First Watt

SIT-4 Power Amplifier

Read Me First

I fully realize that many, if not all, owners will rush to hook up the amplifier without reading this operating manual. I don't blame you – I don't read them either. However, this amplifier is a little different, so if you only read this page you will might save us both some time.

Heat and Ventilation - This amplifier consumes 200 watts and mostly converts it into heat. Pick a location where the amplifier can get some fresh air to help keep it cool, not in a closed cabinet. Give it some space.

Output Connection - You can pretty much hook this amplifier up to any loudspeaker without danger of damage. Note, however that the (+) Red output connection is actually grounded. The (-) Black output terminal is the live connection. This can be important when you are hooking up active subwoofers to the output of the amp – treat the Red output terminal as common ground, and the Black output terminal as active.

Warmup - The amplifier takes a little while to fully warm up. During this time you can listen to it, but you will find that the performance gets a little better inside a half hour or so.

OK, now you can go play.

Introduction – Commentary by Pass

The SIT-4 is the most recent amplifier produced by First Watt, and is the fourth to use Static Induction Transistors (SIT) as the power amplifying device. In 2011 we introduced our first SIT amplifier using a custom Silicon Carbide (SiC) transistor part made by SemiSouth. The amplifier used a single power device, operating without feedback in single-ended Class A "Common-Source" mode to deliver 10 watts of power emulating the characteristic of a Triode, but operating at voltage and currents directly needed by loudspeakers, eliminating the output transformer.

The success of the monoblock SIT-1 led to the SIT-2, which offered similar performance at higher efficiency, and two channels in the same chassis. 2018 saw production of the SIT-3 which operated the SIT transistor in Common-Drain (follower) mode, again without feedback which was available until 2023.

Some years prior, SemiSouth suffered bankruptcy and we found ourselves unable to acquire more of this special part. However there was a company in Japan - Tokin, known for making industrial Silicon SIT parts suitable for audio use. Their production facility was destroyed the Fukushima earthquake, but we were able to acquire these parts from existing inventories of the Tokin devices over a period of several years. These large Tokin SITs enjoy that same Triode character, but at higher voltage, current and power ratings than our original SITs.

A special variety of Jfet invented in Japan in the 1950's, in the 1970's SITs enjoyed popularity in the "Vfet" power amplifiers from Sony and Yamaha that are still highly regarded in high end audio. Ultimately the difficulty and expense of SIT manufacture made them less competitive compared to later bipolar transistors, and it is only more recently that their superior qualities have been recognized for high end audio.

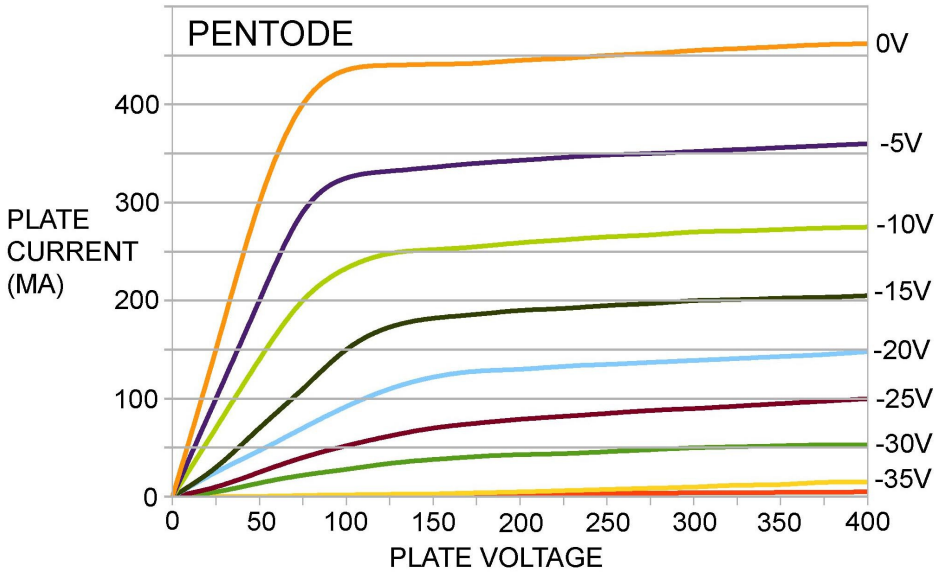
SIT devices have a unique characteristic which is of particular value for audio amplifiers. Quoting inventor Nishizawa's patent abstract, "(The) drain-current to drain-voltage characteristic simulates the anode-current to anode-voltage characteristic of the Triode vacuum tube very closely."

