as flash memory. Though more expensive than flash, F-RAM's advantages include lower power consumption, faster write performance and a much greater maximum number of write/erase cycles.

Pressing any of the user interface buttons triggers activation of a relay to actuate the intended function. Rotating the volume control disc activates the microprocessor and triggers CMOS switching to select the specific resistor set required to attenuate the output to correspond to the indicated decibel reading on the display. All output levels are tested to maintain accuracy from each individual step of volume attenuation.

External Control

1. Infra-red Remote Control

The 2110's hand-held IR remote control is the smallest and lightest remote ever included with a Boulder product. It is machined out of a solid billet of 6061-T6 aluminum. It includes 15 buttons cut from stainless steel that are hand-polished by Boulder technicians in a 9-step process to match the mirror glass display window and front panel buttons. The batteries in the IR remote control are CR2032 3V "coin"-style batteries that feature a leak-proof design in order to prevent damage from the battery acid leaks that can occur when traditional batteries age.

The IR remote is designed to work from a distance of 35 feet and an off-axis angle of 70 degrees.

2. Boulder Link and IP Control

The 2110 has been designed to be seamlessly integrated into custom home installations as well as incorporated into systems with legacy or current Boulder Linked products.

The Boulder Link system is a proprietary system of inter-component communication, specific to Boulder products. It is an RS-435-based communications system that enables a single component to behave as the "master" in a system and initiate power-up, power-off and volume commands as well as transmit any protection or warning notices to the master Boulder product with an alpha-numeric or LCD display. In the 2100 Series, Boulder Link is a continuously scanning system that monitors and keeps track of individual components and all of their status and associated protection circuits.

Upon power-up, a 2110 will detect any other 2100 or 3000 Series amplifiers connected via Boulder Link. It will then communicate with them via microprocessor and automatically determine the proper sequence and rate in which to turn on each amplifier so as to prevent excessive AC line current draw. When connected to 800, 1000 and 2000 Series components, the products will automatically be turned on in the sequence programmed into the products themselves when the 2110 is powered up.

Ethernet connection options have also been made available that will allow IP (internet protocol) control of amplifier turn-on and turn-off.

Provisions have been made available for the control system to inquire with the amplifier about the status of each protection circuit and operating parameter, which can then be fed to outside control displays, such as those from Crestron, Savant, AMX and others.

A 12V trigger via a 1/8" mini-jack connector is also available on the rear panel of the 2100 Power Supply to control the standby function of the amplifier in a trigger-based installation. Both pulse on/off and continuous DC voltage trigger functions are supported.

Mechanical Design

The mechanical design of the 2110 was centered around three principles: elimination of mechanical resonances, efficient heat dissipation and unique aesthetic design. All casework was designed on advanced 3D CAD systems and machining tolerances are held to within 1/1000 or 5/10000 of an inch, depending on the application of the metalwork.

All exterior metalwork of the 2110 is damped, either via the use of direct application of damping materials or by adjoining one subassembly to another in order to significantly raise the resonant frequency of the compound assembly.

All brute supply transformers within the power supply are potted and DC filtered to eliminate mechanical resonances. The smaller standby transformer is mounted a separate circuit board along with all of the microprocessor circuitry for ideal separation and isolation.

1. PCB Mounting

All circuit boards within the 2110 are fastened with stainless steel hardware onto machined mounting assemblies that are custom cut for each circuit board. A non-conductive layer of pliable damping material is then sandwiched between the circuit board and the bard mounting assembly in order to prevent any vibration or resonance from inducing microphonic distortions.

2. Interlocking Structure and Damping System

No sheet metal is used in the construction of the 2110. All chassis parts are machined and interlocking and are secured via stainless steel hardware to prevent corrosion in harsh or salt air environments. The interlocking chassis component design has been implemented to eliminate resonances through harmonic cancellation. When bolted together, the individual harmonic resonances of each chassis part will raise the overall resonant frequency of the entire structure to well outside the audio bandwidth.

All chassis covers are machined with a slight arc in their shape in order to create tension against the mounting hardware upon installation. This performs the dual function of keeping the top cover tight and rattle-free and preventing any future loosening of screws without the need for any type of locking compound. Once in place, the top cover is held in place via counter-sunk stainless steel screws.

