



M O O N

TECHNICAL WHITE PAPER

MOON i-5 Integrated Amplifier

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November 2002
Revision: 9

Company Philosophy

Keeping an open mind and producing the best products at every price point is Simaudio's basic design philosophy. We strongly believe in the long term use of products and are against forced or premature obsolescence. Consequently, we will never manufacture a product under a certain level of performance, where the lower limit is determined by 1) the costs associated with high quality electronic components and 2) the R&D investment to achieve a long lasting durable design. As well, our manufacturing facility addresses numerous environmental concerns that include Recyclability, careful attention to packaging and the ROC cleaning process for aluminum and steel.

Purchasing a component represents the beginning of, what we see as a long term relationship between Simaudio and the customer.

Design Philosophy

Simaudio has been designing integrated amplifiers since the early eighties. When we recently launched our state-of-the-art MOON product line, it was mandatory to include an integrated amplifier. By incorporating some of the same technologies found in our stand alone MOON amplifiers and pre-amplifiers, we have developed the i-5 Integrated amplifier.

These technologies include "**Advanced Renaissance**" common to our MOON amplifiers and featuring a no overall feedback design which uses a very precise differential circuit employing only 1 step of local feedback (found in the output stage to maintain low THD). The result is **virtually non-existent intermodulation distortion** (which is far more damaging than harmonic distortion) and **an extremely fast amplifier with no phase errors resulting from feedback**. More importantly, with this circuit topology, the speaker cannot send back its counter-reaction after a musical impulsion which normally leads to a reduction in clarity of the music, a lack of tonal accuracy and the feeling of the live performance being lost. As well, a more natural type of sound is achieved when there's no feedback circuit found in the gain stage, but this comes at a small price; The i-5 has to be fully "broken-in" and warmed up for at least 3 days to reach optimal performance. Since this integrated amplifier is designed to be powered up at all times, this really isn't an inconvenience.

A **lean design** is another relevant MOON technology used here; The shortest possible signal path is the result of eliminating all potential sources of signal interference. In the case of the MOON i-5, **the signal path measures fifteen inches in length** (from input RCA to output binding post). Sonically, a faster transient response is achieved, thus bringing the listener that much closer to the music.

We decided to **minimize signal path obstacles** by using a passive circuit for the preamplification section. This circuit is void of both carbon-based parts (resistors, pots, etc) and capacitors; both of which adversely affect the signal by introducing coloration and a degree of inaccuracy.

Designing the MOON i-5 **gain stage** required a substantial R&D effort. After a great deal of time and effort, we selected an electronic component manufactured by Crystal. This device functions in a slightly different way than an M-DAC, but it basically reproduces our “**RBG circuitry**” in a single chip configuration. RBG technology (Richard Benoit Gain - named after the engineer who developed this circuit) is found in our MOON P-5 preamplifier. By applying more or less impedance (using a network of relays) in a shunt to ground mode against the input signal, we can increase or decrease the gain without degrading the quality of the audio signal, regardless of the selected level of gain. Since physical space was a major consideration inside the MOON i-5, we elected to go this Crystal device and assigned it the name RBG-cy to make a distinction between it and our other gain control circuits. This device helps to achieve a major goal of RBG technology; minimize the signal path length, and consequently preserve the signal from PCB dielectric coloration.

Finally, there was the mandatory requirement for an **outstanding power supply**. Through the use of high quality components with low resonance characteristics, including **our own proprietary designed toroidal transformer** (see VPI process in technical design features), we have provided as much current stability as is physically possible. The result is improved precision and control of the musical signal. This was a major area of concern considering that this power supply feeds both an amplifier and preamplifier circuit.

Significant Integrated Amplifier Characteristics

- Larger than average power supplies.
- Stable to most known speaker impedance.
- Class AB output, Class A to 5 watts for greater efficiency.
- No overall feedback resulting in:
 - a) Real-time amplification
 - b) More accurate music with respect to tonality
 - c) Greater musical fidelity
- Low power consumption; The Simaudio Moon i-5 amplifier is designed to be powered up at all times for optimal performance.