As with Triodes, the characteristic curves of the SIT allow operation on Class A "load lines" that can determine the relative values of second and third order harmonics and have little in the way of higher order distortion. It is a now a common observation that the most appealing sound tends to come from a dominant second order harmonic character followed by a lesser values of higher order harmonics.

SITs continued to be used in microwave, radar and other exotic applications, but after Sony and Yamaha ceased production, they largely disappeared from audio amplifiers. Recently there has been renewed interest in SITs, partly because two audio companies stepped up and spent the money required to fabricate new devices suitable for audio power amplifiers.

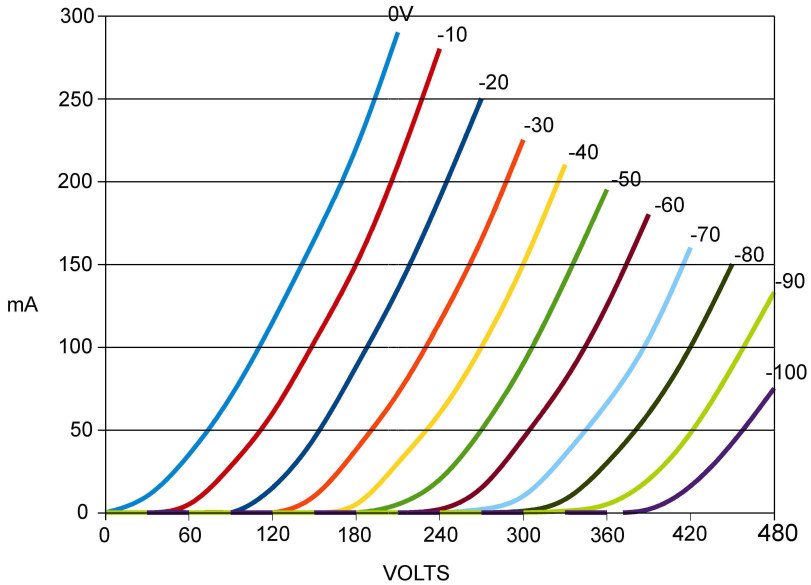
The first of these was Digital Do Main in Japan, which produced at least two audio amplifiers based on newer Tokin versions of original Yamaha parts. The other was First Watt, with the SemiSouth Silicon Carbide 50 watt device in the SIT-1, 2 and 3. The new SIT-4 uses the Tokin THF51s rated at 600 volts, 30 amps and 400 watts in a 10 watt/ch amplifier.

To see what's special about SITs, we start with a look at the curves of a Pentode tube. This graphic describes the amount of current which will flow through a Pentode as a function the Plate to Cathode voltage with eight different values of the Grid control voltage.



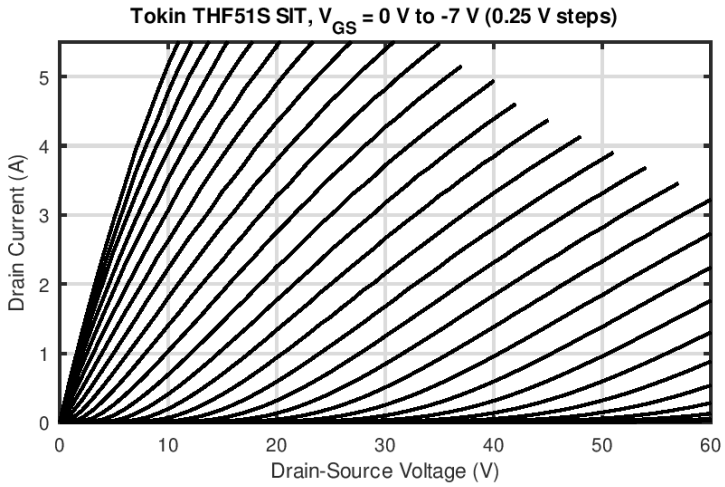
The behavior of an ordinary Jfet or Mosfet is very similar. As with the Pentode, the current flowing from Drain to Source in a Fet will flatten out as the voltage between those pins increases. In this regard Mosfets have a similar shape to the curves of Bipolar transistors, except that Bipolars use input current for control instead of voltage.