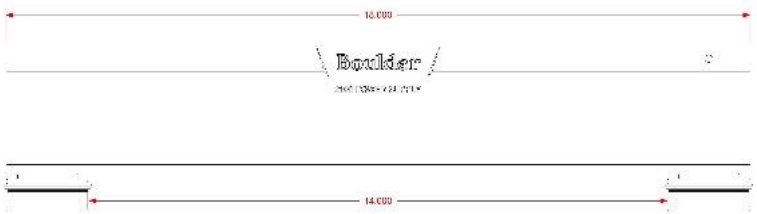
The power supply and preamplifier chassis are supported on multi-layer feet comprised of a nine-piece system of damping and shock absorption. Each foot is made of a machined aluminum main housing and a polished stainless steel insert that incorporates two layers of damping material (one firmer and one softer) in a constrained layer damped arrangement, isolating the power supply and preamplifier from any direct coupling to the surfaces on which they are placed. This eliminates the need for any specialty racks, shelves, or isolation accessories.

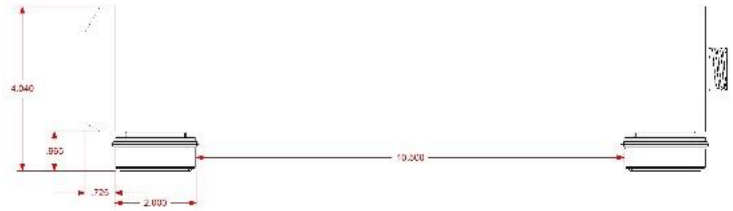
Technical Specifications

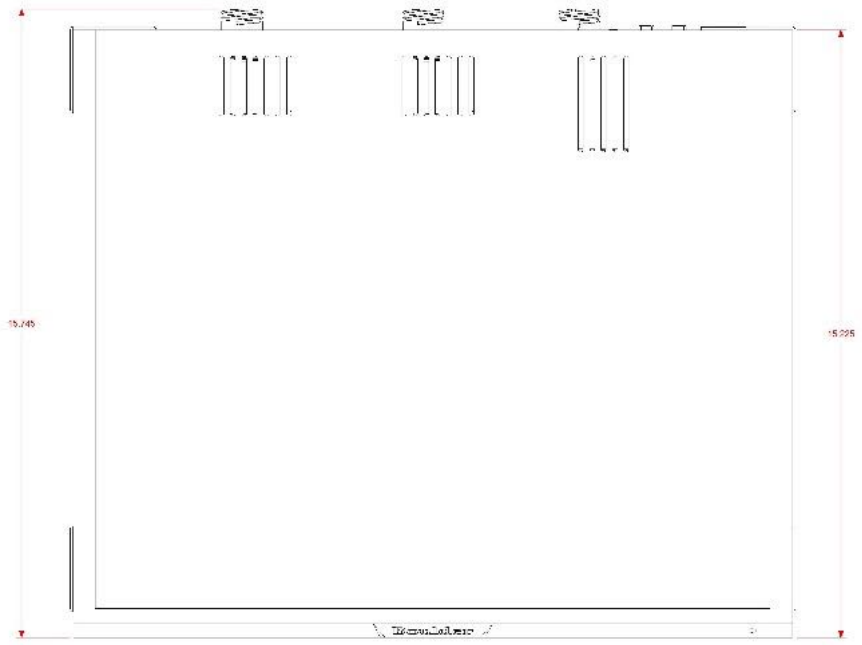
Balanced Inputs	6 pairs, 3-pin XLR
Main Balanced Outputs	3 pairs, 3-pin XLR
Auxiliary Balanced Outputs	1 pair, 3-pin XLR
Maximum Input Level	7 Vrms
Maximum Output Level	28 Vrms
THD+N, 2V Output from 20 Hz to 5 kHz	0.0008% (-102 dB)
@ 20 kHz	0.001% (-100 dB)
Maximum Voltage Gain	+20 dB
Volume Range	100 dB
Volume Steps	0.1, 0.5, 1.0 dB, ±0.01 dB
Auxiliary Path Gain	-1.0 dB
Frequency Response, 20 Hz to 5 kHz	+0.0 dB, -0.03 dB
Frequency Response, -3 dB	0.02 Hz & 300 kHz
Crosstalk, L to R or R to L	-134 dB, 20 Hz to 20 kHz
Crosstalk, Adjacent Inputs	-134 dB, 20 Hz to 20 kHz
Crosstalk, Main to Auxiliary Outputs	-130 dB, 20 Hz to 20 kHz
Input Impedance	333kΩ, Balanced
Output Impedance	100Ω, Balanced
Power Requirements	90-120V/200-240 VAC, 50-60Hz
Power Consumption	240W Max 85W On (Idle) 500mW Standby