General Description and Specifications

Type.....	Solid State
Configuration.....	Dual Mono (partial)
Transformers.....	0.5kVA at 6% regulation
Power Supply Capacitance	40,000 μ F
Class of operation	Preamplifier - Class 'A' / Amplifier - Class 'A/AB'
Remote.....	All-Aluminum Simple Function
Single-Ended Inputs (RCA).....	5 pairs
Input Devices Types - preamp.....	J-FET
Input Sensitivity.....	300mV - 3.0V RMS
Input Impedance.....	14,000 ohms
Tape output.....	1 pair
Preamplifier Output.....	1 pair (for another amplifier or subwoofer)
Output Device Types - Amplifier	Bipolar - 1 pair per channel
Output Binding Posts.....	WBT (shielded)
Output Power @ 8 ohms.....	70 Watts per channel
Output Power @ 4 ohms.....	110 Watts per channel
Output Impedance.....	0.04 ohms
Damping Factor.....	> 200
Gain Control.....	RBG cs version
Gain.....	30dB
Dynamic Headroom	3dB
Signal-to-noise ratio.....	97dB @ full power
Maximum Output Voltage.....	23.5 Volts
Slew Rate.....	20V/ μ s
Maximum current	16 amperes peak / 9 amperes continuous
Frequency Rspnse.....	10Hz – 75kHz (+0/-3dB)
Crosstalk @ 1kHz	-50 dB
IMD.....	Unmeasurable
THD (20Hz – 20kHz @ 1 watt)	< 0.1%
Phono Section	Optional IPS (external)
Power consumption @ idle.....	40 watts
Shipping Weight.....	26 lbs. / 12 kgs.
Dimensions (w x h x d)	19 x 4 x 15 inches / 43 x 10 x 38 cm.

Technical Design Features

In designing the MOON i-5 Integrated Amplifier, it was essential that the power supply be outstanding - not just adequate or substantial. The key to this outstanding power supply is a powerful 500VA proprietary designed transformer. However, one essential detail almost always ignored in the technical discussion of amplifiers must be addressed here: The transformer's regulation factor. Audiophiles are all too often interested with the power of transformers when comparing various amplifiers. The difference between 500VA and 1000VA means very little on its own unless a regulation factor accompanies the VA figure. Simaudio transformers have regulation factors ranging from 3 to 6 percent. Perfection, in theory, would be 0 percent, but this isn't feasible. In the case of a fully regulated power supply, the regulation factor can be overlooked, but this type of power supply would substantially drive up both the price and size of the audio component, subsequently defeating what Simaudio set out to accomplish in designing the MOON i-5 Integrated Amplifier. Transformer regulation factors as bad as 20 percent are common-place in the audio industry. The Moon i-5 has a factor of 6 percent.

Transformers experience a multitude of losses, each of which will contribute to degrading the performance of an audio component. Unfortunately, most high-end audio manufacturers have no background in transformer design, and therefore, will simply order them from a transformer manufacturer by simply specifying the VA, the different voltages and perhaps the regulation factor. The end result is what you find in a majority of the audio equipment available; a low efficiency, a poor regulation factor, high heat losses, high eddy current losses, vibrations and a great deal of magnetic field losses. All of these negative elements find their way into the audio signal and reduce the sheer purity of the music. Luckily for Simaudio, John Poulin (President and Director of Research & Development) has an extensive background in transformers from his experiences in the Telecommunications industry, where leading edge technologies are often developed and/or used.

The grade of steel used in the transformer core will have a significant impact on the amplifier's sonic character. With respect to "M" designations, M1 is regarded as the highest quality grade of steel. The steel used in the transformer cores found in Simaudio gear exceeds the quality found in the M1 grade. It is a high quality Japanese steel which is slowly rolled with extreme precision, possesses superb chemical purity and properties of losses. The transformer design itself is made with less flux density than usual, thus reducing the sensitivity to electromagnetic disturbances. As well, we use a very unique process called VPI, vacuum pressure impregnation, on the core to reduce its mechanical micro vibration that often disturbs the sonic purity in any electronic environment. At this point it should be fairly obvious why Simaudio has put so much effort into its transformer designs.

Chronologically, here are some of the significant highlights of the transformer manufacturing process which we call the *VPI (Vacuum Pressure Impregnation) Process*.

- The core is made from a very accurately processed steel imported from Japan.
- These cores are first placed into a vacuum chamber where -28 PSI is applied for 15 minutes, removing any air pockets trapped inside the core structure.
- Epoxy resin is then released from a holding tank into the vacuum chamber, filling any microscopic gaps that may exist in the cores.
- Pressure is then applied at +30 PSI for 15 minutes, causing the resin to return to its holding tank. Chamber pressure is then stabilized to a normal level.
- These treated cores are then baked at 300 degrees Fahrenheit for 8 hours.
- Core insulation is then applied for mechanical, temperature and electrical protection.
- All transformer wire is Class H type for the longest possible lifespan.

These custom toroidal transformers function at a very low temperature (the same as their operating environment) due to their stress-free performance characteristics. The result is an electronic component with a much longer life expectancy.