By contrast, Here is a set of Triode (300B) curves:



300B TRIODE

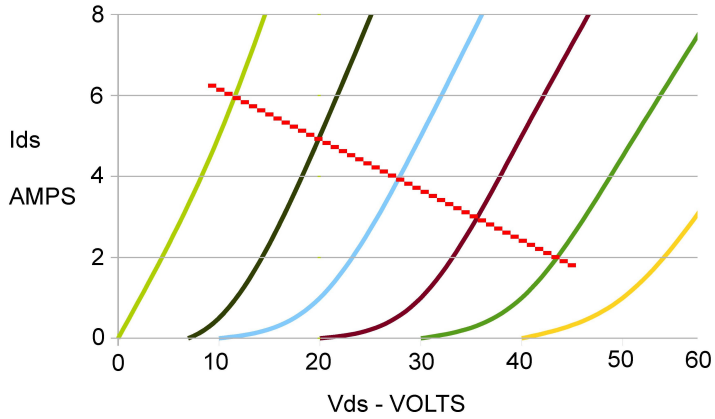
In a Triode the current through the device depends not only on the control pins but also the voltage across the device, similar to a resistor whose value is controlled by the grid voltage:



Audiophiles have gone to great expense to achieve as little as 1 watt of power using Triodes because of their specific sonic character. Unfortunately Triode performance is limited partly by the need to transform the high voltage / low current operation of the Triode down to the low voltage / high current domain of loudspeakers. This means an output transformer and the limitations/expense that come with it.

It has been a goal of some designers to get transistors to sound like Triodes, with limited success. Fets can sound like Pentodes, but it takes some gyrations to make a conventional Fet to resemble a Triode. There are two things we want out of a solid state device for this purpose. We want a “square law” input characteristic like that of tubes (which Fets are good at) but also a relatively low Drain resistance, equivalent to the Triode's low Plate impedance.

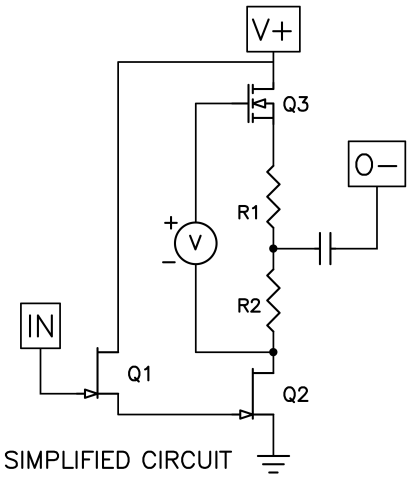
This allows for a single gain stage with both voltage and current gain, and having a high input impedance and low output impedance without a feedback loop or degeneration. It also allows “working the load-line”, which describes the path of the gain device through the region of voltage vs current in the course of amplifying the musical signal driving the loudspeaker. By altering the load line, you can lower the distortion or create a particular distortion character.



LOAD LINE EXAMPLE (IN RED)

In the original SIT-1 amplifier we put a knob on the front which gave users some control over the load-line setting. It revealed a common preference for a negative phase 2nd harmonic distortion character. We have settled on this sonic signature as a standard for SIT amplifiers. Also, these have a softer overload characteristic, with more “rounded” waveforms.