All specifications measured at 240VAC mains power

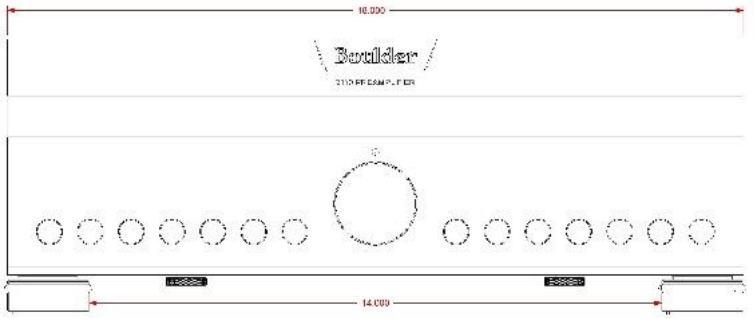
Mechanical Specifications: 2100 Power Supply

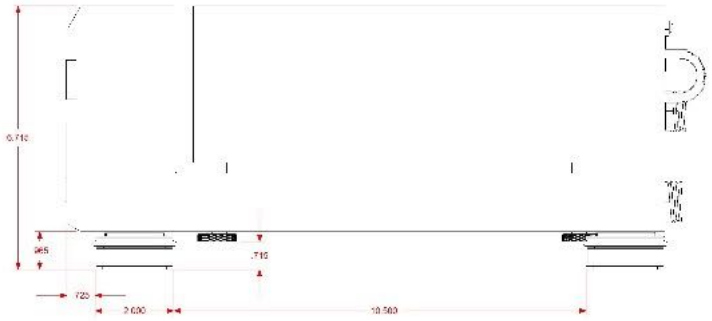


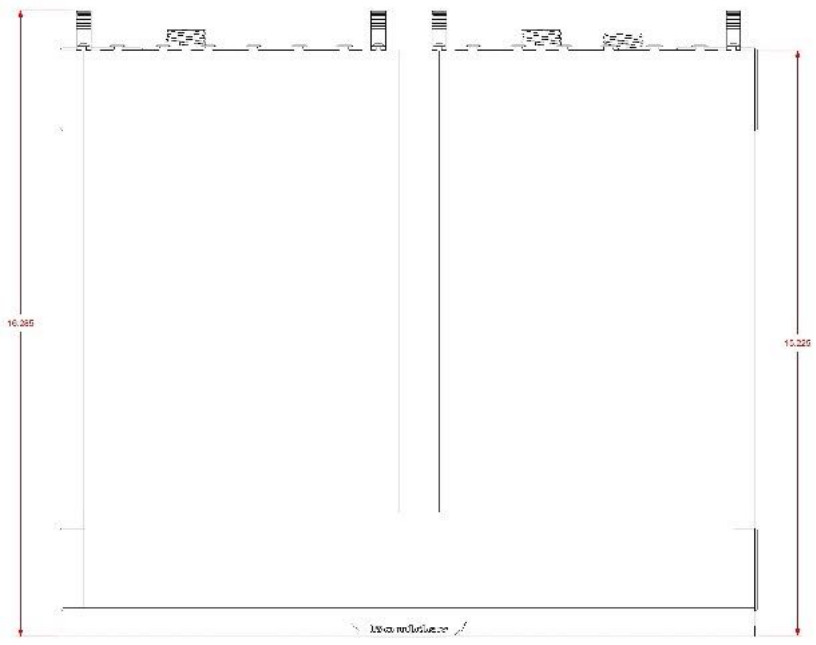




Mechanical Specifications: 2110 Preamplifier







Boulder Amplifiers

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