The MOON i5 power supply then splits into two sophisticated bridges using ultra fast recovery diodes on the output stage for a dual mono power supply. The input gain stage uses a dual mono fully regulated power supply section. We believe this is the only way to achieve no-compromise high-end performance.

Input stage devices are very high quality and precisely matched J-FETs. They are employed in the circuit based on their sonic merits and also because they are very accurate. We need this kind of precision in our open loop input section with no feedback where we can only rely on parts quality and stability. These devices produce a very natural harmonic structure for signal amplification.

Output stage devices are a new Motorola Bipolar design. We could have used MOSFETs, but since we already use Bipolar devices in all our amplifiers, we decided it best to maintain our successful recipe. These devices are matched on the basis of their HFE characteristics to tolerances of 0.5% or better. For those who believe that either a MOSFET is better or a Bipolar is better, we have one point to make: Any technology can either be well implemented or poorly implemented. They all have their strengths and weaknesses, and they're all capable of producing excellent results.

The MOON i-5 Integrated Amplifier has two circuit boards; one for audio and one for the digital control section. **The main audio circuit boards are made of FR4 material** and have a thickness of 0.062 inches. The base has 2 ounces of pure copper. The plating on top of the base is 1.5 ounce pure copper for a total of 3.5 ounces. This reduces impedance inside the circuitry affecting the sound by yielding better timbre and rhythm of music, as well as offering slightly extended dynamics.

Extremely rigid chassis construction minimizes the effects that outside vibrations have on the amplifier's performance, thus reducing mechanical coloration to the music. As well, mechanical grounding is addressed through the use of four height adjustable cylindrical cones which screw onto the amplifier's base. Not only do all the physical aspects of the chassis serve a purpose, they all come together to form an extremely attractive audio component. Speaker outputs are the heavy gold-plated binding posts chosen for both their sonic merits and build quality.

The Moon i-5 Integrated Amplifier has 5 single-ended inputs, including a preamplifier output, via pairs of gold-plated RCA connectors with teflon dielectric insulation. The A-4 single-ended input completely bypasses the gain stage, therefore allowing the input source component to be controlled by it's own volume setting, a home theatre processor for instance. This bypass feature can be defeated.

The highest quality electronic components are used throughout the MOON i-5:

- Vishay Dale metal film resistors with tolerances of 1% or better.
- Film Capacitors from Phillips, Ero, Wima and Thompson.
- Electrolytic Capacitors from Nichicon, United Chemi-con and Cornell.
- Output section wiring is custom proprietary silver plated OFC copper with Teflon insulation.
- All other signal path wiring uses silver plated copper with Teflon insulation.

Other significant design factors include:

- The use of 2% silver alloy multicore solder throughout the circuit for better accuracy and precision of the audio signal.
- Short signal paths for better dielectric coloration factor.
- Tight component match in all critical positions for better transparency.
- Symmetrical circuit design for better focus and soundstage.
- Low impedance capacitor networks for better transient response.
- Teflon dielectric on specific wires for better dielectric coloration factor.

Quality Control

By this point, it must be quite obvious that Simaudio pays careful attention to quality control throughout the each stage of the entire manufacturing process, From the selection and inspection of individual electronic components through to final testing and packaging. Simaudio pays extra special attention to all soldering during the assembly; *We encourage the experts to take a good look at our soldering joints.* Simaudio achieves this high quality through the presence of two key staff members; Our Main Engineer is class 3 certified (the highest level, even surpassing aerospace requirements) and our Head of Production is class 2 certified (above standard household products). We believe this calibre of soldering is mandatory for both heavy gauge wire and PCB traces. When not properly soldered, these joints can seriously jeopardize long term product reliability.

Once assembled, each MOON i-5 Integrated Amplifier undergoes a rigorous test procedure. Some of the more significant aspects include:

- Visual inspection
- Voltage level measurements
- Distortion, Bandwidth & Crosstalk testing
- Damping factor verification
- Bias calibration
- Minimum 24 hour burn-in
- Precision tuning calibration including fine bias adjustments
- Listening tests

Our commitment to the reliability and quality control invested into each and every MOON i-5 Integrated Amplifier is backed up by a ten year factory warranty.

The Simaudio MOON i-5 is our 'statement' integrated amplifier. It's a zero overall feedback, using an in-house designed proprietary transformer, short signal path, ultra high performance gain control section and some of the finest electronic components available. The result is an exceptional sounding integrated amplifier capable of handling many speaker loads. This is a product that is built to last while providing musical nirvana for many years, and furnished at an extremely competitive price.