Do simple SIT amplifiers sound the same as single-ended Triodes (SETs)? Maybe not - it would be a matter of opinion. Without an output transformer with its significant limitations, the SIT has a bandwidth and distortion edge. I suppose if it glowed as well, it might be perfect ;)

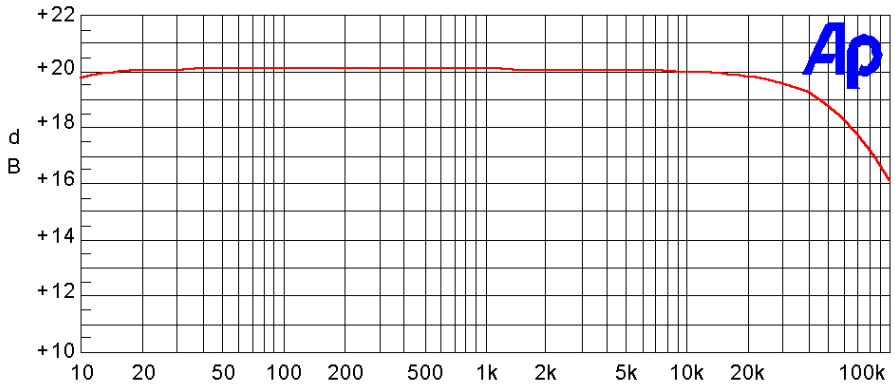


SIMPLIFIED CIRCUIT

Above is the simplified diagram of the circuit of the SIT-4. This is a single-ended Class A circuit using a SIT (Q2) in common-source mode without feedback. It is biased by a conventional Mosfet “mu follower” current source Q3 and is input buffered by Q1, the NOS Toshiba 2SK170, the finest of Jfets. It has an easily driven high input impedance.

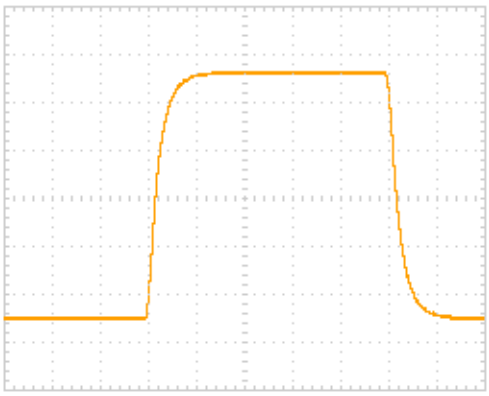
It has plenty of gain, and handles 4 ohm loads – my test speakers are SR-1's at 3.8 ohms with 86 dB/watt sensitivity, and the SIT-4 drives them surprisingly loud, although it was designed around Altecs, Klipsch, JBL, Lowthers, and other high efficiency speakers.

Here are some performance graphics. Keep in mind that they are achieved in a single-stage without negative feedback. Here is the frequency response curve, showing bandwidth to -3 dB at 80 Khz.

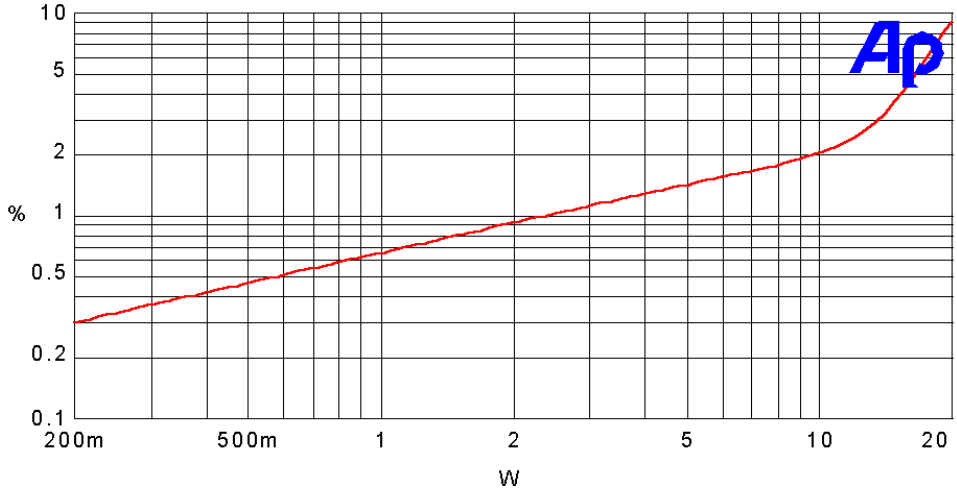


SIT 4 FREQUENCY RESPONSE

The square wave at 10 Khz at 1 watt, 8 ohms

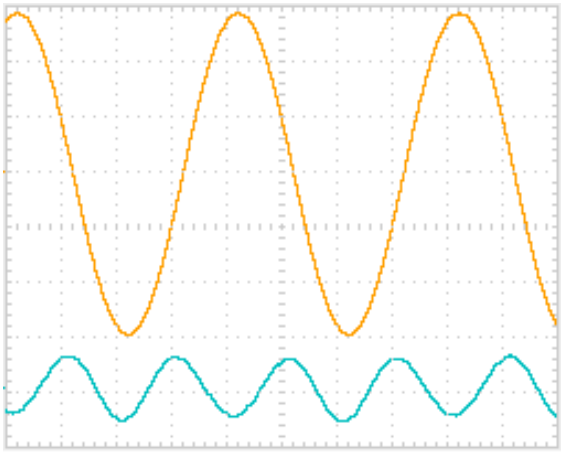


The distortion/power curve shows the 2nd harmonic dominance up to 10 watts:



SIT 4 THD @ 8 OHMS

Distortion waveform (blue trace) @1Watt, showing the negative phase 2nd harmonic.



I always keep in mind that the graphics and numbers only hint at the sonic performance.

It's always interesting to compare the test data to the listening experience. Sometimes the two line up well for good or bad, but sometimes an amplifier that tests well still leaves critical listeners disappointed. Sometimes the reverse is true.

Objective tests don't necessarily tell the whole story, but they are at least reliably repeatable.

Human perception is perhaps not the most reliable, but humans are the customer.

When developing product I rely on whatever information I can get, having developed some sense of the relationship between measurements and listening over the last 50 years.

Still, developing audio product is a lengthy task if you do it right.

The process is simple: Think, Build, Measure, Listen. Then repeat.

For the SIT-4 this process began in 2018, and the design is now finished as we enter 2024.

This amplifier is generally aimed at those audiophiles who appreciate the detail, warmth, depth and imaging. It is not necessarily for everyone, although I believe it will be generally appreciated for its special subjective qualities.

I hope you like it. And Happy New Year.

- Nelson Pass 1/1/24

Now the following is for your protection:

Do not defeat the AC line Earth ground connection on the amplifier power cord. It provides an extra barrier to prevent potential shock hazard. Do not replace the fuse with a type other than specified.

Do not operate the amplifier outside in the weather, or in and around water or anything resembling water. If you spill a drink in the amplifier or if your dog/cat/child urinates on it, turn it off immediately, unplug it, and do not operate it until cleaned by a qualified technician.

If something gets loose or rattles around inside or smells funny, or if you can’t touch the heat sinks for 5 seconds or so, then turn it off, unplug it from the wall, and contact First Watt.

There are no user serviceable parts inside. Do not open the amplifier, and if you do anyway, don’t operate it with the cover off. There are hazardous voltages inside. If you need to change the operating AC voltage, contact First Watt. We are much happier helping you solve problems so that we can be certain that it’s done properly. If you are far away and don’t want to ship the product for repair, we will assist your technician with information and parts.

Summary of the nominal specifications:

Measured at 120 V AC and an 8 ohm load:

Distortion @ 1 watt	0.6%
Input Impedance	100 Kohm
Gain	20 dB
Output Impedance	4 ohms
Output power	10 watts @ 2% THD, 8 ohms
Frequency response	4 Hz to 80 Khz (-3 dB)
Noise	75 uV unweighted, 20-20 KHz
Power consumption	200 watts
Fuse	3AG slow blow type - 2.5 Amp for 120VAC 1.25 Amp for 240 VAC
Weight	32 lbs
Dimensions	17” W x 15” D x 5” H

Warranty: Parts and labor for 3 years, not covering shipping costs or consequential damages. Warranty work is provided by authorized distributors outside of the U.S. And by First Watt within the U.S. Amplifiers under warranty outside of the U.S. not purchased from an authorized distributor can be serviced in the U.S. by First Watt at the cost of freight and customs charges.

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